Improving baseline forecasts in a 500-industry dynamic CGE model of the USA

by

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Abstract

MONASH-style CGE models have been used to generate baseline forecasts illustrating how an economy is likely to evolve through time. One application of such forecasts is to examine how exogenous shocks (such as a proposed policy) cause changes away from the forecast path. Since the future state of the economy can be critical to the impact of such shocks, an accurate forecast is likely to enhance the reliability of policy analysis.

This thesis examines methods for improving baseline industry/commodity projections by conducting forecasting-performance validation of a 500-industry MONASH-style recursive-dynamic CGE model of the U.S., known as USAGE. USAGE generates baseline forecasts by incorporating expert projections for certain macro and energy variables and extrapolating historical trends in tastes and technology. A previously-produced USAGE forecast for 1998 to 2005 of commodity outputs using information available up to 1998 is explored. When compared to actual outcomes, USAGE comfortably outperformed a non-model extrapolation-based trend forecast. However, there were numerous large errors prompting the question of whether USAGE should have performed even better. This thesis seeks to answer this question and closely examines the twenty largest USAGE errors.

The thesis extends forecasting-performance model-validation methodology. It shows how CGE forecasting techniques can be improved by: obtaining expert industry-specific projections; carefully assessing on a case-by-case basis whether it is reasonable to project forward changes in preferences and technologies; and, changing the model's implementation to better reflect historically observed policy behaviour.

It is found that in instances where important trends either dissipate or reverse, large forecast errors can arise. For some commodities, had all publicly available information in 1998 been appropriately utilised, some trends should not have been expected to continue and hence a better forecast could have been generated. Furthermore, the nature of some forecast errors suggests that projecting forward large values for preference variables relating to import penetration might best be avoided. In some instances, changes to regulatory regimes that were put in place by 1998 suggested that affected industries had highly constrained growth prospects. These regulatory changes should be taken into account in forecasting exercises.

For commodities in the trade-exposed textile, clothing and footwear (TCF) industries, moderately better results could have been produced by implementing import-price forecasts in a way that is

more aligned with outcomes that are consistent with the historical operation of U.S. trade policy. Moreover, the key drivers behind USAGE errors in the TCF industries were usually the significant underestimation of the impact of domestic-import preference twists, as well as the overestimation of factor-input cost savings.

Upon implementation of improved methodology, vast improvements in forecast accuracy for some industries were obtained. However, the average forecast error across industries did not greatly improve due to the sheer volume of commodities. While it is disappointing that the average error is not very reducible, it is also reassuring because it implies that the default implementation of the model is quite powerful. A large reduction in the forecast error—and hence improvement in model performance—would probably necessitate the input of numerous industry specialists.

Statement of Authorship

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Peter George Mavromatis Date

Acknowledgements

As a staff candidate for a PhD, in the eyes of the university I am officially unsupervised. In practice, however, nothing could be further from the truth. Indeed, this thesis would not have been possible without the key input and support of Sir John Monash Distinguished Professor, Peter B. Dixon. Professor Dixon spent seemingly countless Saturdays ensuring that I understood the many intricacies of the USAGE model and has provided ongoing encouragement throughout my time at the Centre of Policy Studies.

I also express my gratitude to Professor Maureen Rimmer for the time she spent assisting me with re-implementing the model; and to Dr Marnie Griffith for her assistance in relation to some of the industry research. In addition, I would like to thank Dr Michael Jerie for his efforts in answering my many questions about the GEMPACK software package.

I wish to express deep gratitude to my wife, Priscilla. Much of this thesis was written during the course of many weekends. This meant that Priscilla was ladened with many additional responsibilities, not least, regularly carrying the flag at various family events and explaining my absence—a task that can be quite painstaking at times.

Finally, I would like to thank my Mother, Godmother and late Father, for their unending love and support. Without their guidance and direction throughout the past four decades, it is unlikely I would have had the opportunities afforded to me.

1.0 Introduction & Summary of Findings

The practical focus of CGE models has been a key driver in shaping their development. In particular, CGE models have provided a useful tool for analysing the impact of policy proposals and other economic shocks. The models are comprehensive such that the associated analysis of the results is derived wholly from the theory of the model (or a small-scale version of the model).

MONASH-style models, which are the focus of this thesis, have also been used to generate baseline forecasts illustrating how an economy is likely to evolve through time. One application of such forecasts is to examine how exogenous shocks (such as through a proposed policy) cause changes away from the forecast path. The results are usually presented as percentage deviations away from the baseline (e.g., employment in the coal industry is 5% higher/lower than projected).

Where industries are forecast to become larger over time, the impact of policy to the economy can become of increased significance—more so than had a *status quo* forecast been assumed. In other cases, where industries are in decline, assessing policy impacts against the backdrop of a baseline forecast contraction prevents overstating the likely economic effects of the change.

The importance of generating accurate economic projections provides motivation to perform a specific form of model validation that relates directly to forecasting-performance. Undertaking this kind of validation is significant because, *inter alia*:

1. an accurate forecast is likely to enhance the reliability of policy analysis; and
2. baseline forecasts can be compared to outcomes with a view to gaining an understanding of the discrepancies such that the model can be improved (both its theory and implementation).

MONASH-style forecasts utilise specialist macro and sectoral projections (such as those by experts and government agencies) and incorporate trends in naturally exogenous variables such as consumer preferences, technologies and international trade conditions. The strength of such trends is estimated by a specific type of CGE simulation that is known as an "historical" simulation. The historical simulation is conducted in relation to a preceding time period, with the specific results projected forward to form part of the forecast simulation.

This thesis conducts forecasting-performance validation of a 500-industry/commodity MONASH-style CGE model of the U.S., known as USAGE. The validation of USAGE is an extension of Dixon and Rimmer (2010a and 2012), which describe a broad range of model validation techniques; but most relevant here, is their examination of a detailed forecast for 1998 to 2005 of commodity outputs (see also Dixon and Rimmer, 2010b). The forecast was made using information available up to 1998 and included extrapolated trends from an historical simulation for 1992 to 1998.

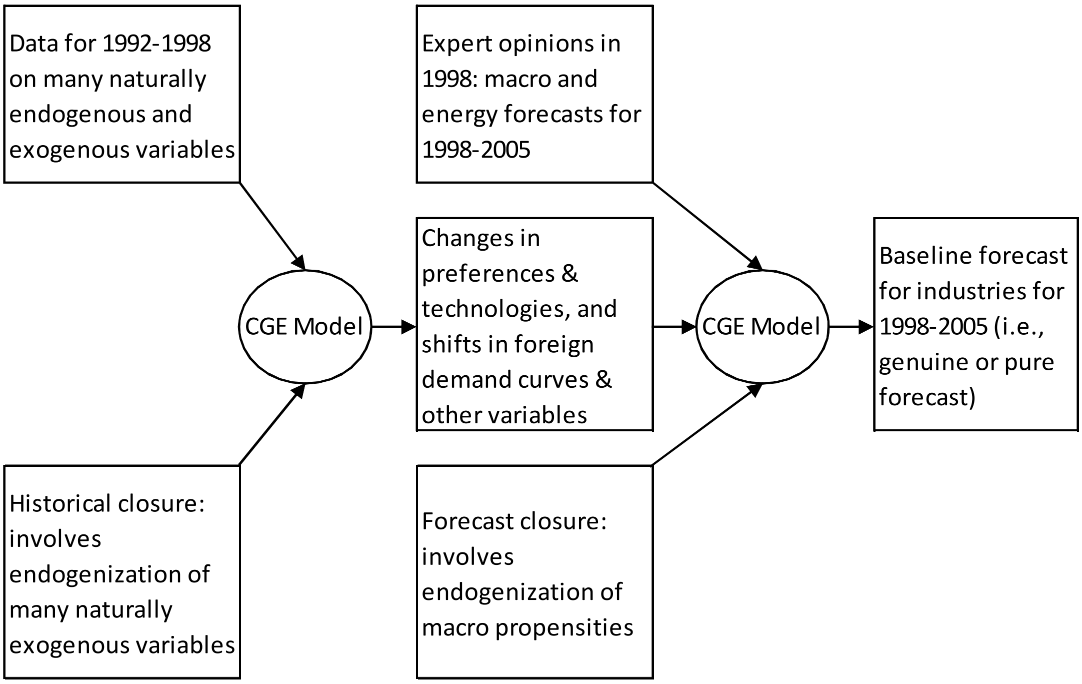

Figure i: Relationship between historical and forecast simulations

Figure i is an adaptation of an illustration from Dixon and Rimmer (2010b). It provides an overview of the approach taken by Dixon and Rimmer (2010b and 2012) to generate the 1998 to 2005 forecast. The authors begin by compiling historical data for the U.S. economy for 1992 and 1998. This includes input-output data for 1992 as well as other data from a variety of statistical agencies. The data includes observations on many naturally endogenous and naturally exogenous variables such as employment and tax rates, respectively. These data are able to be fed into the model (USAGE) by adopting a special type of closure (i.e., choice between endogenous and exogenous variables) known as an 'historical closure', which will be explained in detail in Chapters 1.3.1 and 1.3.2. The model is then calibrated at 1992 and subsequently has shocks applied to it that generate a new input-output database and other data for 1998.

When implemented in this form—known as an historical simulation—the model generates estimates for changes in macro propensities from 1992 to 1998, as well as estimates for changes in technologies, tastes, shifts in foreign demand curves and other variables for the same period.

The CGE model employed by Dixon and Rimmer (2010b and 2012) is highly detailed and in some instances is used to generate data estimates at the disaggregated industry level when only broader sectoral data are available. These estimates of actual outcomes are model-consistent and assumed to be correct unless there is external evidence to the contrary.

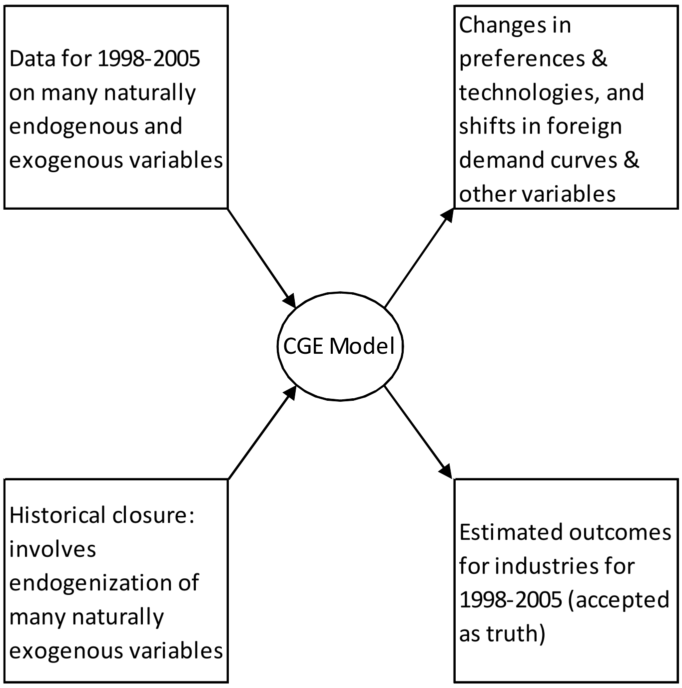

Figure ii: Generation of actual outcomes for comparison with baseline forecast simulations

At the conclusion of the historical simulation for 1992 to 1998, much of the groundwork has been laid for the 1998 to 2005 forecast simulation. A picture of 1998 incorporating all known movements in variables from 1992 has been created. Now, a new closure is adopted, the forecast closure, and applied in a simulation starting from the 1998 database. The forecast closure will be explained in detail in Chapters 1.3.3 and 1.3.4. It includes endogenizing macro propensities and exogenizing naturally endogenous macro variables for which expert opinions exist in 1998 on the outlook for these variables for 1998 to 2005. The same is true for expert energy projections, as well as for naturally exogenous variables (e.g., factoring in a reduction in tariff equivalents). The expert projections are implemented by applying shocks to the relevant variables in the model. Forecasts for technologies, tastes, and shifts in foreign demand curves, etc., are arrived at by projecting forward their growth rates as computed by the historical simulation for 1992 to 1998. With the model implemented under the forecast closure, Dixon and Rimmer (2010b and 2012) are able to simulate a detailed baseline forecast for industries for 1998 to 2005. This baseline forecast can thought of as a genuine or pure forecast as it does not include any actual outcomes or 'truths' for 1998 to 2005.

Having generated genuine forecasts for 1998 to 2005 according to the method illustrated in Figure i, Dixon and Rimmer (2010b and 2012) compared these forecasts with actual outcomes. In this way, they tested the validity of their forecasting method.

As a prior step, they first had to estimate the 1998 to 2005 outcomes at the required level of detail (500 industries). Figure ii depicts the process for generating the actual outcomes. Observations for the U.S. economy for 1998 and 2005 are introduced to the model using an historical closure. As well as revealing 'true' movements in preferences, technologies and world trading conditions for the period, the model generates estimated outcomes for industries—these outputs are accepted as 'truth'. According to Dixon and Rimmer (2012, p. 60):

> "Having made the genuine output forecast for 1998 to 2005, we then performed a series of forecast simulations in which we successively introduced the 'truth' for the movements in different groups of exogenous variables. The aim was to assess the importance of different exogenous factors in determining the accuracy of forecasts for outputs by commodity."

As might be expected, the forecast errors are reduced as the true 1998 to 2005 movements in the exogenous variables are successively introduced. The exogenous variables include: macro and energy; trade variables; technology and preference variables; required rates of return on capital; and the commodity composition of public expenditure. Dixon and Rimmer (2010b and 2012) go on to compare and contrast which sets of variables provide the greatest contributions to forecast accuracy. The authors find that the introduction of accurate trade forecasts, along with technology and preference variables, make the strongest contributions to forecasting-performance.

Dixon and Rimmer (2012, p. 64) suggest that the strong contribution from the trade variables is somewhat surprising because most commodities have relatively small import shares in the U.S. market and export shares in output. However, the authors conclude that improving trade projections are likely to provide larger payoffs in terms of forecasting accuracy because:

1. trade forecasting has relative less resources devoted to it than compared to, say, macro and energy forecasting where there is a dearth of dedicated government and private agencies conducting research (pp. 64-5); and
2. it would seem especially difficult to improve projections for technology and preference variables beyond the historical extrapolations provided by the model (p. 65).

Dixon and Rimmer (2010b and 2012) also consider how the model's forecasts either beat or get beaten by trend forecasts. In particular, the success of the 1998 to 2005 forecast was evaluated relative to a non-model extrapolation-based trend forecast. This was done by calculating the average error (AE) of the forecast and a coefficient (*M*) that gives the ratio of average errors between the CGE forecast and the non-model extrapolation-based forecast (Dixon and Rimmer, 2012, pp. 60-1). *It was found that the CGE model comfortably outperformed its counterpart—however, there were numerous large errors giving rise to the question of whether the CGE model should have performed even better.* This thesis seeks to answer this question and it is in this regard that the twenty largest USAGE errors are closely examined. This thesis extends the *forecasting-performance* form of model-validation used by Dixon and Rimmer (2010b and 2012) by focusing on:

1. expert opinions in 1998—obtaining industry-specific projections, rather than limiting this to macro and energy projections;
2. changes in preferences and technologies, and shifts in foreign demand curves and other variables—carefully assessing on a case-by-case basis whether it is reasonable to project these forward; and
3. the structure of the forecast closure—changing the model's implementation to better reflect historically observed policy behaviour.

In terms of Figure i, this thesis is about making changes to the inputs to the baseline forecast simulation with the aim of reducing the forecast errors. Focusing on the sources of the largest errors, it is found that:

1. For some commodities, had all publicly available information by 1998 been appropriately utilised, certain taste and technology trends that had a strong impact on output between 1992 and 1998 should not have been reasonably expected to continue. Commodities where output forecasts were detrimentally influenced by changing trends (that either dissipated or reversed) are: Dolls & Stuffed Toys; Theatres (mainly production and distribution of motion pictures); Electron Tubes; and Magnetic & Optical Recording Media (mainly blank tapes and videos, excluding rentals). If important publicly available information had been embodied into the forecast by nullifying the projection of important historical trends, significantly smaller errors could have resulted. Furthermore, the nature of some forecast errors suggests that there is a case to be argued against projecting forward large values for variables relating to the impact on domestic market share of changes to preferences in commodity usage (by households, producers, and creators of industrial capital) based on the source of that commodity (imported versus domestically-produced). In other words, where domestic-import preference changes have historically caused significant damage (or

alternatively, boosted) the market share of domestic producers, this ought not to be projected forward unless there is overwhelming evidence to suggest otherwise.

2. In some instances, changes to regulatory regimes that were put in place by 1998 suggested that affected industries had highly constrained growth prospects. No attempt is made to reflect such changes in the default implementation of the model. As a result, commodity output forecasts for Asbestos Products and Commercial Fishing were detrimentally influenced. Had important publicly available information been appropriately accounted for, a better forecast could have been generated by incorporating the likely effects of what were clearly restrictive regulations. Dixon and Rimmer (2012, pp. 67-8) describe the nature of the forecast error for Asbestos Products. The authors explain how health and safety regulations by 1998 suggested poor growth prospects and that the strong Asbestos Products-using technical change identified in the period from 1992 to 1998 ought not to have been extrapolated into the forecast for 1998 to 2005. In the case of Commercial Fishing, following an output contraction in the period from 1992 to 1998, tighter environmental constraints by 1998 implied that output was unlikely to expand. The remedy adopted here is to enforce a zero-growth forecast for this commodity.

3. For commodities in the trade-exposed textile, clothing and footwear (TCF) industries moderately better results could have been produced by incorporating two changes to the forecast:

    a. The first of these changes relates to implementing import-price forecasts in a way that is more aligned with outcomes that are consistent with the historical operation of U.S. trade policy. The Uruguay Round of multilateral trade negotiations (MTN) was implemented over the period from 1995 to 2000 for developed countries. As part of this the U.S. lowered tariffs and commenced the phase-out of quotas but reserved the right to impose safeguards once the phase-out was complete. In addition, the U.S. refused to agree to accelerated quota growth and tariff reductions. Consistent with this stance, by 1998, U.S. policy-makers had traditionally behaved in a way that allowed TCF import prices to fall at a rate that delicately balanced the interests of domestic TCF producers and U.S. households.

       Under the default application of the model, there is no attempt to embody this “balanced” approach to TCF-related trade policy. Instead, the standard implementation of the forecast for 1998 to 2005 merely projects forward the historical growth in the foreign-currency price of imports—even though what appears to have been the force behind an important growth factor for this variable was no longer present during the forecast period.

An important outcome of the 1998 to 2005 forecast for the TCF sector was that ratios of landed-duty-paid import prices to basic prices of domestic commodities were systematically overestimated. This had the effect of understating the competitiveness of imported TCF commodities and, hence, overstating domestic output growth. The overestimation of import-domestic relative-price movements resulted from a confluence of events in the period from 1992 to 1998, which allowed for rapid growth in a particular determinant of landed-duty-paid import prices, namely foreign-currency prices. In essence, an appreciation of the nominal exchange rate and a reduction in tariffs—a combination that alone would weigh heavily on landed-duty-paid import prices—effectively induced strong growth in the foreign-currency prices of TCF imports. In the absence of these foreign-currency price rises, it is doubtful that U.S. policy-makers would have stomached the extent of the (likely) negative impact on domestic TCF producers (though households would have been thrilled). Had such a situation unfolded, restrictive trade policies may have been implemented (or threatened) such as a suspension of tariff reductions, more widespread use of quotas and the launching of anti-dumping actions.

In light of the potential for this kind of policy response, exporters of TCF commodities to the U.S.—keen to avoid higher barriers to an important destination—prevent their product prices from plummeting on the U.S. market. They do this by adjusting their foreign-currency prices to take into account movements in the foreign exchange rate and in import duties. For example, consider the behaviour of import prices for the Apparel industry. Between 1992 and 1998, the power of the tariff on apparel (i.e., 1 + tariff rate) declined by 9%. Foreign producers of Apparel were also favoured by an appreciation in the foreign exchange rate of more than 13%. These two factors alone would have delivered a substantial competitive advantage to the foreigners. Had the foreigners taken full advantage of their increased competiveness, this would likely have incurred a response by U.S. policy makers in the form of higher import barriers to protect domestic producers. To avert such a situation from arising, foreign producers increased their prices, i.e., the foreign-currency price of the commodity was adjusted higher. In the case of Apparel, the foreign-currency price ultimately rose by 15% from 1992 to 1998. The increase in the foreign-currency price, combined with the effects of the tariff reduction and the currency appreciation, culminated in an 8% reduction in the basic price of imported Apparel on the domestic market; and the change in domestic-import relative prices resulted in a more palatable competitive outcome for domestic producers and policy makers.

A practical way to capture the outcome of this phenomenon in the model (thereby avoiding unrealistic forecasts in foreign-currency price movements for TCF commodities) while simultaneously placating households, is to project forward movements in real import prices, or more specifically, the CPI-deflated landed-duty-paid prices of TCF imports. Indeed, that is the approach employed in this thesis and which, by and large, produced an improved forecast (rather than to project forward foreign-currency import prices, which takes no account of important policy considerations). *Version 1* of the improved 1998 to 2005 forecast takes into account the nature of the errors discussed in points 1, 2 and 3a.

It should be noted that there are competing hypotheses that purport to explain the movement in foreign-currency import prices. For example, one could argue that quotas, while being phased out, were still prevalent enough during 1992 to 1998 for foreigners to try to keep their prices high and maximise profit margins. However, weighed against this argument is that import volumes rose sharply over the same period allowing foreigners to capture, for example, a circa 50% share of the U.S. Apparel market by 1998. Also, as quotas are removed, it is reasonable to expect that higher import volumes might be characterised by lower quality and lower margin imported products. But, if such an effect occurred, it wasn't evident in the data, which showed that there were taste and technology changes in favour of imported Apparel from 1992 to 1998; and that these changes intensified in the period from 1998 to 2005.

b. The second change to the implementation of the forecast relates to primary-factor productivity growth, which is an important determinant of basic prices of domestic commodities. From 1992 to 1998, there was strong productivity growth in the TCF sector. Part of this growth emanated from a surge in mergers and acquisitions that often resulted in the closure of low-productivity plants. Additional plant closures occurred as manufacturers shifted operations abroad to lower-cost regions. In the 1998 to 2005 forecast, the impact on output through cost effects of rising primary-factor productivity growth was projected forward. This greatly enhanced the competitiveness of domestically-produced TCF commodities by muting growth in their basic prices. Yet by 1998 it seemed clear that for the TCF sector this ought not to be baked in to the forecast as the bulk of the productivity gains, or low hanging fruit, had already been obtained. Hence, in this thesis, a cessation of primary-factor productivity growth in TCF industries is assumed for *version 2* of the improved forecast 1998 to 2005, in addition to accounting for the nature of the errors discussed in points 1, 2 and 3a.

4. Forecasts for cyclical commodities in the oil, mining and mining-services sectors typically could not have been improved in the absence of strong convictions by 1998 about an impending energy and resources “super-cycle” or extended boom.

5. Forecast errors that arose for construction-related commodities may have been unavoidable. Errors of this nature emerged due to the gross underestimation of demand for these commodities. This is because activity was fuelled by virtually unprecedented low borrowing costs. In these instances, it is difficult to conclusively argue that the modeller could have produced a better forecast.

The general finding of this thesis is that although vast improvements in forecast accuracy could be obtained for some industries and sectors, the average forecast error across industries does not fall greatly due to the sheer volume of commodities. While it is disappointing that the average error is not very reducible, it is also reassuring because it implies that the default implementation of the model is quite powerful. In all, about 4% of commodities were specifically examined to assess the potential for error reduction. After extending the improved method of the model’s implementation to all TCF commodities, about 7.4% of commodities were in some way directly re-projected. To generate a large reduction in the forecast error would require an extensive amount of work and probably call for the input of numerous industry specialists.

The rest of this thesis is organised as follows:

Chapter 1.1 describes the history of the Johansen school of CGE modelling, from Johansen through to ORANI (the first of the MONASH-style models) and to the later generations of MONASH models (such as USAGE—the model being examined here).

Chapter 1.2 provides technical explanations in relation to model closures, or the choice of exogenous variables. MONASH-style models are unique in the way that closures are handled. In order to conduct forecasting-performance validation of the USAGE model, it is necessary to understand how 'historical' and 'forecast' closures are developed.

Chapter 1.3 describes how simulations are conducted through the development of historical and forecast closures from an initial standard long-run closure. This chapter takes the reader through various equations in USAGE, highlighting theoretical concepts that are especially relevant to the validation exercise. It is not intended to be a low-level overview of the entire model. Rather, it provides the reader with detailed examples of how closure changes (i.e., changes made by swapping the exogenous status of particular variables throughout different equations) enable the model to accept extraneous data and estimate values for variables that are unexplained in the standard long-run closure, such as naturally exogenous (and unobservable) technology and preference variables. The estimates for these variables can then be used in a forecast simulation and are often important in shaping the results.

Chapter 2.0 summarises the origin of the twenty largest errors for the 1998 to 2005 USAGE forecast conducted under standard implementation techniques, as per Dixon and Rimmer (2012). The errors are split into two categories—absolute size and size relative to the error in the trend forecast. This chapter also defines how the errors are calculated and how forecasting-performance is measured.

Chapter 2.1 summarises the results of the same USAGE forecast that was implemented using an improved method that followed from validation of the model's performance.

Chapter 2.2 provides a detailed examination of the twenty largest forecast errors. For commodities where the USAGE forecast could have been better, the chapter contains: explanations of why the model gave erroneous prospects to the commodity; an analysis of industry conditions as they were known by 1998; an explanation of why the original forecast ought to have been rejected; and a strategy to improve the forecast.

Chapter 2.3 provides explanations as to why the forecast results of some commodities with large errors could not have been enhanced. It also describes why the USAGE model gave erroneous prospects to these commodities and analyses industry conditions as they were known by 1998.

Chapter 3.0 contains a brief summary and concluding remarks. There is a reiteration of the importance of forecasting-performance validation and of the improved techniques for implementing baseline forecasts in USAGE that arose from this exercise.

1.1 From Johansen to MONASH

MONASH-style computable general equilibrium (CGE) models began in the mid-1970s with the development of ORANI (Dixon *et al* 1977 and 1982)—a detailed, comparative-static model of the Australian economy. The intention of ORANI was to provide policy makers with a quantitative tool to analyse the economy-wide impact on employment of changes in protection. MONASH-style CGE models are highly adaptable and have provided insights on a wide range of economic questions including but not restricted to policy- and market-induced structural change across: individual industries, broader sectors and regions, and the overall economy.

For instance, motor vehicle tariff reductions are an example of policy-induced structural change on an industry, while changes in the international terms of trade, such as through a commodity price boom, exemplify market-induced structural change that directly impacts the resources sector, and indirectly affects the broader economy in various important ways as a result of numerous flow-on effects.

The first version of ORANI was operational in 1977 and was directly descended from path-breaking work of Norwegian economist Leif Johansen (Dixon and Rimmer, 2010a). In 1960, Johansen's book titled: "A Multisectoral Study of Economic Growth", provided details of the first CGE model. It departed from previous economy-wide models (e.g., Leontief's input-output system) by providing clear descriptions of the behaviour of individual agents, such as utility-maximisation by households and cost-minimisation by producers.

In addition, Johansen differentiated between basic or sellers' prices (that motivate production decisions) and purchasers' prices (that motivate consumption decisions). The gap between these price types was modelled as a trade-services commodity, which was a combination of transport, wholesale and retail margins. This and other aspects of the book, including the treatment of investment and employment and its wide ranging use of statistical data, made Johansen's model highly practical.

According to Dixon and Rimmer (2010a), among the defining features of Johansen-style CGE modelling are that the model is presented as a rectangular system of linear equations in change and percentage-change variables and solved by matrix inversion. Furthermore, the linear representation and the linear solution method help to: clarify properties of the model; to elucidate real world issues; and to check the validity of the model.

Since CGE models can produce an overwhelming number of results, Johansen built a small-scale back-of-the-envelope (BOTE) model to help organise, understand and explain the results. These same concepts were employed and subsequently extended in the development and presentation of ORANI. The linear percentage change format used by Johansen allowed for complex functional forms to be implemented in models. This produced equations that were more readily interpretable (i.e., intuitive), and easier to calibrate from a technical perspective than their levels representation.

A criticism of Johansen-style CGE models was his method of one-step linear solutions.[1] These were merely approximations of a non-linear model where the theory was being represented by a system of linear equations. Where large changes were involved, the Johansen solution method resulted in material linearization errors. The subsequent use of multi-step solution methods provided accurate solutions to these models.[2]

In addition to this, as the dimensions of ORANI were far greater than Johansen's model, a computationally efficient form of the model was achieved by a process of condensation. This is where large dimensional, non-key, endogenous variables are substituted out of the computational form of the model (Dixon *et al* 1992). Since results for eliminated variables can be recovered by backsolving using the eliminated equations this ensures there is no loss of information.

The evolution of ORANI resulted in MONASH—a recursive-dynamic model of the Australian economy. This model incorporates time-period specific relationships between investment and the accumulation of capital. The MONASH model was used as a template to construct the most detailed CGE model in the world—USAGE. USAGE stands for "U.S. Applied General Equilibrium" and is a policy-oriented model of the U.S. economy. In this regard, MONASH-style models are often employed to analyse current policy proposals. In doing so, the model can produce forecasts illustrating a base case scenario of how the economy is likely to develop. The anticipated impact of the proposed policy is then presented in relation to the baseline forecast in the form of deviations away from baseline forecasts, e.g., post-policy implementation, employment in industry j is 2% lower than was forecast pre-policy.

USAGE, which is the model used in this thesis, has been used in numerous studies including:

- the effects of trade barriers and their removal—Fox, Powers and Winston (2008), and United States International Trade Commission (2004, 2007, 2009 and 2011);
- the impact of immigration—Zahniser *et al* (2012a) and (2012b);

1 Dixon and Rimmer (2010a, p. 34) notes that this was the main objection in North America.

2 Dixon and Rimmer (2010a, pp. 19-22) provides details on how to compute solutions without linearization errors in the Johansen framework.

- the analysis of productivity shocks— Giesecke (2011);
- the economic effects of environmental policy—Osborne (2009), Gehlhar *et al* (2010), and Anspacher *et al* (2011);
- the impacts of terrorism and catastrophic events—Giesecke *et al* (2012); and
- the effects of flu epidemics—Dixon *et al* (2010).

1.2 Types of Closures

MONASH was highly innovative with regard to its use of closures (list of exogenous variables). As a general rule in CGE models there are more variables (v) than there are equations (e). Hence to "close" the model v – e variables must be set exogenously or independently determined. Variables include prices and quantities for a given year, while the equations impose the standard conditions found in CGE models such as: demands equal supplies; prices equal unit costs, etc. According to Dixon and Rimmer (2002, p. 1):

> "With different closures MONASH produces: estimates of changes in technologies and consumer preferences (historical closure); explanations of historical developments ... (decomposition closure); forecasts for industries, regions, occupations and households (forecast closure); and projections of the deviations from forecast paths that would be caused by the implementation of proposed policies and by other shocks to the economic environment (policy closure)."

Dixon and Rimmer (2002) describe four basic types of closures, i.e., choices of v – e exogenous variables: decomposition, historical, forecast and policy. The decomposition and historical closures refer to the past:

> **Decomposition closure —** This is the standard long-run closure, where variables that are not normally explained in a CGE model (i.e., are naturally exogenous) are declared exogenous, and naturally endogenous variables are endogenous. Exogenous variables are either observable (such as tax rates and certain macro and industry variables) or unobservable (such as technology and preference variables). A decomposition simulation essentially explains economic history by identifying the key drivers behind the actual outcomes, e.g., how significant was a change in technology relative to a change in government policy in explaining why a commodity's output moved strongly in a particular way.

> **Historical closure —** This exogenizes everything known about the past and introduces these observations into the model in the form of shocks. In this closure, exogenous variables are either observable or assignable. For an assignable variable, its movement can be assigned a value without contradicting any observations or assumptions made about the historical period. Since all exogenous variables in a decomposition simulation take the same values they had (either endogenously or exogenously) in the

corresponding historical simulation, the solutions from both simulations are identical. In light of these identical solutions under the historical and decomposition closures, the reader may be wondering why both types of simulations are undertaken. In short, the simulations have quite different objectives. The historical closure is such that historical simulations cannot compute the effects of anything naturally endogenous. This is because such variables are exogenous in the historical closure, where the primary goal is to obtain values for taste and technology variables.

Another application of historical simulations is to provide updated input-out databases taking into account statistics released subsequent to the last published table. For example, if the latest USAGE database is for, say, 1992 and this corresponds with the latest published input-output data, the modeller could update the USAGE database to some future period (say 1998) by shocking the 1992 database with observed movements between 1992 and 1998 in both naturally exogenous and naturally endogenous variables. The updated database could then be used in generating a baseline forecast from say, 1998 to 2005.

The forecast and policy closures relate to the future:

Forecast closure — This exogenizes everything believed to be known about the future, including numerous naturally endogenous variables. The purpose of this is to take advantage of projections by specialist organisations, e.g., volumes and prices for oil as forecast by the Energy Information Administration (EIA); and most macro variables, such as real GDP, exchange rates, etc. In order to exogenize these naturally endogenous variables, some naturally exogenous variables must be endogenized, such as macro coefficients (e.g., the average propensity to consume), and the positions of both foreign demand curves and domestic export supply curves. However, since less is known about the future than the past most technology and taste variables remain exogenous. In USAGE, the values for these coefficients under forecast simulations are usually linked to their estimated values from historical simulations. Forecast simulations, *inter alia*, can be used to predict industry and commodity outputs as well as their compositions.

Policy closure — This is a conventional closure (such as decomposition) where the values for naturally exogenous variables, such as such as macro coefficients and the positions of both foreign demand curves and domestic export supply curves, are obtained from the values generated in the forecast simulation. Policy simulations are aimed at identifying differences from forecast in micro and macro variables, and as a result not all of the exogenous variables have the values they had in the associated forecast simulation. The impact of policy changes, which are concerned with the movement in *any* naturally exogenous variable (not just government-related variables such as taxes, etc), are reflected in "shocks" or alterations to the so-called policy variable(s) of interest. Where USAGE is implemented under dynamic protocols, policy changes are made with a view to identifying deviations from explicit forecast paths for the relevant micro and macro variables.

This thesis is mainly about the historical and forecast closures. The importance of the decomposition closure is that it gives a starting point for the derivation of the historical closure. Indeed, this is its only role in this thesis. The policy closure has no role in this thesis. It is mentioned here for completeness and to help understand why we do forecasts, which is to assist with conducting policy simulations—because the future state of the economy can be critical to these results.

1.3 Closure Development for Simulations

The initial solution in a CGE model is derived mainly from input-output data for a particular year. In simulations, the model computes movements in the e endogenous variables away from their values in the initial solution. These movements arise from perturbations of the v – e exogenous variables from their values in the initial solution. There are numerous ways of choosing the v – e variables. In recursive-dynamic models such as MONASH and USAGE, these movements are typically computed from one year to the next, such that the year t+1 solution becomes the initial solution for a computation that creates a solution for year t+2, and so forth. However, these movements in exogenous variables need not necessarily be constrained to one year and may refer to changes over several years (such as 1992-1998 or 1998-2005, etc.) as is the case for long run simulations. In the context of this thesis, we develop a closure that is appropriate for long run analysis.

1.3.1 The Historical Simulation Closure

This thesis is concerned with the validation of results from a forecast simulation for the U.S. economy. Part of the methodology for conducting a forecast simulation calls for the model's database to be updated to reflect the latest available statistics. This is generated by a preceding historical simulation. As shall be discussed below, the historical closure is carefully developed by incrementally moving away from the standard long run (i.e., decomposition) closure through altering vectors of exogenous variables in the model (which is implemented using a proprietary software package called GEMPACK). The historical simulation is primarily aimed estimating technology variables. According to Dixon and Rimmer (2002, p. 240), technology variables "include growth rates in total-factor productivity and biases in technical change favouring the use of some inputs relative to others." Technology variables are not directly observable. The historical simulation deduced changes in these variables between two points in time, 1992 and 1998, as a result of movements in outputs, factor inputs and real wages over the same period. In other words, changes in technology variables are endogenously determined by exogenously set movements in employment, capital and real wage rates. To help to understand how this is so consider (1.3.1) the GDP identity in constant price terms; and (1.3.2) the economy-wide production function, which relates real GDP to inputs of labour and capital, and to a technology shift term (A):

$$GDP_{EXP} = C + I + G + X - M \tag{1.3.1}$$

$$GDP_{INC} = A * F(L,K) \tag{1.3.2}$$

1.3.1 The Historical Simulation Closure

In the USAGE historical simulation from 1992 to 1998, movements in C, I, G, X and M were set exogenously at their observed values. This meant that GDP, while formally endogenous, was effectively tied down. With movements in L and K also set exogenously using observed data for years 1992 and 1998, the model was able to compute the change in A. In the context of an historical simulation this effectively ensures that GDP from the income side will 'hit the target' as determined by GDP from the expenditure side. As will be seen below, conceptually similar calculations take place at the industry level to determine all-factor-augmenting technical change for the period in question. Armed with results for the technology variables, along with data reflecting changes in real wage rates, the historical simulation also endogenously computes movements in rates of return, which are implied by the factor-price frontier. The factor-price frontier relates the marginal product of labour to the marginal product of capital, of which the latter determines the rate of return. Exogenization of (observed) real wage rates means that the marginal product of labour is tied down in an historical simulation. As a result, rates of return on capital (i.e., rentals) must have the flexibility to adjust to the exogenous wage rate values.

The complexity associated with implementing an historical closure in practice typically requires the modeller to take a cautious, step-by-step approach. The initial step is to introduce the values for the naturally exogenous variables that prevailed in the standard long-run closure (i.e., the decomposition closure). This includes values representing growth rates for macro variables such as CPI inflation, household and population growth, world GDP, labour supply and employment hours. It also includes more disaggregated values for items such as import prices and real wage rate changes at the sectoral level. Hereon, the historical closure is typically developed by incrementally moving away from the decomposition closure. For instance, the next series of steps have the effect of cumulatively introducing values for naturally endogenous variables for which there are data. For the 1992 to 1998 USAGE historical simulation, exogenizing values for C, I, G, X and M were among the first steps in this process. In the software that runs the model (GEMPACK) this is implemented by using a "swap" statement to replace the vector of variables that are exogenous in the decomposition closure with a vector of variables containing the observed historical data. This usually involves swapping variables that are contained within the same equation, but can also entail swapping variables that appear in different equations. According to Dixon, Koopman and Rimmer (2012, p. 91):

> "Absorbing macro variables requires endogenization of naturally exogenous propensities. For example, to allow growth in household consumption to be set exogenously at its observed value requires endogenization of the average propensity to

> consume. Absorbing micro observations requires endogenization of corresponding naturally exogenous taste, technology and trade variables. For example, data on growth in consumption of tobacco products (a naturally endogenous variable) is absorbed by allowing the model to tell us endogenously that there was a change in consumer preferences (a naturally exogenous variable) against this product."

To elaborate further, if the modeller were to introduce information on the movements in sectoral import volumes (and hence aggregate imports) this could be achieved by endogenizing twists in domestic/import preferences by users. In other words, in the standard long-run closure the vector of imported commodities is endogenous and the vector of the preference variable is exogenous (as it is unexplained). Then, in moving to the historical closure, the observed values for imported commodities are declared exogenous and the preference variables become endogenously determined in line with the relationships expressed by the equations in the model. These domestic/import preferences reflect changes in domestic/import quantity ratios beyond those that can be explained by changes in domestic/import price ratios as well as growth in the market for the commodity in question. These kinds of preference twists in USAGE also apply to the use of factor inputs. Thus the capital-labour ratio might not purely reflect prevailing rental-wage rates and technologies, indicating a shift in preferences towards the use of one factor relative to another.

In progressing through the series of swaps that form the historical closure the key is to maintain a valid closure.[3] Indeed there is nothing to prevent a situation of the exogenous/endogenous status of a variable changing throughout the development of a closure. The ability to perform an historical simulation at the end of each step is some measure of success. However, it is not enough for the model to merely be executed without computer error before the moving to the next step. The modeller ought to review the simulation results at the end of each step and, if these are satisfactory, move on. Aside from reducing modelling complexities from a computer software standpoint (i.e., fewer changes usually translate to fewer possible sources of computer error), an advantage of adopting a process as careful as introducing just a few swaps at a time is the increased ease in interpreting the results. Hence, upon running a simulation in its entirety, it should be easier to identify the key drivers behind the movement in a variable of interest from the ability to quantify the impact of any particular step throughout the development of the historical closure.

It is typically the case that observed data does not cover every industry or only exists for the broader sector. Indeed, the number of "sectors" (i.e., aggregations of industry groups) may differ depending on the variable and the data provider. For instance, in USAGE there are more than 500

[3] Failure to maintain a valid closure will prevent the execution of the model.

industries/commodities but data observations for a particular variable are almost invariably limited to some aggregated form.[4] To take advantage of subsets of data in an historical simulation it is necessary to create special purpose equations. The role of such equations includes the facilitation of mapping the observed micro data to each industry. At this juncture, different approaches can be taken with regard to allocating the data throughout the model. One approach is to perform the necessary calculations outside of the model and input the results as exogenous shocks in an historical simulation. In this situation the modeller could impose the simplifying assumption that growth in the broader sectors applies uniformly to each component USAGE industry—without regard to other data that might otherwise distinguish between rates of growth. Correcting for inconsistencies between macro and micro data can be handled in a similar fashion via adopting across-the-board adjustments.[5] For example, detailed data on imports and exports may not coincide with macro trade data. This necessitates certain adjustments to the data to prevent the inconsistency from transmitting through the model. Dixon and Rimmer (2002, p. 201) describe a typical modelling response to this situation:

> "...if detailed data on export prices imply an increase of 5 per cent in the aggregate price index for exports, but the macro data indicate an increase of 7 per cent, then before using the detailed data in MONASH, we could make an across-the-board 2 percentage point upward adjustment."

A different approach to the allocation of sector-level data between USAGE industries is for the process to be model-determined. In executing this within-model approach, all other information within the simulation can be utilised, thereby helping to distinguish growth rates between constituent industries within sectors for a particular variable, e.g., imports. For instance, other data within the model, such as relative prices and Armington[6] (import-domestic substitution) elasticities, might suggest that some industries within a particular sector were likely to, say, suck in imports at a faster rate than other industries. From an intuitive standpoint this should produce more realistic

[4] In practice, there are many classifications with the number of observations differing according to the conventions adopted by the data provider. For example, employment data by the Bureau of Labor Statistics (BLS) is classified into 338 categories; the United States International Trade Commission (USITC) provides export and import data across 397 categories, etc.

[5] There may be occasions where data sets from different sources (or even from within the same organisation) may be internally inconsistent.

[6] The Armington specification is of imperfect substitution between imports and domestic products. The import-domestic substitution elasticities were named Armington elasticities in Dixon *et al* (1982). Through the implementation of the Armington specification, highly unreasonable movements in imports (known as "flip flop", indicating almost complete specialisation in the commodity favoured by relative-price changes) are less likely to occur in response to changes in relative prices. Flip flop can be a problem in long-run simulations where the ratio of import to domestically-produced commodity is determined by relative prices and the commodities are treated as perfect substitutes—see Dixon, Koopman and Rimmer (2012).

and model-consistent outcomes than the alternative approach of broad-brush growth assumptions that are imposed exogenously.

The within-model data allocation approach can be illustrated by an example: consider an economy with three industries, but where historical employment data are available only for two broader sectors. Hence, with one piece of information missing (three industries minus two sectors), to allow an historical simulation to absorb the available data, the number of degrees of freedom in labour productivity in the model is reduced (from three to two) by including special purpose equations such as follows:

$$\ell_{SEC}(q) = \sum_{j=1}^{3} S(j,q) * \ell_{IND}(j) \quad , q=1,2 \tag{1.3.3}$$

and $$alab_{IND}(j) = \sum_{q=1}^{2} M(j,q) * f_{SEC}(q) \quad , j=1,2,3 \tag{1.3.4}$$

where

$\ell_{SEC}(q)$ is growth in employment in sector q, for $q \in$ SEC;

$\ell_{IND}(j)$ is growth in employment in industry j, for $j \in$ IND;

$S(j,q)$ is the share of sector q's employment accounted for by industry j;

$alab_{IND}(j)$ is labour-saving technical change in industry j;

$f_{SEC}(q)$ is a shift variable for sector q that can be used to impose labour productivity assumptions; and

$M(j,q)$ is a coefficient that maps industries to sectors by taking the value 1 if industry j is part of sector q and zero otherwise.

For simplicity, assume that each industry is contained in just one sector[7]—in particular, industries 1 and 2 comprise sector 1, while industry 3 is the only constituent of sector 2. Hence, the matrices on the R.H.S. of (1.3.4) are arranged in the form:

$$RHS(1.3.4) = \begin{pmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} f(1) \\ f(2) \end{pmatrix}$$

[7] The notation 'IND' refers to USAGE industries, while 'SEC' might refer to Bureau of Labor Statistic (BLS) groupings, or some other source.

Thus, there are five equations to determine five variables (labour-saving technical change in each industry and the sector-level shift variables). The variables, $\text{alab}_{\text{IND}}(1)$ and $\text{alab}_{\text{IND}}(2)$ *both* equal $f_{\text{SEC}}(1)$, while $\text{alab}_{\text{IND}}(3)$ equals $f_{\text{SEC}}(2)$, with values determined by the model to ensure that the sector-level observations for employment growth are met. This implies that labour-saving technical change is identical in each industry j contained in sector q.

In reducing the degrees of freedom to accommodate the sectoral employment growth observations, it seems better to assume equal labour productivity within a sector, compared to an equal employment growth assumption, as there may be information in the model that suggests otherwise. This is discussed further below.

To implement this in an historical simulation, $\ell_{\text{SEC}}(q)$, which is naturally endogenous, is exogenized and shocked with the value implied by the sectoral employment data. The corresponding 'swap' is to endogenize the sectoral shifter, $f_{\text{SEC}}(q)$. Assuming that the share of sector 1's employment is evenly split between each industry and that the observations inferred from historical data for $\ell_{\text{SEC}}(1)$ and $\ell_{\text{SEC}}(2)$ are 10 and 4, respectively, then:

$$\ell_{\text{SEC}}(1) = S(1,1) * \ell_{\text{IND}}(1) + S(2,1) * \ell_{\text{IND}}(2)$$

and $$\ell_{\text{SEC}}(2) = S(3,2) * \ell_{\text{IND}}(3)$$

$$\Rightarrow \quad 10 = 0.5 * \ell_{\text{IND}}(1) + 0.5 * \ell_{\text{IND}}(2)$$

and $$\Rightarrow \quad 4 = 1 * \ell_{\text{IND}}(3)$$

With sectoral employment growth defined in terms of employment growth by each industry contained within a sector, it can be seen that employment growth in industry 3 is pre-determined as it is the sole component of sector 2. For industries 1 and 2, employment growth will be determined by the model through taking into account, in each industry, information relating but not limited to: technical change, profitability, capital growth, exports and output growth—however, the share-weighted sum of employment growth for these industries will sum to the sector observation.

According to Dixon, Koopman and Rimmer (2012, p. 93), if, say, output in industry 1 grew at a faster rate than in industry 2, under an historical simulation that adopts the uniform-within-sector technology assumption, it is not unreasonable to suppose that there would have been faster employment growth in industry 1 than for industry 2.[8] Overall, industry allocation of sector-level growth observations through being informed by all available data on relevant variables within the model compares favourably to an external data allocation rule where the observations are uniformly applied to each component industry.

[8] This is the likely outcome of an historical simulation; but it is theoretically possible that other factors in the model could impact this result. For instance, other data relating to labour demand could lead the model to infer that there was a strong factor-input preference twist towards labour in industry 2 (and away from capital) but away from labour in industry 1 (and towards capital)—though this would be a very unusual phenomenon within a sector. In practice, historical simulations are implemented in such a way that computed values for these twists are typically uniform for each component within a sector. This allows the model to absorb data for capital stocks at a sectoral level, as fully disaggregated industry level observations are usually not available.

1.3.2 Explanation of the Development of the Historical Closure

This chapter contains the derivation of an historical closure from a decomposition closure with the intention of illustrating theoretical concepts in the model that are important in the context of the validation exercise. By understanding how an historical closure is developed, the reader is better positioned to come to grips with the key estimates in an historical simulation and how these can influence the results of a forecast. This is not intended to be a detailed description of the entire model. Instead, it is aimed providing general explanations of how closure swaps enable the model to accept extraneous data so as to estimate values for variables that are unexplained in the standard long-run decomposition closure (such as technology and preference variables). It should be noted that there is no unique method to input extraneous data for use in historical (and forecast) simulations. The closure swaps described in this discussion (and that appear in Table i) are illustrative of one approach that can be undertaken and draw heavily on Dixon and Rimmer (2002).

Recall that the decomposition closure exogenizes variables that are not normally explained in a CGE model (i.e., are naturally exogenous), while naturally endogenous variables are determined endogenously. Exogenous variables can be observable (e.g., certain macro and industry variables) or unobservable (e.g., technology and preference variables). This standard long-run closure provides a starting point with which to create a closure that is suitable to conduct an historical simulation. In an historical simulation, some naturally endogenous variables are exogenized in order that they are able to accept shocks with the values implied by the observed data. In this way, simulations using an historical closure provided the initial database values that, by and large, were used to generate the USAGE forecast for 1998 to 2005.

Table i details a list of selected exogenous variables that could comprise part of three types of USAGE closures—Historical, Decomposition and Forecast. It also contains a list of variables that are exogenous in all closures and may receive shocks prior to implementing swaps. Swap numbers are provided down the left hand side and right hand side of the table but are not in numerical order of implementation. The table is presented over two pages and is divided into economy-wide and industry/sector-level sections. In addition to variables that are exogenous in all closures, the first page reveals the swaps required to accommodate macro-level data; while the second page does the same for micro-level data. In the equations below that help to explain the swaps used to derive the historical (and later, the forecast) closure, exogeneity in decomposition mode (the standard long-run closure) is denoted by a tilde (~) above the variable in question.

Figure iii provides a diagrammatic overview of the swaps undertaken to move the closure from decomposition to historical mode. The related swaps of macro or economy-wide variables and micro or industry-level variables are grouped within boxes; while the solid arrows in the boxes indicate the swaps being undertaken and are pointing to the exogenous variable in the historical closure. The broken arrows are pointing at the main variable that has data observations or is effectively pre-determined. Where braces are used, this is to highlight the inter-relatedness of the swaps and their impact.

Figure iv relates to Chapter 1.3.4. The solid arrows in the boxes indicate the swaps being undertaken and are pointing to the exogenous variable in the forecast closure. The broken arrows are pointing at the main variable that has a specialist forecast or is effectively pre-determined. As is the case with Figure iii, the variables contained within braces indicate the inter-relatedness of the swaps and their impact.

Table i: Selected Exogenous Variables in Sample Historical, Decomposition and Forecast Closures (Swaps are in no particular order)

Exogenous all closures (naturally exogenous, observed or extraneous forecast)

CPI inflation	cpi
Number of households	h
World GDP	z_world
*Import price shifters in foreign currency	fpmcr(i)
Nominal wage rate shifters by industry	fwage_obs(j)

Macro-level data

Swap	Historical			Decomposition			Forecast		Swap
1	Aggregate real government demands	gr	←	Ratio of real private consumption to real government consumption (gamma)	γ	→	Aggregate real government demands	gr	1
2	Aggregate real household consumption	cr	←	Average propensity to consume—public & private consumption to GNP ratio	APC	→	Aggregate real household consumption	cr	2
3	Average value of household preferences for commodities	a3_ave	←	Overall shifter variable that enables input of extraneous household consumption data	f3_adj		Overall shifter variable that enables input of extraneous household consumption data	f3_adj	3
4	Aggregate real investment expenditure	ir	←	Uniform shifter in investment-capital ratios	ik_ratio_u	→	Aggregate real investment expenditure	ir	4
5	Uniform shifter in investment-capital ratios	ik_ratio_u	←	Overall shifter variable that adjusts investment to meet macro target	y-adj		Overall shifter variable that adjusts investment to meet macro target	y-adj	5
6	Uniform twist in import-domestic preferences	twist_src_gen		Uniform twist in import-domestic preferences	twist_src_gen	→	Aggregate imports	M	6
7	General export demand shifter	feqc_gen		General export demand shifter	feqc_gen	→	Terms of trade	toft	7
8	Nominal exchange rate	phi	←	All-industry primary factor-augmenting technical change	A	→	Aggregate exports	X	8
9	All-industry primary factor-augmenting technical change	A	←	Total employment	L		Total employment	L	9
10	Terms of trade	toft	←	Uniform shifter for import prices	fpmcr_gen		*Uniform shifter for import prices	fpmcr_gen	10
11	Average intermediate input-using technical change	ave_int	←	General price shifter	fp0dom		General price shifter	fp0dom	11
12	Average nominal wage	ave_wage	←	Uniform shifter in changes in rates of return	f_ror		Uniform shifter in changes in rates of return	f_ror	12

Table i *continued* - asterisk (*) denotes that the computed 1992 to 1998 Historical Simulation value is projected forward

Micro-level data

Swap	Historical			Decomposition			Forecast		Swap
13	Investment observations for sectors	y_s_obs(r)	←	Ratio of investment to capital shifter in sector r	fy_s(r)		Ratio of investment to capital shifter in sector r	fy_s(r)	13
14	Exports of commodity i	x4(i)	←	Export demand shifter for commodity i	fepc(i)	→	*Contribution to output from shift in export demand for commodity i	cont_fepc(i)	14
15	Total imports of commodity i	x0imp_obs(i)	←	Import-domestic preference twist by commodity i	ftwist_src(i)	→	*Impact on domestic market share of import-domestic preference twist by commodity	impftwist(i)	15
16	Observations of household consumption of commodity i	x3_obs(i)	←	Shifts in household preferences by commodity i	a3(i)		*Shifts in household preferences by commodity i	a3(i)	16
17	Observed employment by sector	ℓ_ s(q)	←	Labour productivity in sectors	f_s(q)		Labour productivity in sectors	f_s(q)	17
18	Industry-specific shifter for labour productivity	f(j)	←	Labour productivity in industries	alab(j)	→	*Contribution to costs in industry j from primary factor-saving technical change	cont_a1prim(j)	18
19	Current capital stocks by sector	k_s(r)	←	Labour-capital preference twist by sector	twist_ℓ k_s(r)		Labour-capital preference twist by sector	twist_ℓ k_s(r)	19
20	Domestic output of commodity i	x0dom(i)	←	Input-using technology and taste change for commodity i	ac(i)	→	*Contribution to output from input-using technology and taste change for commodity i	cont_ac(i)	20
21	Price observations of domestically-produced commodities	p0dom_obs(i)	←	Intermediate input-saving technical change	a_int(i)		*Intermediate input-saving technical change	a_int(i)	21
22	Shifter variable for rate of return in industry j	fror(j)	←	Rate of return in industry j	ror(j)		Rate of return in industry j	ror(j)	22
23	Shifter variable used to activate impftwist(i) calculation in historical simulations	dftwist_h(i)		Shifter variable used to activate impftwist(i) calculation in historical simulations	dftwist_h(i)	→	Shifter variable used to determine ftwist_src(i) in forecast simlations	dftwist_f(i)	23

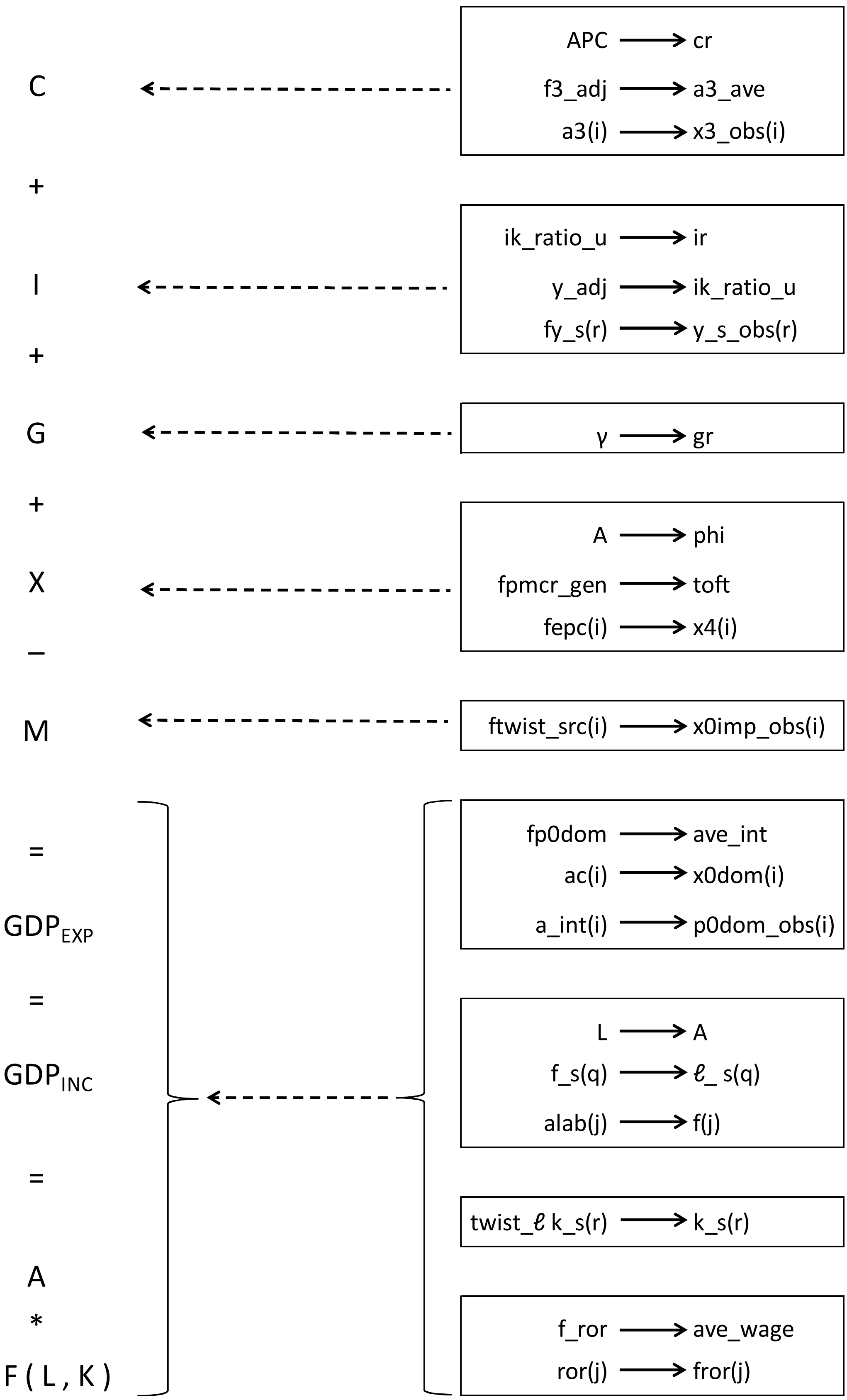

Figure iii: Graphical summary of the development of the historical closure

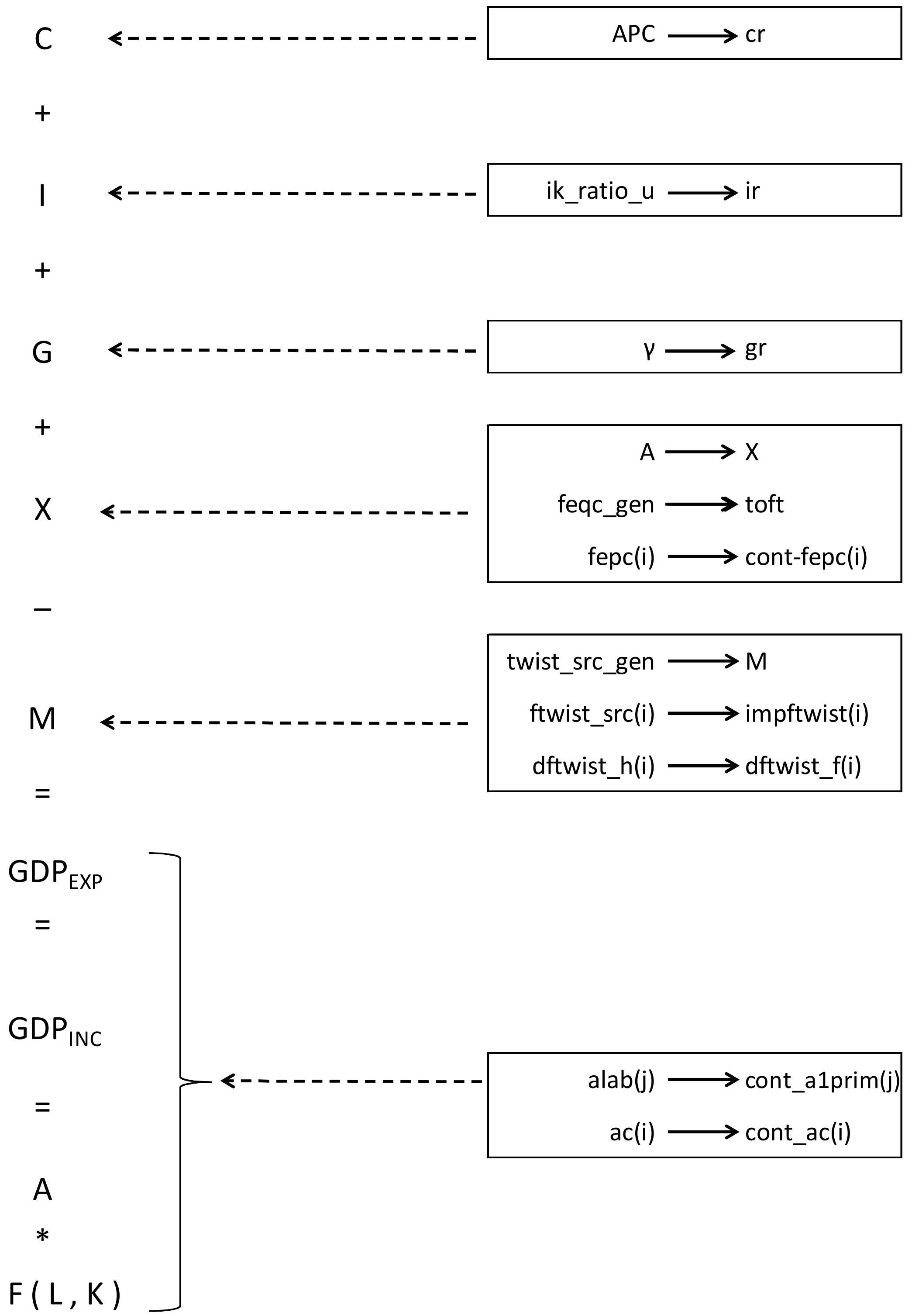

Figure iv: Graphical summary of the development of the forecast closure

Governments

Swap number 1 allows for the implementation of equations that make use of data observations for real government demands in aggregate and at the commodity level. This is enabled in USAGE by including linearized equations of the form:

$$\tilde{\gamma} = cr - gr \qquad (1.3.5)$$

$$x5(i) = \tilde{x}5\_obs(i) + f5\_gen \quad ,i=1,2, \ldots, N_{COM} \qquad (1.3.6)$$

where

γ is the ratio of real private consumption to real government consumption;

cr is the percentage change in aggregate real private consumption;

gr is the percentage change in aggregate real government consumption;

$x5(i)$ is the percentage change in government demand for commodity i;

$x5\_obs(i)$ is the percentage change implied by observations of government consumption data at the commodity level; and

$f5\_gen$ is the percentage change in a uniform shifter variable on government consumption.

The ratio of real private consumption to real government consumption is described in (1.3.5).[9] In decomposition simulations, the ratio of private to public consumption is assumed to be fixed—the model computes aggregate real household consumption and hence, aggregate real government demand is tied to this result. Exogenizing aggregate real government demand in the historical closure via swap number 1 enables the input of the value for growth in this variable as inferred by observations for 1992 and 1998. Correspondingly, the ratio of private to public consumption, γ, is endogenized. In (1.3.6) the structure of public consumption is effectively exogenous in both decomposition and historical closures. In particular, government demands for commodities, $x5(i)$, are determined by factors external to the model. The structure public spending is implemented by shocking $x5\_obs(i)$ with the value implied by extraneous data for the period 1992 to 1998. In order to prevent the possible over-determination of aggregate real government demand arising from the

[9] Linearized variables (usually denoted by lower case characters) represent the percentage-change form of the levels variables (usually denoted by upper case characters). For example, the level of aggregate real consumption is denoted by "CR", whereas the percentage change is denoted by "cr". The levels form of the equation for the ratio of real private consumption to real government consumption is $\Gamma = CR/GR$. The percentage change is calculated by $100 * (\Delta\Gamma) / \Gamma = \gamma = cr - gr$.

model's absorption of both macro and micro data, the scalar shifter variable on government consumption, f5_gen, remains endogenous. This ensures that the sum over all commodities of the values for $x5(i)$ is equal to the aggregate that was exogenously imposed through swap number 1.

Households

Swap numbers 2, 3 and 16 implement equations that make use of household consumption observations in aggregate and at the commodity level. Under the decomposition closure, the link between total consumption (private and public) and gross national product is fixed[10], as are household taste or preference changes. In an historical simulation, these variables are allowed to move to take on values consistent with the exogenous imposition of total private consumption and the micro-level commodity structure. The model includes equations similar to the following (for ease of exposition, these are presented in a mixture of levels and percentage change form):

$$cr = c - \tilde{c}pi \qquad (1.3.7)$$

$$C + G = \tilde{A}PC * GNP \qquad (1.3.8)$$

$$x3(i) - \tilde{h} = EPS(i) * (c - \tilde{h}) + \sum_{i=1}^{N_{COM}} ETA(i,k) * p3(k) + \tilde{a}3(i) - a3\_ave \quad , i = 1,2,\ldots,N_{COM} \qquad (1.3.9)$$

$$a3\_ave = \sum_{i=1}^{N_{COM}} S_3(i) * \tilde{a}3(i) \qquad (1.3.10)$$

$$x3(i) = x3\_obs(i) + \tilde{f}3\_adj \quad , i = 1,2,\ldots,N_{COM} \qquad (1.3.11)$$

where

cpi is the percentage change in the consumer price index (exogenous in all closures);

C and c represent nominal total household consumption expenditure in levels and percentage change form, respectively;

G is nominal total government demands in levels form;

APC is the average propensity to consume out of gross national income;

GNP is the level of nominal gross national income;

[10] In decomposition simulations conducted across time periods beyond one year, USAGE adopts smooth growth assumptions for GNP and the average propensity for total consumption.

$x3(i)$ is the percentage change in household demand for commodities undifferentiated by source;

$p3(k)$ is the percentage change in an index of consumer prices for commodities undifferentiated by source;

$x3\_obs(i)$ is the percentage change implied by observed household demand for commodities undifferentiated by source;

$a3(i)$ is the percentage change in the overall movement in household preferences for commodities;

$a3\_ave$ is the percentage change in the average value of household preferences for commodities;

$S_3(i)$ is the share of commodity i in the household budget;

$EPS(i)$ is household expenditure elasticities for commodities;

h is the percentage change in the number of households (exogenous in all closures);

$ETA(i,k)$ is household price elasticities; and

$f3\_adj$ is the percentage change in a macro shift variable used to adjust for data discrepancies.

In (1.3.9), household demands are related to a function of aggregate consumption and household expenditure; consumer price elasticities; and preferences. The average value of household preferences for commodities is defined in (1.3.10). The term $a3(i) - a3\_ave$ is employed such that changes in preferences do not affect aggregate consumer spending:

$$0 = \sum_{i=1}^{N_{COM}} S_3(i) * (a3(i) - a3\_ave)$$

This ensures that movements in household preferences do not lead to changes in consumption that violate the budget constraint.[11] In an historical simulation, $x3\_obs(i)$, which is naturally endogenous, is exogenized and shocked with the value implied by household consumption data. Swap number 16 is completed once the preference variable, $a3(i)$, is endogenized. Swap number 2 impacts (1.3.7) and (1.3.8) by effecting the exogenization of aggregate real private consumption and the endogenization of the average propensity to consume out of gross national income. The endogeneity of $f3\_adj$ in (1.3.11) via swap number 3 ensures the alignment of observed aggregate

[11] Thus a change in household preferences results only in substitution towards the more desired good(s) and away from other goods. Impacts related to income effects are dealt with elsewhere in the model.

real consumption with the sum of its commodity-level components.[12] This occurs by $f3\_adj$ assuming a (typically fractional) value that makes uniform adjustments to $x3(i)$. Swap number 3 is completed with the exogenization of the preference variable, $a3\_ave$.

Returning to (1.3.7), note the exogeneity of the consumer price index.[13] This is a nominal or price variable that is exogenous in all closures in this version of USAGE. Such a variable is referred to as the "numeraire". A noteworthy point in relation to choosing the exogenous variables in a closure (irrespective of closure *type*) is the selection of the numeraire. General equilibrium models do not usually seek to explain the absolute price level. In general, there are three methods available to tie down the price level. The simplest of these is for the modeller to exogenize a single nominal variable, which becomes the numeraire. This could be the role of the exchange rate or a macro price index such as the CPI (as is the case here). A successful test of homogeneity (by applying a shock to the numeraire) will leave relative prices unchanged by resulting in equal effects on all endogenous nominal variables with all real variables unaffected.[14] A different approach, which doesn't explicitly exogenize any nominal variable(s) is to specify a relationship between a nominal and real variable. For example:

$$w = f(L)$$

This says that the percentage change in nominal wages (w) is a function of employment. Employment could, itself, be exogenous or determined elsewhere in the model. A homogeneity test would be conducted by shocking employment or its determinants. Under a successful outcome, all nominal variables (including the wage rate) would move uniformly. Similarly, a relationship between nominal and real variables could be specified with linkages over periods of time:

$$w_{(t)} / w_{(t-1)} = f\left(L_{(t)} / L_{(t-1)}\right)$$

This equation, which includes pre-determined wage and employment variables for period t–1, effectively relates future wage pressures to employment growth forecasts. The third approach to tie down the price level is for the modeller to have multiple exogenous and/or pre-determined nominal

[12] An equation is "switched off" if it simply determines the value of an endogenous shift variable that goes to no other part of the model. In the decomposition closure where $x3\_obs(i)$ is endogenous and $\tilde{f}3\_adj$ is exogenous, (1.3.11) is switched off because it simply determines the value of $x3\_obs(i)$, and plays no role in determining household consumption.

[13] For illustrative purposes, the CPI was included in the top section of *Table i* thereby indicating it is exogenous in all of the sample closures.

[14] Real endogenous variables are homogenous of degree zero with respect to the numeraire, whereas nominal variables are homogenous of degree one.

variables. For example, joint numeraires could be accomplished via exogeneity of the CPI and the stock of bonds at the start of period t in nominal dollar terms. Inflation alone would reduce the stock of bonds in real terms. This would lead to negative wealth effects with consequent reductions in consumption. To avoid real effects from emerging in a test for homogeneity, the shock to the CPI would need to be met by some artificial, proportionate increase in the stocks of bonds.

Investment

Swap numbers 4, 5 and 13 allow for the implementation of equations that make use of data observations for real investment demands in aggregate and at the sectoral level. Broader sectoral level observations are employed here because fully disaggregated industry-level historical investment observations usually do not exist. This is handled in the model by equations of the form:

$$AGGINV * ir = \sum_{j=1}^{N_{IND}} \left(VINVEST(j) * y(j) \right) \tag{1.3.12}$$

$$y(j) = k(j) + \tilde{i}k\_ratio(j) + \sum_{r=1}^{N_{SEC}^{(r)}} MINV(j,r) * \tilde{f}y\_s(r) + \tilde{i}k\_ratio\_u \quad , j = 1,2,...,N_{IND} \tag{1.3.13}$$

$$y\_s(r) = y\_s\_obs(r) + \tilde{y}\_adj \quad , r = 1,2,...,N_{SEC}^{(r)} \tag{1.3.14}$$

$$y\_s(r) = \sum_{j \in SEC(r)} \left[\frac{VINVEST(j)}{SECINVEST(r)} \right] * y(j) \quad , r = 1,2,...,N_{SEC}^{(r)} \tag{1.3.15}$$

where

$AGGINV$ is the level (or value) of aggregate nominal investment expenditure;

ir is the percentage change in aggregate real investment expenditure;

$VINVEST(j)$ is the nominal value of investment by industry j;

$SECINVEST(r)$ is the nominal value of investment by sector r;

$y(j)$ is the percentage change in investment in industry j;

$k(j)$ is the percentage change in industry j's capital at the beginning of the period;

$ik\_ratio(j)$ is the percentage change in investment-capital ratio shifters by industry;

ik_ratio_u is the percentage change in a uniform shifter in investment-capital ratios;

$MINV(j,r)$ is a coefficient with value 1 if industry j is part of sector r and zero otherwise;

$fy\_s(r)$ is the percentage change in a shift variable that affects investment only for industries in sector r;

$y\_s(r)$ is the percentage change in investment in sector r;

$y\_s\_obs(r)$ is the percentage change implied by observed investment in sector r; and

y_adj is the percentage change in a shifter variable that adjusts sectoral investment to meet the macro target.

In the standard long-run decomposition closure, both the economy-wide investment-capital shifter and the industry-level investment-capital shifters are exogenously determined. This allows decomposition simulations to generate results for capital available for use in industries at the beginning of the simulation period through the exogenous specification of changes in rates of return; and, for investment to be determined by exogenously imposed movements in investment-capital ratios. In an historical simulation, data for aggregate real investment is imposed via (1.3.12) and (1.3.13) by exogenizing and shocking the naturally endogenous variable, ir, with the extraneous observation, while freeing-up the economy-wide investment-capital ratio shift variable, ik_ratio_u.[15] Since data are often limited to the broader sector level, investment observations across r sectors are introduced in (1.3.14). Investment in industry j is mapped to sector r via (1.3.15), which defines percentage changes in sectoral investment as a share-weighted sum of percentage changes in investment in the component industries. For instance, beginning with sector 1 (i.e., r = 1) the computation is made by summing all the j-terms on the right hand side of (1.3.15) for which industry j is part of sector 1, and so on. The sectoral shifter $fy\_s(r)$ in (1.3.13) ensures that all industry components of each sector sum to the aggregate value of the sector. In order to ensure that the sectoral investment data are consistent with the macro observation, ik_ratio_u is re-exogenized and, correspondingly, y_adj becomes endogenous (swap number 5).

Imports

Swap number 15 implements equations that provide detail on imports and estimate cost-neutral changes or twists in technology and preferences for imported goods relative to domestic goods. These import twists reflect, for any given ratio of import-domestic purchasers' prices and level of demand pressure (or market growth), the changed import-domestic ratio users of commodity i have

[15] In (1.3.12), aggregate investment equals the sum of investment in all industries.

in their demands for that commodity. This is important because it explains why domestic sales of a domestically produced commodity may move in a way that is inconsistent, or only partly consistent, with changes in relative prices and growth in the market. The model includes equations similar to the following:

$$\begin{aligned} x0imp(i) = & \sum_{j=1}^{N_{IND}} \left[S_1(i,imp,j) * x1(i,imp,j) + S_2(i,imp,j) * x2(i,imp,j) \right] \\ & + S_3(i,imp) * x3(i,imp) + S_5(i,imp) * x5(i,imp) \quad , i = 1,2,\ldots, N_{COM} \end{aligned} \tag{1.3.16}$$

$$\begin{aligned} & x(i,s,a) = xyz(a) - \sigma_{ARM} * \left(p(i,s,a) - p(i,a)\right) + DUMMY(i,s,a) * twist\_src(i) \quad , \\ & \qquad i = 1,2,\ldots,N_{COM} \\ & \qquad s = dom, imp \\ & \qquad a = \text{all agents} \left(\text{industries, capital creators, households and governments}\right) \end{aligned} \tag{1.3.17}$$

In (1.3.16):

$x0imp(i)$ is the percentage change in total imports of commodity i;

$x1(i,imp,j)$ is the percentage change in intermediate input use of imported commodity i by industry j;

$x2(i,imp,j)$ is the percentage change in inputs for capital creation of imported commodity i by industry j;

$x3(i,imp)$ is the percentage change in household demand for imported commodity i;

$x5(i,imp)$ is the percentage change in government demand for imported commodity i;

$S_1(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in current production;

$S_2(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in investment activities;

$S_3(i,imp)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by households; and

$S_5(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by government.

Thus, (1.3.16) defines the percentage change in imports of commodity i as a share weighted average of the percentage changes in the demands by each of the model's agents. A stylized version of these demands is given by (1.3.17). In this equation:

> $x(i,s,a)$ is the percentage change in the demand for commodity i from source s (domestic or imported) by agent a. This covers producers, capital creators, households and governments;
>
> $xyz(a)$ is the percentage in agent a's activity level (e.g., output, investment and aggregate expenditure);
>
> σ_{ARM} is the Armington domestic-import substitution elasticity;
>
> $p(i,s,a)$ is the percentage change in the purchasers' price to agent a of commodity i from source s;
>
> $p(i,a)$ is the percentage change in the purchasers' price to agent a of commodity i. This is a weighted average of the percentages in the $p(i,s,a)$ over s equals dom and imp; and
>
> $twist\_src(i)$ is the percentage change in a variable that affects the domestic-import ratio of all agents' purchases of commodity i independently of domestic-import relative prices.
>
> $DUMMY(i,s,a)$ is a coefficient defined as follows:

$$
\begin{aligned}
&DUMMY(i,dom,a) = S(i,imp,a)\\
&DUMMY(i,imp,a) = -S(i,dom,a)
\end{aligned}
$$

where

> $S(i,s,a)$ is the share of source s in agent a's expenditure on commodity i.

Movements in the twist variable impart changes in each agent's ratio of imported to domestic purchases. To understand this, imagine a situation in which prices and activity levels are held constant. Then (1.3.17) implies that:

$$
\begin{aligned}
&x(i,imp,a) - x(i,dom,a)\\
&= \left(DUMMY(i,imp,a) - DUMMY(i,dom,a)\right) * twist\_src(i)\\
&= \left(S(i,imp,a) + S(i,dom,a)\right) * twist\_src(i)\\
&= twist\_src(i)
\end{aligned}
$$

Thus, for example, if $twist\_src(i)$ equals 10, then we are imposing a 10% increase in the ratio of imported to domestic goods in the purchases of commodity i by all agents. This twist in agent a's import-domestic preferences is cost neutral. To establish cost neutrality, we start by noting that in the absence of price and activity changes:

$$\begin{aligned} x(i,imp,a) &= S(i,dom,a) * twist\_src(i) \\ x(i,dom,a) &= -S(i,imp,a) * twist\_src(i) \end{aligned}$$

The percentage change in agent a's expenditure on commodity i [$\exp(i,a)$] is:

$$\exp(i,a) = \sum_{s} S(i,s,a) * \left[p(i,s,a) + x(i,s,a) \right]$$

With prices held constant we obtain:

$$\begin{aligned} \exp(i,a) &= -S(i,dom,a) * S(i,imp,a) * twist\_src(i) \\ &\quad + S(i,imp,a) * S(i,dom,a) * twist\_src(i) \\ &= 0 \end{aligned}$$

The term $twist\_src(i)$ is determined in (1.3.18) as follows:

$$twist\_src(i) = \omega * (x0dom(i) - gdpreal) + \tilde{f}twist\_src(i) + twist\_src\_gen \quad , \quad i = 1,2,\ldots,N_{COM} \qquad (1.3.18)$$

where

ω is a positive parameter that controls the sensitivity of domestic-import twists to growth in domestic output relative to GDP;

$x0dom(i)$ is the percentage change in domestic output of commodity i;

$gdpreal$ is the percentage change in real GDP;

$ftwist\_src(i)$ is a percentage change variable that allows for import-domestic twists by commodity; and

$twist\_src\_gen$ is a percentage change variable that allows for a uniform (or all-commodity) import-domestic twist (exogenous in decomposition and historical closures).

According to Dixon and Rimmer (2002), the term $x0dom(i) - gdpreal$ reflects the idea that there is pro-cyclical demand pressure that arises out of instances where output for a commodity is growing more rapidly than the broader economy. In such cases, there is a tendency for users to seek overseas suppliers for reasons not related to relative-price changes (perhaps due to shortages). As a result, demand-shifts occur towards imports. The term $ftwist\_src(i)$ is interpreted as a shifter variable that allows for twists in import-domestic ratios beyond those that can be explained by movements in relative prices and demand pressures for the commodity. In an historical simulation, information on the movements in commodity-specific import volumes are introduced by endogenizing twists in the import-domestic preferences of industries, creators of capital, households and government. This is accommodated in the model by (1.3.19):

$$x0imp(i) = x0imp\_obs(i) + \tilde{f}0imp\_adj \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.19}$$

where

$x0imp\_obs(i)$ is the percentage change implied by observed imports by commodity; and

$f0imp\_adj$ is the percentage change in a macro shift variable, which could be used, if necessary, to adjust the commodity-level import data to achieve consistency with macro import data.

In the historical closure, swap number 15 exogenizes the naturally endogenous variable, $x0imp\_obs(i)$, in place of $ftwist\_src(i)$, which becomes endogenous.[16] Once exogenous, $x0imp\_obs(i)$ is shocked with the value implied by the available data on imports. Such data are thought to be reliable, requiring no separate macro imports target. With import volumes known for all commodities, aggregate imports can be determined via a specific add-up of all imports of commodities as observed in the data. This is seen in (1.3.20):

$$M = \psi_M\left[X0IMP(1),\ldots,X0IMP(N_C)\right] \tag{1.3.20}$$

where

M is aggregate imports;

$X0IMP(i)$ is the level of imports of commodity i; and

ψ_M is a function used to aggregate imported commodities.

Exports

Swap numbers 8, 10 and 14 serve to allow for shifts in export-supply and -demand curves to accommodate information on exports and the international terms of trade. Prior to the implementation of these swaps, the quantity of exports is still being determined endogenously (as per the assumptions of the decomposition closure). It is useful to pause at this stage of development of the historical closure to gain an understanding of how the model calculates

[16] As shall be seen below in the discussion regarding the development of the forecast closure, the *impact* of this import-domestic preference twist on domestic market share is exogenized and projected forward.

exports—at least from a broad or stylized perspective. Recall that GDP from the expenditure side and income side is given in (1.3.1) and (1.3.2), respectively. Those equations are reproduced here and include exogeneity indicators (~) to highlight those variables that are assumed to be fixed at this juncture:

$$GDP_{EXP} = \tilde{C} + \tilde{I} + \tilde{G} + X - \tilde{M}$$

$$GDP_{INC} = \tilde{A} * F(\tilde{L}, K)$$

Under constant returns to scale as is assumed in USAGE:

$$MP_K = \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right)$$

Assuming that the value of the marginal product of capital is equal to the nominal rental on capital (Q):

$$VMP_K = P_G * MP_K = P_G * \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right) = Q$$

$$\therefore \quad \frac{P_G}{P_I} * \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right) = \frac{Q}{P_I} \approx \tilde{R}OR$$

where

P_I is the price index for capital goods, i.e., asset price;

P_G is the price index for domestic goods, i.e., GDP deflator;

Q is the rental price of capital; and

ROR is the rate of return on capital.

The term $\frac{Q}{P_I}$ may be interpreted as a proxy for ROR; while the term $\frac{P_G}{P_I}$ may be interpreted as a proxy for the terms of foreign trade (TOFT) because P_I includes import prices but not export prices while the reverse is true for P_G :

$$\therefore \quad \tilde{R}OR = H(TOFT) * \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right)$$

$$\text{Hence} \quad K = \zeta\left(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT\right) \tag{1.3.21}$$

Assuming that the price of imports in foreign currency is exogenous, then for any given price of exports in foreign currency it is possible to infer an upward-sloping export supply schedule. This can be explained in stylized terms. For instance, if export prices are low, then it must be true that the terms of trade are low. This is because the absorption deflator (which includes imported capital goods) has to be growing faster than the GDP deflator (which includes exports). With the rate of return, labour and technology all exogenously fixed, it must also be true that the marginal product of capital is high. That is:

$$\tilde{R}OR \leftarrow \text{fixed} \quad \& \quad \frac{P_G}{P_I} \leftarrow \text{low via } P_G \quad \Rightarrow \quad MP_K \text{ or } \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right) \leftarrow \text{high via low } K$$

This, in turn, implies that capital is scarce—therefore output (which includes exports) must be low. The latter can be seen from the equation for GDP from the income side: $GDP_{INC} = \tilde{A} * F(\tilde{L}, K)$.

Rearranging GDP from the expenditure side as follows: $X = GDP_{EXP} - (\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M})$, reiterates that at this point in the development of the historical closure, exports and output are the only variables that are not exogenous or otherwise tied down. Hence, the term $(\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M})$ acts as a constant, such that the low output emanating from a condition of scarce capital translates into low exports.

Now consider a scenario where export prices are high. With the price of imports in foreign currency assumed exogenous, the terms of trade must be high—because the GDP deflator (which includes exports) has to be growing faster than the absorption deflator (which includes imports, such as capital goods). If the rate of return is fixed and the terms of trade are high, then the marginal product of capital must be low. Since labour and technology are also fixed, then capital must be abundant, implying that production is high. Again, from the minimal slack in the GDP identities, a high level of output implies that exports are high.

With high export prices translating into a high level of exports and vice versa, the export supply function must be upward sloping from left to right. Substituting from (1.3.21) into (1.3.2) and then into (1.3.1) yields the export-supply curve:

$$X = GDP(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT) - (\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M}) \tag{1.3.22}$$

The export-demand schedule is given by (1.3.23) and total exports by (1.3.24):

$$x4(i) = \tilde{z}\_world + \theta(i) * \left[pe(i) - \tilde{f}epc(i)\right] + \tilde{f}eqc(i) + \tilde{f}eqc\_gen \quad , i = 1, 2, ..., N_{COM} \tag{1.3.23}$$

$$X = \psi_X\left[X4(1),\ldots,X4(N_C)\right] \tag{1.3.24}$$

where

$x4(i)$ is the percentage change in export demand for commodity i;

z_world is the percentage change in global economic activity, i.e., world GDP;

$\theta(i)$ is foreign elasticity of demand for commodity i;

$pe(i)$ is the percentage change in the foreign-currency f.o.b price (value on departure of U.S.) of commodity i;

$fepc(i)$ is the percentage change in price (vertical) shifts in the export-demand schedule for commodity i;

$feqc(i)$ is the percentage change in quantity (horizontal) shifts in the export-demand schedule for commodity i;

$feqc\_gen$ is the percentage change in a uniform horizontal shifter in the export-demand curves of all commodities;

X is aggregate exports;

$X4(i)$ is the level of exports of commodity i; and

ψ_X is a function used to aggregate exported commodities.

The export-demand curve is a function of global activity; the degree of influence on world prices through varying export volumes; relative prices between the U.S. and abroad; and several autonomous variables that, *inter alia*, can be used to simulate general and commodity-specific changes in foreign preferences through shifting the export-demand curve to a different position.

Recall that the closure of the model is developed in a step-by-step fashion. At this stage of the process (departing from the standard long-run decomposition closure) foreign-currency import prices are fixed while the variable for the terms of trade is endogenous. If the accommodation of observations in export volumes were to be restricted to variations in the export-demand function, any large change in export volumes could result in unrealistically large changes in the term of trade. This would make the simulation results difficult to interpret as there would be large changes in foreign-currency export prices and unrealistic exchange rate movements. The potential for extreme movements in the opposite direction would be created if the adjustment was limited to the export-supply function.

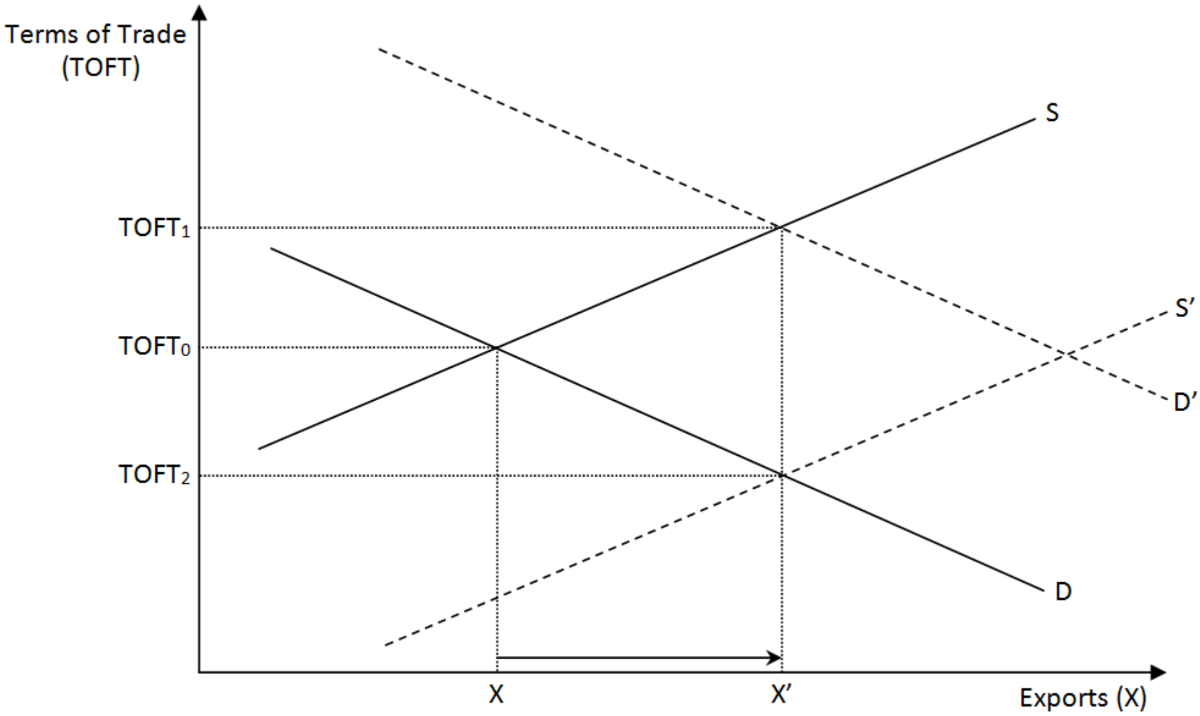

Figure v: Export-demand and -supply curves in the development of the historical closure

Figure v is adapted from Dixon and Rimmer (2002): at this step in the process of moving away from the decomposition closure (i.e., swaps 7, 10 and 14), A, L, ROR, C, I, G and M are fixed at their levels attained by the end of the previous step, reflected by the export-supply curve (S); meanwhile, the export-demand shifter (fepc) is also fixed at its value from the previous step, yielding the export-demand curve (D). This combination results in the intersection of $TOFT_0X$. Accommodating the increase in exports from X to X' via an endogenous move in the demand curve alone would increase the terms of trade from $TOFT_0$ to $TOFT_1$. Achieving the rise in exports from an endogenous move in supply curve alone (through changes in technology) would decrease the terms of trade from $TOFT_0$ to $TOFT_2$. There is a potential for changes in technology and the terms of trade to be unrealistically large, hampering the interpretation of results. To prevent this situation arising, the increase in exports is accommodated by fixing the terms of trade at its observed value and allowing both demand and supply movements (endogenous fepc and A, respectively), with the split determined by the model.

At this juncture, we pause briefly to consider the connection between the exchange rate and the terms of trade. The exchange rate is defined in terms of foreign dollars per U.S. dollar. In (1.3.25), the terms of trade is defined as the ratio of foreign export prices to foreign import prices, implying that export prices have been converted by the nominal exchange rate. With domestic-currency export prices broadly tied down by the CPI (the numeraire), a large rise in the demand for exports would see the increase in foreign-currency export prices accommodated by a strong appreciation of the exchange rate. Given that foreign-currency import prices are largely tied down by the exogeneity of the shifter, $\text{fpmcr}(i)$, the terms of trade would also rise sharply. Alternatively, a large increase in the supply of exports, such as through the endogenization of a technology variable (A), would require a large devaluation of the exchange rate to allow for the decline in foreign-currency export prices and associated fall in the terms of trade. Hence at this step of the process, in order to avoid extreme movements in the terms of trade and exchange rate, endogenous movements in export-demand *and* -supply curves are allowed to occur by implementing swaps 7, 10 and 14.

Firstly, swap number 14 introduces commodity-level detail for exports via exogenizing and shocking the vector of export demands in (1.3.23). The corresponding swap is to endogenize the vertical shifter in the export-demand schedule. With the exogenization of exports, all expenditure components (C, I, G, X and M) of GDP are exogenous and GDP is effectively tied down. As is the case with import volumes, the detailed export data are thought to be reliable. With no need for a separate macro exports target, aggregate exports can be determined via (1.3.24), which is a specific add-up of all commodity exports as observed in the data.

Prior to implementing swap number 10, GDP from the income side has only one degree of freedom, namely, capital. However, in swap number 10 the variable, toft, is exogenized and shocked with the value implied by the move in the terms of trade—as explained above, this has the effect of tying down capital along with GDP from the income side. The swap is completed once the variable, $\mathrm{fpmcr\_gen}$, is endogenized. Swap number 10 is implemented using equations of the form:

$$\mathrm{toft} = \mathrm{xpi} - \mathrm{mpi} \qquad (1.3.25)$$

$$\mathrm{pmcr}(i) = \tilde{f}\mathrm{pmcr}(i) + \tilde{f}\mathrm{pmcr\_gen} \quad , i = 1, 2, \ldots, N_{COM} \qquad (1.3.26)$$

where

toft is the percentage change in the terms of trade;

xpi is the percentage change in the exports price index (foreign currency f.o.b. export prices);

mpi is the percentage change in the imports price index (foreign currency c.i.f. import prices);

$\mathrm{pmcr}(i)$ is the percentage change in the foreign-currency price of imported commodity i;

$\mathrm{fpmcr}(i)$ is the percentage change in a shifter variable used to apply import price observations and forecasts; and

$\mathrm{fpmcr\_gen}$ is the percentage change in a macro or uniform shifter variable for import prices.

In order to allow the export-supply curve to move, swap number 8 endogenizes an economy-wide technical change variable (A or all-industry primary-factor-augmenting technical change) and exogenizes the nominal exchange rate (phi), with the latter shocked at its observed change from 1992 to 1998.[17] Swap number 8 has the dual purpose of allowing supply-side GDP to adjust to 'hit the target' set by expenditure-side GDP and allowing the model to determine the split between export-demand and -supply movements.[18]

Labour

Swap numbers 9, 17 and 18 allow for the implementation of equations that make use of disaggregated data observations for employment. Equation (1.3.27) is a close reproduction of (1.3.3), while (1.3.28) is based on (1.3.4) with one additional variable, $f(j)$, which is a shift variable for industry j that allows labour productivity to vary between industries in the same sector according to some specification that is external to the model:

$$\ell\_s(q)=\sum_{j=1}^{N_{IND}} S(j,q)*\ell(j) \quad ,q=1,2,\ldots,N_{SEC}^{(q)} \tag{1.3.27}$$

$$\tilde{a}lab(j)=\sum_{q=1}^{N_{SEC}^{(q)}} M(j,q)*\tilde{f}\_s(q)+f(j) \quad ,j=1,2,\ldots,N_{IND} \tag{1.3.28}$$

where

$\ell\_s(q)$ is the percentage change or growth in employment in sector q;

$\ell(j)$ is the percentage change or growth in employment in industry j;

$S(j,q)$ is the share of sector q's employment accounted for by industry j;

$alab(j)$ is the percentage change in labour-saving technical change in industry j;

$f\_s(q)$ is the percentage change in a shift variable for sector q that can be used to impose labour productivity assumptions in sectors; and

[17] Recall from the discussion relating to implementing household consumption observations that the CPI is exogenous and acts as the numeraire. Hence, exogenizing and shocking the nominal exchange rate (phi) causes changes in relative prices (and international competitiveness), which in turn causes real effects in the model.

[18] Following the approach taken by Dixon and Rimmer (2002), L and ROR are not endogenized at this step of the process because as the closure is developed further information is introduced that deals with employment, wage rates and profitability. In fact, implementing detail on employment partly reverses swap number 8 by re-exogenizing all-industry primary-factor-augmenting technical change (A). The possibility of this situation occurring is mentioned in Chapter 1.3.1.

$M(j,q)$ is a coefficient that maps industries to sectors by taking the value 1 if industry j is part of sector q and zero otherwise.

As described in Chapter 1.3.1, swap number 17 enables sector-level employment observations to be introduced by exogenizing $\ell\_s(q)$ and shocking it with the extraneous data. Correspondingly, $f\_s(q)$ is endogenized thereby forcing labour-saving technical change to be identical for each sector's constituent industries. This is able to occur once swap number 18 is implemented: $alab(j)$ is endogenized while $f(j)$ is made exogenous and left unshocked, thereby playing no further role in this version of the historical closure. Given that the sector-level employment observations will sum to total labour (L), swap number 9 endogenizes L and exogenizes all-industry primary-factor-augmenting technical change (A). The latter avoids an indeterminacy that would arise if both A and $alab(j)$ were endogenous, in which case the model could reach a solution by more than one combination of values for economy-wide and industry-specific technological change.

Capital

Swap number 19 allows the historical simulation to absorb sectoral capital-growth data for the period 1992 to 1998. This step in the development of the historical closure makes use of labour-capital twist variables in the model. These impact factor-input demand functions such as can be seen in (1.3.29) and (1.3.30)—these are simplified capital- and labour-demand equations. The labour-capital twist variables refer to shifts in an industry's technology that favour using a different capital-labour ratio for any given ratio of the wage rate to the rental rate on capital (i.e., the rental-wage rate).

$$k(j)=z(j)-\sigma_{\ell k}*(rental(j)-pprim(j))-S\_LAB(j)*twist\_\ell k(j) \quad ,j=1,2,\ldots,N_{IND} \tag{1.3.29}$$

$$\ell(j)=z(j)-\sigma_{\ell k}*(wage(j)-pprim(j))+S\_CAP(j)*twist\_\ell k(j) \quad ,j=1,2,\ldots,N_{IND} \tag{1.3.30}$$

where

$k(j)$ is the percentage change in capital growth in industry j;

$\ell(j)$ is the percentage change in employment in industry j;

$z(j)$ is the percentage change in the activity level in industry j;

$\sigma_{\ell k}$ is the labour/capital input substitution elasticity;

$\text{rental}(j)$ is the percentage change in the rental price of capital in industry j;

$\text{wage}(j)$ is the percentage change in the cost of a unit of labour to industry j;

$\text{pprim}(j)$ is percentage change in the primary-factor composite price to industry j, i.e., the weighted average price of all primary factors;

$S\_LAB(j)$ is the share of labour costs in labour-capital input costs in industry j;

$S\_CAP(j)$ is the share of capital costs in labour-capital input costs in industry j; and

$\text{twist}\_\ell k(j)$ is the percentage change in labour-capital twist in industry j.

For example, over the period 1992 to 1998, if $\text{twist}\_\ell k(j)$ equals 10, then technology in industry j changed such that at any given rental-wage rate, the industry would choose a capital-labour ratio 10% lower in 1998 than in 1992, i.e., $k(j)-\ell(j)=-10$. Since there is no direct effect on input prices, these twists are cost-neutral shifts in technology and thus have no affect on the overall input of primary factors per unit of activity.

It is usually the case that only sector-level data are available for capital. In light of this, swap number 19 is implemented by including equations of the form:

$$k\_s(r)=\sum_{j=1}^{N_{IND}} S(j,r)*k(j) \quad ,r=1,2,\ldots,N_{SEC}^{(r)} \tag{1.3.31}$$

$$\text{twist}\_\ell k(j)=\sum_{r=1}^{N_{SEC}} M(j,r)*\tilde{\text{t}}\text{wist}\_\ell k\_s(r)+\text{ftwist}\_\ell k(j)+\tilde{\text{f}}\text{twist}\_\ell k\_gen \quad ,j=1,2,\ldots,N_{IND} \tag{1.3.32}$$

where

$k\_s(r)$ is the percentage change in capital growth in sector r;

$S(j,r)$ is the share of sector r’s capital accounted for by industry j;

$\text{twist}\_\ell k\_s(r)$ is the percentage change in labour-capital twist in sector r;

$\text{ftwist}\_\ell k(j)$ is the percentage change in a shift variable that allows for labour-capital twist by industry (exogenous in historical closure);

$\text{ftwist}\_\ell k\_gen$ is the percentage change in an all-industry labour-capital twist (exogenous in historical closure); and

$M(j,r)$ is a coefficient that maps industries to sectors by taking the value 1 if industry j is part of sector r and zero otherwise.

Swap number 19 exogenizes the naturally endogenous variable, $k\_s(r)$, allowing it to be shocked with the value implied by the sectoral capital data. Correspondingly, $twist\_\ell k\_s(r)$ is endogenized, forcing equal labour-capital twists for industries within the same sector. The overall impact of swap number 19 is to allow industry allocation of sector-level capital-growth observations to be informed by the model—by permitting the model to take into account all available data on relevant variables such as industry activity levels, rental-wage rates and primary-factor technological change. Finally, with the value of capital known for each industry under the historical closure, the economy-wide aggregation of capital is tied down, i.e., the total capital stock is equal to the sum across industries. In the decomposition closure, aggregate capital is either exogenous or determined by exogenously specified movements in rates of return. The latter treatment is adopted in this thesis.

Output and prices

Swap numbers 11, 20 and 21 allow for the introduction of information relating to the structure of output and prices. These swaps are strongly inter-related; hence in explaining this, the penultimate step of the development of the historical closure, the three swaps must be considered simultaneously. In practice, preparing the model to absorb this information is highly complicated and involves a series of special-purpose equations and variables to prevent data mismatches and indeterminacies. To ease the burden on the reader, matters are simplified by assuming that each industry produces one commodity and no two industries produce the same commodity. In addition it is assumed that a full array of data is available (whereas only higher level sectoral data are likely to be available in practice, thereby requiring sectoral mapping to industries).

In Chapter 1.2, it was noted that CGE models typically include standard conditions such as: prices equal unit costs; demands equal supplies, etc. An example of the zero pure profits condition is seen in (1.3.33), where the price received by industry j for its output is equal to the weighted average of its input costs for effective inputs of labour, capital and intermediate goods. In the case of demands equal supplies, (1.3.34) shows the demand function for output—it extends (1.3.17) by the inclusion of a preference variable, ac(i). As will be explained below, in the historical closure, ac(i) will be endogenized to ensure demand can meet exogenously-given supply, x0dom(i):

$$\begin{aligned} p0dom(j) = S_\ell(j) * \left(wage(j) + a_\ell(j)\right) + S_k(j) * \left(rental(j) + a_k(j)\right) \\ + S_{int}(j) * \left(p\_int(j) + \tilde{a}\_int(j)\right) \quad , j = 1, 2, \ldots, N_{IND} \end{aligned} \tag{1.3.33}$$

$$x(i,s,a) = xyz(a) + \tilde{a}c(i) - \sigma_{ARM} * (p(i,s,a) - p(i,a)) + DUMMY(i,s,a) * twist\_src(i)$$
$$, \quad i = 1,2,\ldots,N_{COM}$$
$$s = dom, imp$$
$$a = \text{all agents (industries, capital creators, households and governments)}$$

(1.3.34)

$$ave\_int = \sum_{j=1}^{N_{IND}} S_{a\_int}(j) * \tilde{a}\_int(j) \tag{1.3.35}$$

$$p0dom(i) = p0dom\_obs(i) + \tilde{f}p0dom \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.36}$$

$$\tilde{c}pi = \sum_{i=1}^{N_{COM}} S_3(i) * p3(i) \tag{1.3.37}$$

where

$S_{int}(j)$ is the share of intermediate-input-saving technical change in total inputs by industry j;

$S_{\ell}(j)$ is the share of labour in total inputs by industry j;

$S_k(j)$ is the share of capital in total inputs by industry j;

$wage(j)$ is the percentage change or growth in the cost of a unit of labour to industry j;

$rental(j)$ is the percentage change in the rental price of capital in industry j;

$p\_int(j)$ is the percentage change in the price of intermediate inputs in industry j;

$a_{\ell}(j)$ is the percentage change in labour-saving technical change in industry j (elsewhere this is denoted $alab(j)$);

$a_k(j)$ is the percentage change in capital-saving technical change in industry j;

$a\_int(j)$ is the percentage change in intermediate-input-saving technical change;

$S_{a\_int}(j)$ is the share of industry j's intermediate-input-saving technical change in overall intermediate-input-saving technical change;

ave_int is the percentage change in the average value of intermediate-input-saving technical change;

$ac(i)$ is the percentage change in input-using technology and taste change. For any given prices and activity level, if ac = 10 then demand for good i,s by all users increased by 10%;

$p0dom\_obs(i)$ is the percentage change in price-observations of domestically-produced commodities;

$\mathrm{p0dom}(i)$ is the percentage change in prices of domestically-produced commodities;

$\mathrm{fp0dom}$ is the percentage change in a general price shift variable;

cpi is the percentage change in the consumer price index;

$\mathrm{p3}(i)$ is the percentage change in an index of consumer prices for commodities undifferentiated by source, i.e., price of household composites; and

$S_3(i)$ is the share of commodity i in the household budget.

In previous steps, primary-factor input demands were absorbed into the model at the micro level (thereby tying down the macro aggregates for labour and capital). In the case of labour, this was accomplished through freeing-up productivity; while for capital, freedom in a twist/technology variable achieved the desired result. In this step, the model must absorb domestic output of each commodity. This result is attained via swap number 20 that exogenizes $\mathrm{x0dom}(i)$ and endogenizes $\mathrm{ac}(i)$, i.e., with the supply side determined, the demand side is allowed to respond by freeing-up a commodity-i-using technical change/preference variable that has the effect of allowing the output-demand curves to shift.

Next, the model must take into account observations for domestic prices. This requires (1.3.36), in which $\mathrm{p0dom}(i)$ is naturally endogenous and determined elsewhere in the model. Swap number 21 enables domestic price observations to be introduced by exogenizing $\mathrm{p0dom\_obs}(i)$ and shocking it with the extraneous data. Implementing the data on prices presents the difficulty of an indeterminacy that could arise given that the model must cope with the exogeneity of output *and* prices. For instance, a large price increase for a commodity implies a large increase in costs. There are different ways to accommodate this cost impact, but for simplicity swap number 21 is completed by allowing freedom in a variable for intermediate-input-saving technical change, $\mathrm{a\_int}(i)$. In the example of increased costs, this would entail technological deterioration, i.e., positive $\mathrm{a\_int}(i)$.

While swap number 21 enables the model to absorb prices at the micro level, it gives rise to a macro level conflict. The so-called 'make matrix' shows the commodity composition of domestic output. Industry output appears in the columns and the supply of domestic commodities appears in the rows. Industry columns in the matrix are affected by $\mathrm{a\_int}(i)$, while $\mathrm{ac}(i)$ affects the commodity rows. Since the total supply of domestic commodities must equal the total output by domestic industries, intermediate-input-saving technological change and commodity-i-using technical change cannot both be unconstrained—firstly, because primary-factor productivity at the micro level (a major component of input-saving technical change) is already endogenous, and secondly, the desired overall output could be attained with different combinations of $a\_int(i)$ and $ac(i)$. Swap number 11 prevents this conflict by controlling the overall average of intermediate-input-saving technical change, i.e., ave_int is exogenized thereby tying down the industry column totals. Thus the model can reconcile each industry's observed inputs with total output and this will be consistent with a unique combination of $a\_int(i)$ and $ac(i)$. In order to complete swap number 11, the macro price variable, fp0dom, is endogenized. Indeed, the choice of fp0dom is necessitated by swap number 21, where detailed data on prices were introduced simultaneous with the CPI being exogenous. Endogenizing the scalar shift variable on prices ensures that the sum over all commodities has the required slack to remain consistent with consumer prices.

Wages

Swap numbers 12 and 22 complete the development of the historical closure by allowing the model to absorb information relating to nominal wages. This is enabled in USAGE by including equations of the form:

$$\tilde{r}or(j) = fror(j) + \tilde{f}\_ror \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.38}$$

$$ave\_wage = \frac{\sum_{j=1}^{N_{IND}} \left[WAGE\_J(j) / \tilde{P}OW\_PAYROLL(j) \right] * \left(wage(j) - \tilde{p}\_payroll(j) \right)}{\sum_{j=1}^{N_{IND}} WAGE\_J(j) / \tilde{P}OW\_PAYROLL(j)} \tag{1.3.39}$$

$$wage(j) = \tilde{f}wage\_obs(j) + \tilde{c}pi + fwage\_gen + \tilde{p}\_payroll(j) \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.40}$$

where

$wage(j)$ is the percentage change or growth in the cost of a unit of labour to industry j;

$fwage\_obs(j)$ is the percentage change or growth in wages as observed in industry j;

$fwage\_gen$ is the percentage change in an overall wage shifter;

ave_wage is the percentage change in the average nominal wage rate;

$p\_payroll(j)$ is the percentage change in the power of the payroll tax in industry j (this did not change in the period 1992 to 1998 therefore it was not shocked and equals zero);

$WAGE\_J(j)$ is the total wage bill in industry j;

$POW\_PAYROLL(j)$ is the power of the payroll tax in industry j;

$\mathrm{ror}(j)$ is the percentage change in the rate of return in industry j;

$\mathrm{fror}(j)$ is the percentage change in a shifter variable for the rate of return in industry j; and

$\mathrm{f\_ror}$ is the percentage change in the average rate of return shifter.

In (1.3.38), expected rates of return can be simulated to move together through shocks to $\mathrm{f\_ror}$, or the modeller could allow for different movements in expected rates of returns across industries through shocks to $\mathrm{fror}(j)$. Equation (1.3.39) defines the average nominal wage rate, exclusive of payroll tax, while (1.3.40) is focused at the industry level and includes payroll tax thereby giving the cost of a unit of labour to industry j.

By this stage, all output prices and volumes—and hence nominal GDP—have been determined. As for the previous step, we make the simplifying assumption that a full array of extraneous data is available for input into the model, including information pertaining to changes in the average nominal wage rate. In swap number 12, the extraneous observation for average wages across the economy is absorbed by the model by exogenizing the naturally endogenous variable, $\mathrm{ave\_wage}$, and shocking it with the value implied by the data. The swap is completed when a macro shifter for the average rate of return is endogenized thereby allowing the average rate of return to be implied through the factor price frontier (via the marginal product of capital). Once the average wage rate is exogenized, the overall real wage rate becomes exogenous because of the exogeneity of the CPI.

Swap number 22 endogenizes the variable, $\mathrm{ror}(j)$, and exogenizes the shifter, $\mathrm{fror}(j)$, which ties down relative rates of return and enables the model to absorb rate of return observations across industries (should the modeller have access to such data). Finally, we distribute the overall nominal wage change across industries. Recall that in the introductory comments for this chapter it was noted that prior to the implementation of any swaps, certain variables that are exogenous in all closures and may receive shocks. Among these variables is a shifter for industry wage rates, $\mathrm{fwage\_obs}(j)$, which is shocked with the values implied by the extraneous data. The endogeneity of the macro variable, $\mathrm{fwage\_gen}$, ensures consistency between the overall change in nominal wages and the industry-level data.

1.3.3 The Forecast Simulation Closure

Through most of its early development, CGE modelling was concerned with comparative-static simulations. Under comparative statics, the comparison of two different equilibria is used to identify the effect of some exogenous shock(s) to an economy. For example, a comparative-static simulation might be used to analyse the impact on, say, employment of a change in tax policy. In the context of a short-run closure (e.g., capital stocks held constant), interpretation of the results would be couched in terms of a "short-run equilibrium" reached at some notional point in the not-too-distant future and compared to the situation today or a point in recent history. Meanwhile, the results of a comparative-static simulation employing a long-run closure (e.g., rates of return exogenously defined) would be interpreted as a "long-run equilibrium" reached in the more distant future versus a starting point of today, etc. Underlying the notion of comparative statics is a *status quo* assumption about the future structure of the economy; and an inherently atemporal model with regard for the process and path of adjustment. In other words, it is assumed that "...the effects of the shocks under consideration are independent of the path that the economy would have followed without the policy shocks." (Dixon and Rimmer, 2002, p. 4.) This assumption is difficult to defend because the effects of any given policy change will: 1) take place in the future and, 2) depend on the future structure of the economy. According to Dixon and Rimmer (2010a, p. 37):

> "...in their USAGE-based study of the effects of import restraints on the U.S. economy, the U.S. International Trade Commission (2007) recognised via their a baseline forecast that import-competing industries such as Textiles, Apparel and Sugar are likely to suffer rapid decline even in the absence of further cuts in protection, that is, output and employment in these industries is likely to be considerably smaller in 2012, for instance, than it was in 2007. By taking this into account, the Commission avoided exaggerating the likely loss of jobs in these industries that would occur in 2012 as a result of tariff cuts."

In any case, the value of generating baseline forecasts in a dynamic CGE model such as USAGE is not limited to enhancing the results of policy simulations, or merely to interest in the development of the economy in the absence of the effects of a particular shock. As mentioned in Chapter 1.0, forecasting-performance (i.e., assessing the accuracy of a forecast) is a useful method of model validation that is intended to identify weaknesses in the model and make improvements. Baseline forecast generation was another aspect where Johansen broke new ground in CGE modelling. Johansen compared forecasts against outcomes in changes in the 1950s to the industrial composition of the Norwegian economy. Chapter 1.0 describes an extension of this type of procedure that has been developed in Dixon and Rimmer (2010b and 2012). In particular, the authors describe the results of an out-of-sample forecasting validation test that was performed using USAGE to generate a baseline forecast from 1998 to 2005 for the outputs of more than 500 commodities. The test relied only on information that was available up to 1998. Indeed, it is on the basis of this work that this thesis hopes to make a contribution, by describing error-reduction strategies that improve the accuracy of baseline forecasts in a dynamic CGE model.

In order to generate a forecast under USAGE, the model must be adjusted from a decomposition closure to a forecast closure. For the same reasons that underlie the cautious development of the historical closure, this is typically done as a step-by-step procedure (explained in Chapter 1.3.4). In each step some of the exogenous variables in a decomposition closure are endogenized so as to allow the modeller to extraneously input values that reflect expected outcomes over the forecast horizon (such as inputting an oil price projection from the U.S. Energy Information Administration). There is no regard as to whether or not that variable is usually determined independently of other variables (for which there may or may not be separate *a priori* projections).

A forecast is not primarily concerned with explaining the effects of a particular shock to the economy (as is the case for decomposition and policy closures). Rather the forecast closure is chosen so as to utilize all available information to allow for the prediction of "outcomes for industries, occupations and regions." (Dixon and Rimmer, 2002, p. 276.) Furthermore, most forecast simulations are performed as a sequence of annual solutions—sometimes called year-on-year forecasts. This is so that policy analysis can subsequently be undertaken by examining the deviations from the baseline path of the economy in question following an exogenous shock. Not only does this help with quantifying the magnitude of adjustment costs to providers of labour and capital but it also gives some perspective to the length of time it takes for resources to be transferred between different uses. Where a forecast simulation is performed as part of a validation exercise the comparison is limited to between two points in time—in this case, 1998 and 2005.

1.3.4 Explanation of the Development of the Forecast Closure

Analogous to Chapter 1.3.2, this chapter contains the derivation of a forecast closure from a decomposition closure with the intention of illustrating theoretical concepts in the model that are important in the context of the validation exercise. We reiterate that:

- this is not intended to be a detailed description of the entire model or the full-blown forecast—rather we seek to provide general explanations of how closure swaps and projections of the impact of technical change variables enable the model to accept extraneous data so as to forecast values for variables that are naturally endogenous, such as commodity outputs and employment;
- the closure swaps described in this discussion (and that appear in Table i and Figure iv) are illustrative of one approach that can be undertaken and draw heavily on Dixon and Rimmer (2002); and
- simulations using an historical closure provided the initial database values that, by and large, were used to generate the USAGE forecast for 1998 to 2005.

As explained in Chapter 1.0, the database used for the beginning of the forecast is arrived at through first conducting an historical simulation for a preceding period (in this case, 1992 to 1998). In addition, estimates for disaggregated technology and taste variables that were endogenously determined in the historical simulation (such as the various preference twists in the use of commodities and factors throughout the economy) are exogenously projected forward in the forecast simulation.

In some cases, a straight-forward extrapolation is used. For example, shifts in household preferences for commodities derived in the historical simulation are projected forward in the forecast. However, in other cases simple extrapolation produces unsatisfactory results: such as for rates of primary-factor-saving technical change, shifts in export demand curves, input-using technology/taste changes, and import-domestic preference twists. In these instances, *contributions* to output are projected forward. For import-domestic twists, for example, Dixon and Rimmer (2002) found that forecasts should be based on extrapolations of twist contributions rather than extrapolations of the twists variables themselves. The twist contribution is the *impact* of the domestic-import preference twist on domestic output. In USAGE, the commodity-level variable that defines the impact of domestic-import twists is given by impftwist(i).

Extrapolating impftwist(i) rather than ftwist_src(i) avoids overstating market share losses to domestic producers caused by high import-domestic twist values where imports are growing rapidly off a low base. However, extrapolating impftwist(i) is not problem free. Assume that in a preceding historical simulation there was a strong twist away from imported commodity i and that imports of i had become negligible by the end of the simulation period. In this instance, the model would calculate a large positive value for impftwist(i), which would imply a big contribution to the domestic production of commodity i during the period of the historical simulation. In the subsequent forecast period, with imports so low, it is not possible for further twists away from imports to make additional meaningful contributions to domestic output. Under these circumstances, where commodities are characterised by low import shares in domestic sales, Dixon and Rimmer (2002) take an additional step to subdue the effects of twist trend impacts on domestic output. In particular, the authors apply a damping factor that limits the effect of impftwist(i) as the import share of commodity i approaches zero—regardless of the value of impftwist(i).

Chapters 2.1 and 2.2 explain the effects of domestic-import twist trend impacts using numerical illustrations of the computation. But for the purposes of understanding the forecast closure, consider the following stylized versions of equations in the model:

$$\text{impftwist}(i) = -\text{AVIMPSH}(i) * \tilde{\text{f}}\text{twist\_src}(i) + \tilde{\text{d}}\text{ftwist\_h}(i) \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.41}$$

$$\text{DTW}(i) * \text{impftwist}(i) = -\text{AVIMPSH}(i) * \tilde{\text{f}}\text{twist\_src}(i) + \text{dftwist\_f}(i) \, , i = 1,2,\ldots,N_{COM} \tag{1.3.42}$$

$$\text{AVIMPSH}(i) = \frac{\left\{ \begin{array}{c} \sum_{j=1}^{N_{IND}} \left[S_1(i,imp,j) * X1(i,dom,j) + S_2(i,imp,j) * X2(i,dom,j) \right] \\ + S_3(i,imp) * X3(i,dom) + S_5(i,imp) * X5(i,dom) \end{array} \right\}}{\left\{ \sum_{j=1}^{N_{IND}} \left[X1(i,dom,j) + X2(i,dom,j) \right] + X3(i,dom) + X5(i,dom) \right\}} \tag{1.3.43}$$

$$, i = 1,2,\ldots,N_{COM}$$

In (1.3.41) and (1.3.42):

> $\text{impftwist}(i)$ is the percentage change in the impact of twist trends on non-margin and non-inventory domestic demand, i.e., it reflects the contributions of technology and preference-related twists to domestic demand growth for domestically-produced goods;
>
> $\text{ftwist\_src}(i)$ is the percentage change in a variable that allows for import-domestic twists by commodity;
>
> $\text{dftwist\_h}(i)$ is the percentage change in a shift variable that is exogenous on zero in historical simulations but endogenous in forecast simulations (exogeneity in historical activates the equation such that $\text{impftwist}(i)$ can be determined for all i);

$dftwist\_f(i)$ is the percentage change in a shift variable that is exogenous on zero in forecast simulations but endogenous in historical simulations (exogeneity activates the equation for all i and ensures that the value for $ftwist\_src(i)$ is determined by this equation, where it subsequently impacts domestic demand through equations such as (1.3.34));

$AVIMPSH(i)$ is a coefficient that gives the average import share of good i across non-margin and non-inventory uses; and

$DTW(i)$ is a coefficient with values in the [0,1] interval, and that increases from zero to one as the share of imported good i in domestic sales of good i rises from zero to 10%.

Thus, (1.3.41) and (1.3.42) allow for the (historical) calculation and subsequent projection of $impftwist(i)$. A damping factor in (1.3.42) prevents $impftwist(i)$ from being fully extrapolated in forecast simulations where the market share of imports is too low for its historical impact on domestic output to continue. This import share is given in (1.3.43), where:

$X1(i,dom,j)$ is the level of intermediate input use of domestic commodity i by industry j;

$X2(i,dom,j)$ is the level of inputs for capital creation of domestic commodity i by industry j;

$X3(i,dom)$ is the level of household demand for domestic commodity i;

$X5(i,dom)$ is the level of government demand for domestic commodity i;

$S_1(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in current production;

$S_2(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in investment activities;

$S_3(i,imp)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by households; and

$S_5(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by government.

Since it is naturally exogenous micro-level variables that are projected forward, there are relatively few departures from the decomposition closure (departures include some macro aggregates, impftwist(i), dftwist_f(i), and contributions to output of certain technology and preference variables). Other naturally exogenous variables that are shocked to reflect expert projections, as in the historical closure, might include: CPI inflation, growth in the number of households and world GDP.[19]

In any case, when compared to preceding historical simulations, forecast simulations usually contain fewer disaggregated variables taking on exogenous values because, according to Dixon and Rimmer (2002), it is difficult to obtain expert projections for all the types for which there are historical observations. For example, the exogenous treatment of total labour in the decomposition closure is retained in forecast mode, whereas disaggregated labour is exogenized in the historical closure. In instances where disaggregated or micro forecast data are available (or can be inferred from existing data), the data are utilised to the fullest extent.

In this chapter, the swap numbers refer to action in the decomposition and forecast columns of Table i, i.e., the middle (grey-shaded) column and the unshaded right hand side column.

Macro forecasts for government, households, investment and imports

Swap numbers 1, 2, 4 and 6 enable the model to accept expert projections for the macro expenditure aggregates. Swap numbers 1 and 2 are identical to the swaps in the development of the historical closure. In swap number 1, the ratio of real private consumption to real government consumption, γ in (1.3.5), is endogenized, while aggregate real government demands are exogenized and shocked with the value for expected growth between 1998 and 2005. The endogeneity of f5_gen in (1.3.6) imparts equal percentage changes on government demand for commodities reflecting an assumption of no change to the structure of public spending.

Swap number 2 exogenizes aggregate real household consumption expenditure (cr) such that it can be shocked with the projected value for growth over the forecast horizon. Swap number 2 is completed with the endogenization of the average propensity to consume out of gross national income (APC).

Swap number 4 enables the utilization of an expert projection for aggregate real investment expenditure. It does so through a swap that exogenizes the variable, ir, to prepare it for the forecast shock; and endogenizing a uniform shifter in investment-capital ratios, ik_ratio_u. The relevant equations here are (1.3.12) and (1.3.13), which contain the variables, ir and ik_ratio_u, respectively.

[19] Furthermore, a forecast simulation can employ a special purpose equation to cater for an expert projection of real GDP growth so as to allow for a comparison with real GDP implied by exogenous projections for growth of C, I, G, X and M. Equations of this type do not require the model to depart from the decomposition closure.

Aggregate imports is exogenized in swap number 6 by endogenizing a broad taste variable related to import-domestic preferences, twist_src_gen, via (1.3.18) and (1.3.20). The variable, twist_src_gen, imposes equal percentage changes across industries in biases related to the use by economic agents of imported commodities relative to their domestic counterparts.

Exports, capital and terms of trade

Swap numbers 7 and 8 facilitate the introduction of expert projections for aggregate exports and the terms of trade by unshackling export-supply and -demand curves. Implementing these swaps also has the effect of determining total capital. Given these swaps are highly inter-related, they are considered simultaneously.[20] One way to understand swaps 7 and 8 is via a demand and supply analysis. We start with an export supply function.

At this stage of the development of the forecast closure, the volume of exports is the only macro expenditure aggregate yet to receive a shock reflecting an expert projection. Total employment retains its exogeneity from the decomposition or standard long-run closure and is shocked with the value for expected growth between 1998 and 2005. In (1.3.2) it can be seen that GDP from the income side is related to technology and a function of capital and labour. From (1.3.1) and (1.3.2), we could write:

$$X = GDP_{EXP} - \left(\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M}\right) \quad \text{and} \quad GDP_{INC} = \tilde{A} * F\left(\tilde{L}, K\right)$$

where the tildes (~) indicate exogeneity at the completion of swap numbers 1, 2, 4 and 6. Combining these two expressions, we obtain (1.3.44):

$$X = \tilde{A} * F\left(\tilde{L}, K\right) - \left(\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M}\right) \tag{1.3.44}$$

Now, we replace K with a function of the terms of trade to develop a supply function for exports (i.e., a function that relates exports to the terms of trade). To do this, we recall from Chapter 1.3.2 that, abstracting from taxes and depreciation, the rate of return is approximately given by the ratio of the nominal rental on capital (Q) to an asset price index (P_I). Assuming that the nominal rental on capital (an indicator of profitability) is equal to the value of the marginal product of capital and that there are constant returns to scale (as assumed in USAGE), we have:

[20] The reader may wish to revisit the explanation on exports in the development of the historical closure in Chapter 1.3.2. In the context of the USAGE forecast simulation for 1998 to 2005, X and X' that appear on the horizontal axis of Figure v can be reinterpreted as export volumes in 1998 and 2005 (projected), respectively.

$$\tilde{R}OR = \frac{Q}{P_I} = \frac{P_G}{P_I} * MP_K = \frac{P_G}{P_I} * \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right)$$

where P_G is a price index for domestic goods (the GDP deflator). The ratio $\frac{P_G}{P_I}$ may be interpreted as an increasing function for the terms of trade (TOFT) because P_I, which is a price index for capital goods, includes import prices but not export prices while the reverse is true for P_G :

$$\therefore \quad \tilde{R}OR = H(TOFT) * \tilde{A} * F_K\left(\frac{K}{\tilde{L}}\right) \qquad (1.3.45)$$

Rearranging, we obtain (1.3.21):

$$K = \zeta\left(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT\right)$$

where K is an increasing function of TOFT. (With ROR, A and L fixed, (1.3.45) implies that an increase in TOFT, which increases H, must reduce F_K. This requires an increase in K.)

Substituting into (1.3.44) gives:

$$X = \tilde{A} * F\left(\tilde{L}, \zeta\left(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT\right)\right) - \left(\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M}\right) \qquad (1.3.46)$$

Equation (1.3.46) is the export supply function. It expresses exports as an increasing function of the terms of trade. (An increase in TOFT generates an increase in ζ, which generates an increase in F, which generates an increase in X.)

On the demand side, the USAGE model specifies exports for each commodity as a function of their foreign-currency price and of shift variables, one of which can represent prices of competing products in other countries. In stylised terms, we can write:

$$X = \Xi\left(\frac{\Phi * P_D}{\tilde{P}_F}, \tilde{F}_{GEN}\right)$$

where X is aggregate exports;

Φ is the level of the nominal exchange rate;

P_D is the f.o.b. domestic-currency price index of U.S.-produced commodities;

P_F is a shifter representing foreign-currency prices of competing products in the rest of the world; and

F_{GEN} allows for a uniform shift in demand for competing products in the rest of the world.

The expression $\frac{\Phi * P_D}{\tilde{P}_F}$ is a proxy for the terms of trade (TOFT) because the numerator represents the foreign-currency prices of exports, while the denominator is the foreign-currency prices of imports. Thus:

$$X = \Xi\left(\mathrm{TOFT}, \tilde{F}_{GEN}\right) \tag{1.3.47}$$

For a given exchange rate, an increase in the price of U.S.-produced commodities (implying a rise in the terms of trade) increases the attractiveness of foreign-produced competing products in other countries through a beneficial change in relative prices—to the detriment of U.S. exports. In instances where relative-price changes between the U.S. and the rest of the world move against the import-competing sector in other countries—a fall in TOFT—U.S. exports rise. These scenarios (effectively changes in the relative-price of tradeable goods) imply that exports are a reducing function of the terms of trade (i.e., the export-demand curve is downward-sloping from left to right).

Having derived the slope of the export-supply and -demand curves [(1.3.46) and (1.3.47)], we turn our attention to the implementation of swap numbers 7 and 8. These swaps allow for the introduction of expert projections for the terms of trade and aggregate exports, respectively, by enabling shifts in the export- supply and -demand curves. Beginning with swap number 8, an expert projection for aggregate exports is facilitated by exogenizing X, thereby allowing this variable to be shocked with the projected value for growth between 1998 and 2005. Swap number 8 is completed by endogenizing an economy-wide technical change variable (A), which allows the export-supply curve to shift. Indeed, the endogeneity of A (e.g., all-industry primary-factor-augmenting technical change) allows supply-side GDP to adjust to equal the target set by expenditure-side GDP. This degree of freedom in technology prevents real GDP from being over-determined.

In the absence of an extraneous forecast for the terms of trade, if the accommodation of observations in export volumes were to be restricted to variations in the export-supply function, any large change in export volumes could result in unrealistic changes in the term of trade, thereby distorting the model's results. The availability (and implementation) of an expert projection for the terms of trade alleviates the potential for such a problem. In swap number 7, the variable for the terms of trade (toft) is exogenized and shocked accordingly. The swap is completed with the endogenization of a general export demand shifter, feqc_gen, which allows for a uniform horizontal (or quantity) shift in export demands. In short, swaps 7 and 8 result in the projection for aggregate export volumes being accommodated by fixing the terms of trade at its projected value and allowing movements in both export-demand and -supply curves (endogenous feqc_gen and A, respectively), with the split determined by the model.[21]

At this juncture, we pause briefly to consider the role of the exchange rate in a USAGE baseline forecast. In the forecast simulation for 1998 to 2005 the nominal exchange rate was endogenously determined. In the model, movements in the nominal exchange rate are closely linked to movements in the terms of trade. The projection for the terms of trade was for little change; hence the nominal exchange rate was computed to move only modestly. If the projection was for a neutral terms of trade, then the role of the nominal exchange rate is to reconcile inflation in the U.S. with inflation in the rest of the world. If there was to be no change to terms of trade and relative inflation rates between the U.S. and the rest of the world were also unchanged, then the exchange rate would remain steady.

Finally, with the completion of this step, capital is determined via (1.3.21), which is presented here taking into account the re-configuration of exogeneity indicators (~): $\tilde{K} = \zeta\left(\tilde{R}OR, A, \tilde{L}, \tilde{T}OFT\right)$

Contributions to outputs and costs of changes in tastes and technologies

Swap numbers 14, 15, 18, 20, 21 and 23 facilitate the projection of the contribution to outputs and costs, at the commodity level, of various preference and technical change variables. As explained in Chapter 1.3.4 in relation to domestic-import preference twists, the model can generate unsatisfactory outcomes when using straight-forward extrapolation to project forward the effects of taste and technology changes. It is with this in mind that we sometimes project forward contributions to outputs and costs in this set of swaps. Similar to the implementation of the USAGE model, in this sample forecast closure, straight-forward extrapolation is used for shifts in household preferences and intermediate-input-saving technical change by industry[22]; while output contributions are projected forward for export demand shifts, domestic-import preference twists, and input-using technology and taste change by commodity. In the case of primary-factor-saving

[21] This is similar to the approach used in the historical closure and explained in detail in Dixon and Rimmer (2002), with the exception that there is no projection for the nominal exchange rate. In the historical closure, the nominal exchange rate was exogenous so as to be shocked with its observed change from 1992 to 1998, while a uniform shifter for foreign-currency import prices was endogenous, thereby allowing the model to reconcile the projections for the terms of trade and the exchange rate.

[22] In the USAGE model, average output-augmenting technical change is projected forward, rather than intermediate-input-saving technical change. In this thesis, we have focused on the latter variable to avoid unnecessary complication. The reader may recall that the intermediate-input-saving technical change variable was relevant in the exposition of the historical closure where swaps allowed the model to absorb price observations for domestically-produced commodities.

technical change, the cost-saving effect is projected forward.[23] Take, for example, shifts in export demand curves (swap number 14). If exports of commodity i were low, then even a small rise in absolute dollar terms would equate to a large increase in growth. For instance, a move from $1 to $10 is equivalent to a 1,000% increase—hence, rather than projecting forward a 1,000% increase, we project forward the contribution to output. In this way, for the preceding historical simulation, if exports of commodity i were low in total output, its output contribution is low and more realistic forecast simulation outcomes are obtained if it is this contribution that is projected forward.

Swap numbers 18 and 20 operate in a similar fashion, whereby we project forward contributions to costs for primary-factor-saving technical change and to outputs for input-using technology and taste change, respectively. Meanwhile, swap numbers 16 and 21 facilitate straight-forward extrapolations of household preferences and intermediate-input-saving technical change, respectively.

Swap numbers 15 and 23 allow for the contribution to output of domestic-import preference twists to be projected forward. An alternative way to interpreting this is that we are projecting forward the impact on the market share of domestic producers of historically-computed domestic-import preference twists. At the micro level, the variable impftwist(i) is exogenized and shocked with values extrapolated from their historically simulated assessments. Swap number 15 is completed by endogenizing ftwist_src(i), a variable that influences domestic demand for domestically-produced goods. Swap number 23 ensures that ftwist_src(i) is determined in the 1998 to 2005 forecast simulation by (1.3.42), which includes a damping factor on impftwist(i) that is not required in the historical simulation for 1992 to 1998.

This concludes the development of the forecast closure. It is opportune to reiterate that growth in foreign-currency import prices is also projected forward in the forecast simulation. Extraneous projections for CPI inflation, the number of households and world GDP are also included in the USAGE forecast. These variables appear in the top section of the first page of Table i. As shall be seen in the next chapter, projections for import prices and the various technical and taste change variables can heavily influence the forecast for commodity outputs, sometimes resulting in large errors.

A final note here relates to how industry-level capital and investment is determined in the forecast simulation. We saw in this chapter how capital is determined by (1.3.21). In a seven-year forecast simulation of the type described in this chapter, industry-level rates of return, ror(j), are given exogenously. With total employment and the terms of trade exogenous and shocked in accordance

[23] In swap 18, the contribution to costs of primary-factor-saving technical change, cont_a1prim(j), is exogenized and projected forward, rather than a1prim(j) itself.

with an expert projection, and technology largely determined, capital in each industry is also largely determined. In other words, for the purposes of a forecast simulation, capital is put in place by assumptions about rates of return—independently of investment. If the rate of return in industry j is high, this implies that capital is scarce, and vice versa. The exogeneity of industry-level investment-capital ratios, ik_ratio(j), then allows for the determination of investment in each industry. For instance, if the commercial fishing industry is implied to have a 10% increase in capital, then investment in that industry is assumed to have risen by 10%. Given that there is an extraneous forecast for aggregate investment, the endogeneity of a uniform shifter in investment-capital ratios, ik_ratio_u, ensures consistency via an across-the-board adjustment to the industry-level investment results.

2.0 The Size and Source of Forecast Errors

Economic forecasting is a difficult pursuit and inaccurate predictions seem to be a relatively common occurrence. Even if a forecast model is correctly specified and is a good representation of the economy, the structure of that economy is unlikely to remain unchanged. Structural shifts can, and do, occur and as time goes by these changes can become more pronounced. It is, therefore, an important consideration to account for the likely future structure of the economy when analysing the impact of potential policy changes. Where structural change is predicted in a baseline forecast the effects of policy changes can widely differ from a *status quo* assumption about the future structure of the economy. As noted previously, this thesis examines methods for improving baseline economic forecasts using a dynamic CGE model. Forecasting can be used to test the validity of such models, as well as to highlight possible improvements, by investigating the discrepancies between the forecast and actual outcomes.

USAGE is a recursive-dynamic, 500-industry CGE model of the U.S. developed at the Centre of Policy Studies, Monash University, in collaboration with the U.S. International Trade Commission (USITC). USAGE generates baseline forecasts by incorporating expert projections for certain macro variables and extrapolating historical trends in technology, consumer preferences, positions of foreign demand curves for U.S. products, and numerous other naturally exogenous variables. In instances where important trends either dissipate or reverse, large forecast errors can arise. This thesis seeks to provide explanations and guidance as to whether these various trends from the period 1992 to 1998 would continue for the 1998 to 2005 USAGE forecast. Dixon and Rimmer (2010a, p. 23) note that the importance of the baseline was recognized by the USITC in their 2007 report on import restraints:

> "...in the 2007 report they incorporated an explicit baseline out to 2011 that recognised the secular decline of import-competing industries, such as Textiles, Apparel and Sugar. Thus, in the 2007 report, the USITC avoided exaggerating the likely economy-wide effects in 2011 of reductions in import restraints."

The aim of the paper by Dixon and Rimmer (2010b) was to assess the aforementioned method of baseline forecast generation. In particular, using data available up to 1998 the method was applied to generate "pure" forecasts for 1998 to 2005. These forecasts were then compared with the actual outcomes for this period and with alternate forecasts derived as extrapolated trends from 1992 to 1998. In measuring forecasting-performance, Dixon and Rimmer (2010b) calculate the average error

(AE) of the forecast as well as a coefficient (*M*) that gives the ratio of average errors between the pure USAGE forecast and the extrapolation-based trend forecast.

AE can be defined as:

$$AE = \left(\frac{1}{N}\right) * \sum_{c} \left| f_c - a_c \right| \bigg/ \left(1 + \frac{a_c}{100}\right)$$

where

f_c is the forecast of the percentage change in the output of commodity *c* between 1998 and 2005;

a_c is the actual percentage change in the output of commodity *c* between 1998 and 2005; and

N is the number of commodities (503 in the present application of USAGE).

The term for commodity *c* is the gap between the forecast output for commodity *c* in 2005 and the actual output, expressed a percentage of the actual output. Thus AE is an *unweighted average* across the 503 USAGE commodities in percentage gaps between forecast levels of commodity outputs and actual levels—in the charts further below this is labelled as “AE(uniform)”.

M is defined as:

$$M = \frac{\sum_{c} \left| f_c - a_c \right| \bigg/ \left(1 + \frac{a_c}{100}\right)}{\sum_{c} \left| h_c - a_c \right| \bigg/ \left(1 + \frac{a_c}{100}\right)}$$

where

h_c is the percentage change in the output of commodity c across the historical period, 1992 to 1998, extrapolated to make it apply for a seven-year period rather than a six-year period.

If *M* = 1, then the USAGE-based forecast has the same level of accuracy as a non-model-based forecast generated by trends. Alternatively, if *M* = 0.7, then the USAGE model has eliminated thirty percent of the error involved in simply relying on historical trends. (Dixon and Rimmer, 2010b, p. 28) In this case, *M* is the ratio of the *unweighted* average errors, with the weights for each commodity equal to 1/503. Hence, this is labelled “M(uniform)” in the charts that appear further below. According to Dixon and Rimmer (2010b, p. 30), USAGE forecasts incorporate trend assumptions for nearly all technology, preference and trade-shift variables; and movements in these variables are major determinants of changes in the commodity composition of U.S. output. The authors contend that there are three reasons explaining how USAGE can outperform (or underperform) trend forecasts (p. 30):

> "The first is that USAGE forecasts for commodity outputs are driven by macro and energy forecasts that deviate from trends. Second, the starting point for the USAGE forecasts is different from the starting point for the historical trends. Sales structures for each commodity and rates of return and cost structures for each industry in 1998 differ from those in 1992. These differences mean that trends imposed with 1998 being the starting point can have different effects from similar trends imposed in 1992. For example, a given trend in foreign demand for commodity *i* will have a different effect on output depending on the share of exports in sales of commodity *i*. Third, USAGE recognises detailed demand linkages. Thus, for example, if the USAGE forecast for output or investment in industry *i* differs from the trend forecast and output of *j* depends heavily on sales to either output or investment in *i*, then the USAGE forecast for output of *j* is likely to differ from the trend forecast."

In instances where important trends either dissipate or reverse, large forecast errors can arise. This thesis provides explanations and guidance as to whether these various trends would continue for the 1998 to 2005 USAGE forecast. It is found that for some commodities, certain important trends should not have been expected to continue, and hence a better forecast could have been generated had all publicly available information at 31 December 1998 (the end of the base year of the forecast) been appropriately utilised.

In examining the largest commodity forecast errors, macro and industry-specific commentary is included. With regard to magnitude there are essentially two types of USAGE forecast errors. The first is where the USAGE error is large from an absolute value perspective; and the second is where the USAGE error is large relative to the error attributable to the extrapolated trend. The *M* coefficient is always adversely affected by the second of these two errors. When using extrapolated trend as the benchmark the forecasting-performance of USAGE is enhanced whenever USAGE is closer to the mark (actual growth in the forecast period) irrespective of sign. While it is useful to gain a better understanding of what went wrong in cases where the trend outperformed, there were many instances where the USAGE error was very large but was eclipsed by the forecast trend error. These USAGE errors warrant investigation in their own right as they detract from the overall quality and usefulness of the forecast. Ultimately, the best forecasts are the ones that are right and achieve this for the right reasons (rather than by mere coincidence), thereby increasing confidence in the robustness of the methodology employed.

Table A is divided into two sections; the top section contains commodities for which the USAGE error is relatively large versus trend error and is sorted as such (last column); the bottom section sorts those commodities that incurred the largest USAGE errors (third column). The commodities *AsbestosPrd* (Asbestos Products) and *BootCutStock* (Boot and Shoe Cut Stock and Findings) have large enough errors to merit appearing in both sections. In all, these are the twenty worst performers from an error perspective and warrant further analysis.

AsbestosPrd provided the largest USAGE error and was also the largest error relative to the trend forecast. The nature of the error for this commodity was explained in Dixon and Rimmer (2010b, pp. 31-2) and will not be revisited here. Table A shows that for *AsbestosPrd* the USAGE pure forecast error was 151%, calculated as $\left|f_c - a_c\right| / \left(1 + a_c/100\right)$, while the trend error was 43%, calculated as $\left|h_c - a_c\right| / \left(1 + a_c/100\right)$. If these percentage errors are taken as "co-ordinates" the forecasting-performance of each commodity can be plotted. This is illustrated in Figure A for each of the commodities listed in Table A.

From Table A it can be observed that for *ComFishing* (Commercial Fishing) actual growth was -13% over the 1998-2005 period. This followed a 19% decline from 1992 to 1998—the extrapolated trend was therefore -22%—yet USAGE forecast 36% growth. The USAGE error was 56% whilst the forecast trend missed by just 10%. The difference between these two figures determines the distance from the 45-degree line in Figure A. If both forecasts were spot-on target then the data point would coincide with the origin. If they were both wrong by precisely the same (absolute) percentage then the data point would sit somewhere on the 45-degree line; the larger the error, the further from the origin.

Where *ElectronTube* (Electron Tubes) is concerned both the USAGE forecast and extrapolation yielded high errors. Following a period of strong growth from 1992 to 1998 output of this commodity contracted by 14% in the forecast period of 1998 to 2005. However, the USAGE model forecast a further 114% growth while the trend was extrapolating 189% growth. The USAGE error of 149% was eclipsed by the trend error of 236% and so this made a helpful contribution to the *M* coefficient. As a result USAGE clearly outperformed the simple extrapolation technique. With an absolute difference of -87 this placed *ElectronTube* well below the 45-degree line. (These "vertical displacement" figures appear in the last column of Table A.) There were only six other commodities that were situated even further below the 45-degree line (i.e., easily outperformed the trend forecast); one of these being *RailroadEq* (Railroad Equipment), which is discussed in Dixon and Rimmer (2010b, p. 31) and will not be revisited here.

COMMODITY *i*	USAGE F'CAST 1998-2005	USAGE ERROR %	ACTUAL GROWTH 1998-2005	HISTORICAL 1992-1998	TREND F'CAST 1998-2005	TREND ERROR %	45^o LINE above/(below)
233 AsbestosPrd	**51**	**151**	**-40**	**-12**	**-14**	**43**	**108**
18 ComFishing	36	56	-13	-19	-22	10	**46**
387 Dolls	-31	51	40	16	19	15	**35**
451 Theatres	44	35	7	7	8	1	**33**
40 AccStrucSMD	-13	39	41	29	34	5	**33**
39 PetNgExplor	-18	42	42	46	55	9	**33**
206 BootCutStock	**45**	**108**	**-30**	**19**	**22**	**75**	**32**
38 PetNgDrill	-15	41	44	50	60	11	**29**
23 Nonferrores	9	75	-38	-5	-5	52	**23**
22 Copperore	5	29	-18	-11	-13	7	**22**
231 CutStone	-14	24	13	14	16	3	**21**
345 ElectronTube	114	**149**	-14	148	189	236	(87)
115 Knitfabric	24	**139**	-48	33	40	169	(30)
210 Luggage	-12	**131**	-62	10	12	193	(63)
114 Hosierynec	19	**122**	-46	30	36	153	(31)
116 Apparel	16	**121**	-48	25	30	148	(26)
205 LeatherTan	-5	**119**	-56	-2	-2	124	(5)
209 Leathrgloves	-17	**114**	-61	3	4	166	(52)
211 WmnsHandbag	19	**107**	-42	23	27	121	(14)
351 Recordmedia	42	**101**	-30	29	35	91	10

Table A: The twenty worst errors on a relative and/or absolute basis

Figure B shows that the unweighted AE is 18.9% in the pure forecast. In other words, the forecast error for a typical industry is 18.9%. At first glance the result for the AE seems large, especially when the simulation result for real GDP growth over the period was about 21.64% (not shown). According to Dixon and Rimmer (2010b, pp. 28-9):

> "This would be a disastrously large average error if all industries had actual growth rates in a tight band around 21.64. But they did not. The actual growth rates were spread over the range -66 (for slippers) to 218 (for computer peripheral equipment). Only 151 out of the 503 USAGE commodities exhibited output growth within 10 percentage points of the average. The *M* coefficient gives a more optimistic view of the USAGE forecasts than that obtained from AE. When every commodity is treated as equally important the M coefficient indicates that USAGE reduces the forecast error by 42 percent (*M* = 0.58) relative to a simple non-modelling extrapolation approach..."

As can be seen in Figure B, the bulk of the points lie below the 45-degree line, hence from an *M* perspective the USAGE forecasts have comfortably outperformed a simple trend forecast. This is reflected by the *M* coefficient taking a value well below 1.

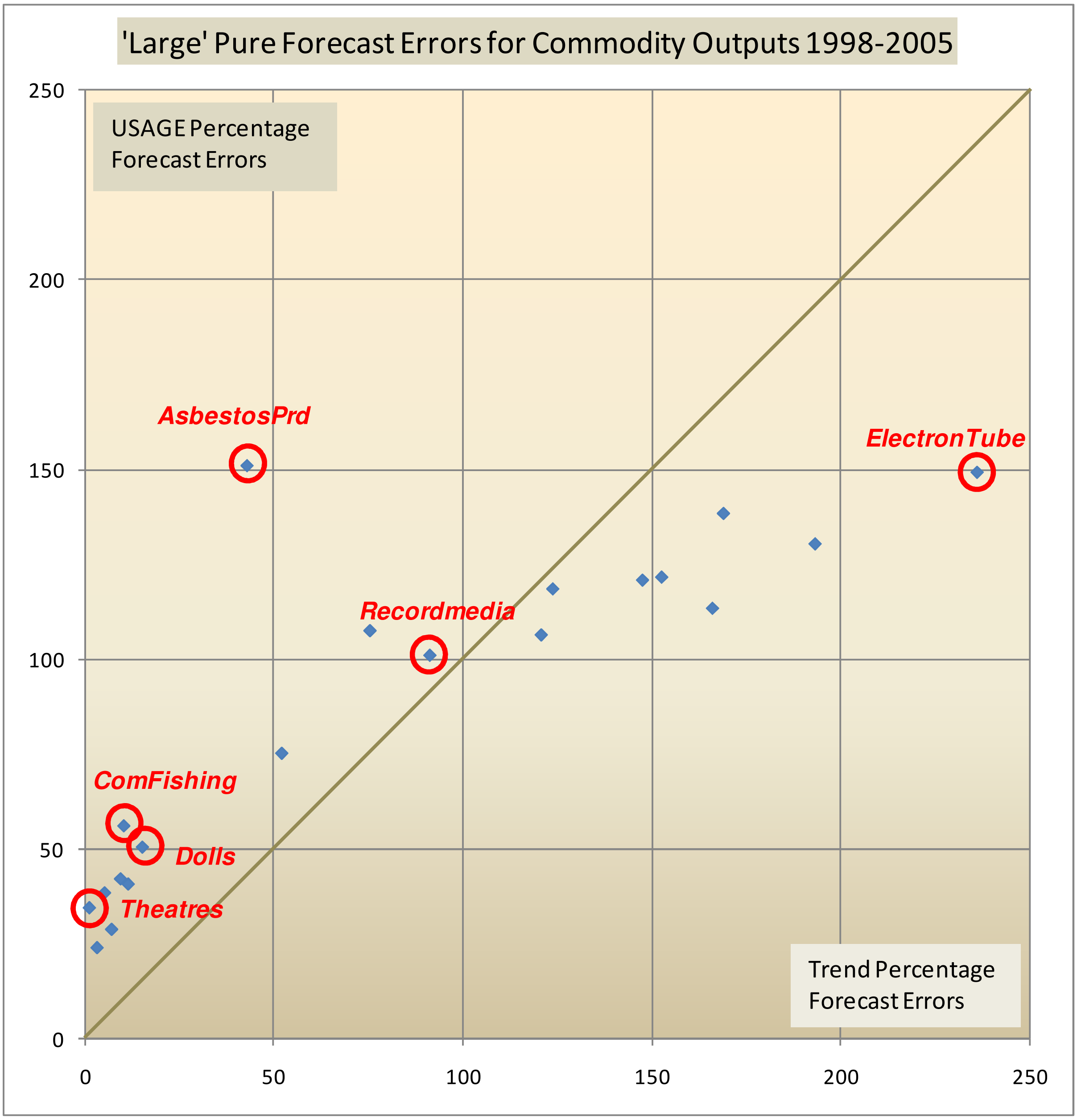

Figure A: Percentage forecast errors for 'large-error' commodity outputs 1998-2005—extrapolated 1992-1998 trend forecast versus the original USAGE pure forecast

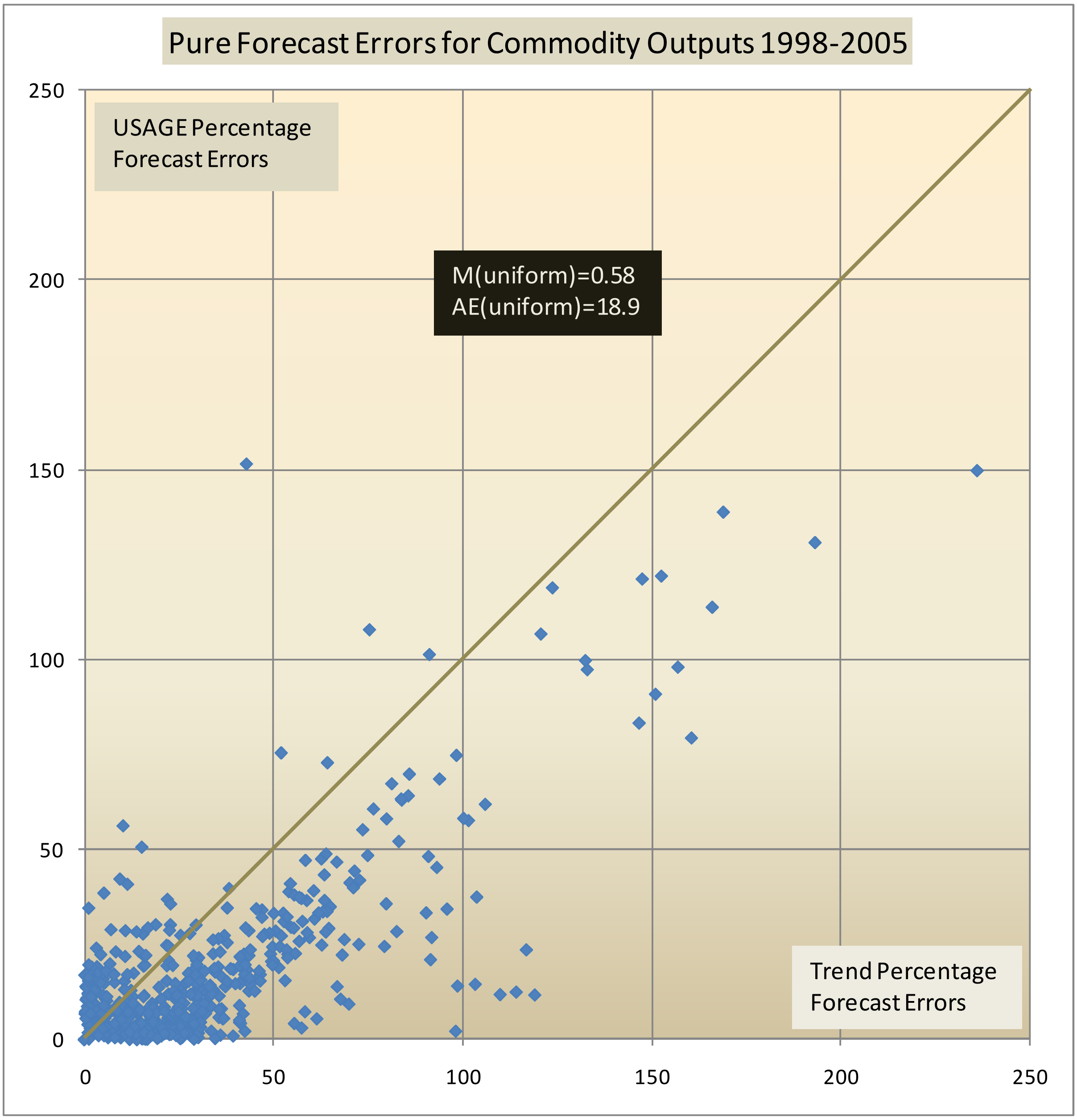

Figure B: Percentage forecast errors for all commodity outputs 1998-2005—extrapolated 1992-1998 trend forecast versus the original USAGE pure forecast

2.0.1 Large Forecast Errors via Domestic-Import Preference Twists

In examining the more sizable errors the approach taken is both 'big picture' macro and nitty gritty 'model specific' reasoning. In relation to the latter, it was discovered that where large domestic-import *twist factors* were projected forward during the forecast run, this entrenched patterns that were perhaps only *temporary* phenomena. Twist factors provide a degree of freedom in the model to generate known variables in historical (or pre-forecast) mode, such as for imports. An import twist is said to describe the change in tastes between imported and domestic commodities. As explained in Chapter 1.3.2, twists do not affect the overall quantity used in a particular good. In the USAGE model there are different types of import twists. For example, there is a:

1. twist that applies overall (*twist_src*)—this takes into account various industry-specific twists (see points 2 and 3) and an economy-wide or uniform twist (twist_src_gen);
2. twist effect (*twist_eff*)—this is the same as $(\mathrm{x0dom}(i)-\mathrm{gdpreal})$ in (1.3.18) and the direction of this depends on whether the industry is growing faster or slower than real GDP. In the former case, this will produce a positive sign on this variable that favours imports; and
3. shifter variable (*ftwist_src*), which relates only to domestic sales of domestically-produced commodities—and the impact of this on output is measured by *impftwist*.[24]

Both *impftwist* and *ftwist_src* apply to domestic demands, but *not* export demand, which depends on foreign preferences. From 1992 to 1998, it was noticed that most twists had been favouring imports, perhaps as people became more aware of the availability of these goods, e.g., through the Internet. More broadly, an interesting finding is that where twists are present, they most often experienced a change of sign or became stronger across simulations (1992-1998 versus 1998-2005) towards imports. For commodities where the model performed less well, this seemed to coincide with a change in sign across simulation periods of *impftwist*, e.g., *BootCutStock, Dolls, ComFishing,* and *AsbestosPrd*. Under these circumstances, the model extrapolated the historical value of *impftwist* into the forecast—and where *impftwist* was large this would typically overwhelm other factors affecting the projection, resulting in large errors in absolute terms of commodity outputs by domestic producers.

[24] *impftwist* helps to explain changes in domestic sales of U.S.-produced commodities that cannot be fully explained by relative-price movements between the domestic good and its imported equivalent, and by growth in the U.S. market for those commodities. In these instances, the model infers that there must have been a change in preferences towards (away from) the domestically produced good and away from (towards) imports. This is referred to as a *domestic-import twist*. The impact of this twist, or contribution to output, is projected forward, resulting in a boost (reduction) to domestic production in the forecast.

Commodity *i*	*impftwist* 1992-1998 %	*impftwist* 1998-2005 %	Above/(Below) 45° Line
233 AsbestosPrd	25	-49	108
18 ComFishing	99	-68	46
387 Dolls	-53	39	35
206 BootCutStock	-62	110	32
351 Recordmedia	31	-46	10
211 WmnsHandbag	17	-85	(14)
345 ElectronTube	27	-2	(87)

Table B: 'Large-error' commodities where actual computed *impftwist* changed sign across simulations and whose impact was ≥|25%| in at least one of the periods

Table B shows a subset of the commodities in Table A where actual estimated *impftwist* changed sign across simulations *and* was ≥|25%| in at least one of the simulation periods. For these commodities the table reveals that USAGE often underperformed trend (this is indicated by a positive figure in the last column). Because the impact of domestic-import *twist factors* is extrapolated into the forecast assumptions in USAGE, this has the effect of reinforcing historical preference patterns that might only be temporary in nature. Without detailed industry analysis it is difficult to predict when import twist factors are about to move sharply against historical trend. Indeed, even with a full industry analysis such moves may not be expected.

2.1 Results Summary for ‘Large-Error’ Commodities

Commodity/Sector	Cause of Error	Industry Conditions[25]	Modelling Strategy
***ComFishing* – Commercial Fishing** <u>Growth: 1998-2005</u> Forecast: +36.4% Actual : -12.8% USAGE error = 56% [|36.4 – -12.8|/ (1 + -12.8/100) = 56]	From 1992 to 1998 the increase in domestic sales of U.S.-produced *ComFishing* could not be fully explained by relative-price movements between the domestic good and its imported equivalent, and by growth in the U.S. *ComFishing* market. This led the model to infer that there must have been a change in preferences towards the domestically produced good and away from imports. This is referred to as a *domestic-import twist*. The <u>impact</u> of this twist on output was projected forward, resulting in a strong boost to domestic production in the forecast. In reality, these domestic-import twist factors sharply reversed. Also, the observed sharp decline in the export demand function that occurred from 1992-1998 was extrapolated in the forecast; when, in reality, foreign preferences barely changed. This had a negating impact on growth, thereby preventing a larger forecast error.	A rudimentary examination of the industry in 1998 would have revealed that a restrictive regulatory regime had been imposed just two years earlier on commercial fishing activities. The Sustainable Fisheries Act (1996) marked a significant strengthening in the requirements to prevent overfishing and rebuild overfished fisheries. This would likely have resulted in lower catches (output) going forward, as well as relatively strong upward pressure on prices of the domestic product versus the imported commodity. This suggests that any shortage could only have been met by higher imports, which is in fact what happened, and had started happening in the period from 1992 to 1998.	Based on industry conditions between 1992 and 1998 a better forecast for *ComFishing* could have been produced. Given the restrictive nature of the regulations it is unlikely that output would have expanded. Knowing this, the strategy in re-running the simulation was to fix output growth at zero and endogenize export volumes (as there was no clear view on likely foreign demand). Furthermore, the model was prevented from projecting forward the impact on domestic production of the domestic-import preference twist. By setting this to zero, this prevented the unlikely large boost to domestic sales of U.S.-produced output versus imports. By forcing zero output growth the USAGE error fell from 56% to 15%. Post simulation it is conjectured that very large shifts in foreign preferences should be closely investigated, in terms of likely sustainability, rather than be automatically projected forward.

[25] Referencing is omitted in this Results Summary table for purposes of presentation. See Chapter 2.2 for referencing of commentary in the ‘Industry Conditions’ column.

***ElectronTube* - Electron Tubes** <u>Growth: 1998-2005</u> Forecast: +114.3% Actual : -14.3% USAGE error = 149%	From 1992-1998 there was a preference shift towards the greater use of *ElectronTube* as a production input. The contribution to output of this so-called *ElectronTube*-using technical and taste change was projected forward. *ElectronTube* derives its demand from the demand for other goods, such as televisions, that were subject to rapid changes in technology that did not require any *ElectronTube* input. The new technologies gained strong momentum from 1998-2005 and this coincided with negative *ElectronTube*-using technical and taste change. Also, analogous to *ComFishing,* the model inferred a preference twist towards the domestically produced good and away from imports. The <u>impact</u> of this twist on output was projected forward, resulting in a boost to domestic production in the forecast—but this did not eventuate. Finally, the observed sharp rise in the export-demand function that occurred from 1992-1998 was extrapolated in the forecast; however, from 1998-2005 foreign preferences moved sharply away from *ElectronTube*.	By 1998, non-*ElectronTube*-using flat panel technology (such as TFT LCD) was already being used in notebook computers. In 1992, Fujitsu introduced the world's first 21-inch full-colour plasma display. As early as 1990, projections were readily available that showed expected global sales of LCD technology would exceed *ElectronTube*-using CRTs before 2000. In light of the rising competitive pressure from flat panel technology, and with the U.S. generally regarded as an early adopter of high-tech audio visual products, falling prices during period from 1992 to 1998 signalled the decline of the CRT technology used in the Electron Tubes industry.	As sleeker, larger-screen replacements had already started to appear on the market, it is plausible that a substantial growth slowdown in *ElectronTube* could have been expected to occur during the 1998-2005 period; and at the very least, output more than doubling (as was the case in the original forecast) would have been seen to be a most unlikely scenario. In the historical 1992-1998 simulation, a large upward shift in the export-demand curve for *ElectronTube* was observed; as well as a strong twist trend impact on domestic sales of U.S.-produced *ElectronTube*; and *ElectronTube*-using technological change. Given rapidly changing industry conditions, it is clear that these factors ought not to have been projected forward, thereby allowing for an improved forecast. As a result, the strategy was to zero out contributions to output from: *ElectronTube*-using taste changes, foreign preference changes, and domestic-import preference twists. This simulation resulted in output growth of 23.3% and markedly reduced the USAGE error from 149% to 17%.

Dolls – **Dolls & Stuffed Toys** <u>Growth: 1998-2005</u> Forecast: -30.8% Actual : +40.4% USAGE error = 51%	From 1992 to 1998 overall domestic output was boosted by a large increase in inventories. At the same time there was a decrease in domestic sales of U.S.-produced *Dolls* that could not be fully explained by relative-price movements between the domestic good and its imported equivalent, and by growth in the U.S. *Dolls* market. This led the model to infer that there must have been a change in preferences away from the domestically produced good and towards imports. The <u>impact</u> of this preference twist on output was projected forward, resulting in significant damage to domestic production in the forecast; and easily outweighing the expansionary effect of other aspects of the model. In reality, these domestic-import twist factors sharply reversed. Furthermore by 1998 there was more than 90% import penetration, making it difficult to accurately forecast domestic output given that it would move off a low base. In this instance, the model does a better job at predicting the commodity's overall absorption, i.e., all U.S. sales of the commodity irrespective of source.	The doll market is segmented between play dolls and collectible dolls; each characterised by totally different sales distributions. Consumers are by far the largest users of dolls, with gifting by parents and grandparents to young girls being the key driver behind purchases. As a result of competition from computer and electronic games targeted to girls, manufacturers brought out more interactive dolls and updated their current products. Moreover, by late 1997 there was evidence than the collectibles market was growing very strongly as an increasing number of baby boomers entered the market; and 88% of the nation's doll retailers had pointed to new collectors as the top industry trend destined to impact store sales over the next five years. By 1998, total sales (domestic and imported) in the U.S. market for Dolls & Stuffed Toys valued at purchases prices was $7.9b (up from $4.8b in 1992). Collectibles was about 22% of the market and growing strongly.	U.S. producers were well positioned to meet growing demand and were already making more innovative products. If inventory changes are excluded, households accounted for more than two-thirds of sales of domestically-produced *Dolls*, with most of the remainder exported. Given the dynamics in the fast-growing collectibles market, a sharp decline in forecast would have seemed unlikely. In light of this, a better forecast for *Dolls* could have been produced. For this to materialise, the strategy in re-running the simulation was to prevent the model from projecting forward the negative impact on domestic production of the import-favouring preference twist. By setting this to zero, this barred the unlikely large contraction to domestic sales of U.S.-produced output versus imports. This resulted in an improved forecast for output growth of 11.0% and reduced the USAGE error from 51% to 21%.

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***Theatres* – Motion Pictures (excludes Video Rentals)** <u>Growth: 1998-2005</u> Forecast: +43.5% Actual : +6.5% USAGE error = 35%	Domestic sales of the U.S. produced commodity increased modestly between 1992 and 1998 despite a materially unfavourable change in relative prices. This arose because household tastes moved strongly in favour of *Theatres* between 1992 and 1998, i.e., by 1998 consumers preferred to purchase far more *Theatres* at any given set of prices and per capita income than was the case in 1992. Given insignificant imports, this drove prices sharply higher for the domestically produced commodity. The price rise hurt export volumes. However, as was the case for U.S. households, foreigners increased their liking to the commodity at any given price, thereby preventing a larger fall in exports. By 1998 the industry was beginning to experience the impact of piracy and other negative dynamics such as rising costs. The forward projection of additional strongly positive preference and taste changes for households and foreigners resulted in an exaggerated strong growth forecast.	By 1998, sales of U.S. entertainment both domestically and abroad were expected to depend, in part, on how new technologies were to be used for the delivery of entertainment and the barriers that U.S. companies were likely to encounter in foreign markets. New technologies at the time included: the internet; DVD and satellite delivery systems for programming. Many industry observers believed that within a decade the Internet would play a major role in delivering filmed entertainment to homes. In 1998 music piracy was a common feature of the internet. However, with the rise in broadband internet connections beginning around 1998, higher quality movies began to see widespread distribution—and ISO images copied directly from the original DVDs were slowly becoming a feasible distribution method. Where faster broadband connections were available (e.g., universities, businesses, and government departments, etc.) the downloading of television shows and movies was not unusual.	Based on the way that the music industry had reacted to piracy it is clear that growth in *Theatres* could have been blunted by growing movie piracy during the forecast period. It must have seemed highly likely at the time that movie piracy would have a strong negative impact on household and foreign demand parameters. (The model calculated a taste shift away from *Theatres* in the actual results for 1998-2005. It is quite conceivable that this is the impact of movie piracy.) Based on these industry conditions a better forecast for *Theatres* could have been produced. In re-running the simulation, the strategy was to prevent the extrapolation of foreign and domestic taste/preference variables on the basis of negative industry dynamics and the likely impact of piracy. This resulted in a vastly improved forecast for output growth of 3.5% and reduced the USAGE error from 35% to just 3%.

***Recordmedia* – Magnetic and Optical Recording Media** <u>Growth: 1998-2005</u> Forecast: +41.7% Actual : -29.8% USAGE error = 101%	From 1992 to 1998 the increase in domestic sales of U.S.-produced *Recordmedia* could not be fully explained by relative-price movements between the domestic good and its imported equivalent, and by growth in the U.S. *Recordmedia* market. This led the model to infer that there must have been a change in preferences towards the domestically produced good and away from imports. This is referred to as a *domestic-import twist*. The <u>impact</u> of this twist on output was projected forward, resulting in a strong boost to domestic production in the forecast. In reality, these domestic-import twist factors sharply reversed. Also, the observed sharp rise in the export demand function that occurred from 1992-1998 was extrapolated in the forecast, further boosting growth. However, in reality, foreign preferences also moved strongly in reverse.	Blank tape technologies (such as VHS and Mini-DV) were jostling for market share in the mid 1990s. However, in November of 1996, Sanyo-Verbatim CD Company announced the onset of Digital Versatile Disc (DVD) production in the first quarter of 1997. DVD had the potential to store seven times the capacity of a CD-ROM. In 1998 the unit shipments of all types of blank tapes were in decline except 8mm videotapes, which increased in 1997. Part of this was due to mounting foreign competition, particularly from China. Although Chinese products using old technology were of inferior quality they had the impact of blunting industry prices. Also, their inferior quality might have explained the strong twist against imports during this period. In relation to exports, by 1998 these comprised 32% of total sales of domestic output. However, from the trade data it was clear that exports were trending downward after peaking in 1996.	Given the advent of new competing technologies and falling export volumes after 1996 it ought to have been realised that domestic output was unlikely to surge in forecast. As China began to export CDs and DVDs (which are technically more *generic* than the technologies these superseded), quality attributes became more difficult to distinguish—perhaps explaining the twist towards imports during the 1998-2005 period. This provided sufficient confidence that the forecast could be considerably improved. The strategy in re-running the simulation was to prevent the model from projecting forward the impact on domestic production of the domestic-import preference twist. By setting this to zero, this averted the unlikely large boost to domestic sales of U.S.-produced output versus imports. It was also determined that export growth opportunities would be limited and the foreign demand curve was held constant; thwarting an unlikely rise in exports. The resultant output forecast was for a 2.8% contraction, and reduced the USAGE error from 101% to 38%.

***Knitfabric* – Knit Fabric Mills** Growth: 1998-2005 Forecast: +23.8% Actual : -48.4% USAGE error = 139%	The original forecast error arose mainly from three sources. First, the forecast underestimated the impact of domestic-import preference twists (the nature of this effect has been described previously). Second, relative prices were expected to strongly favour domestic producers, when in fact they moved in favour of importers. To elaborate, there are different types of prices in the model but output changes are partly driven by changes in relative basic prices such as the landed-duty-paid import price for a commodity. This is a function of the foreign-currency price, the exchange rate, and any tariffs on the commodity. From 1992 to 1998 the foreign-currency price of *Knitfabric* increased, and the main driver of this was projected forward. This strongly contributed to a higher basic price of imported *Knitfabric* than turned out to be the case (in fact, the basic import price fell). Finally, the sharp factor input cost reductions that occurred from 1992 to 1998 were also projected forward; but instead of maintaining their growth rate they largely failed to materialise.	The major domestic players in the industry had embarked on an aggressive expansion and acquisition program during the mid to late 1990s. In the lace & warp knit fabric space rising import competition was a key concern. Throughout the mid-1990s domestic manufacturers remained competitive by introducing new specialty fabrics. During the mid-1990s the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) opened new markets for the textile industry, but also increased foreign competition (as was evident in the trade data). As a result, a number of companies decided to move operations outside of the U.S. A sharp slowdown in import growth was seen in the 1998 trade data. Most of *Knitfabric's* sales were to the *Apparel* industry. *Apparel* registered 25.0% growth during the historical simulation along with strong and persistent import growth.	Following strong increases in 1996 and 1997, growth in *Knitfabric* imports paused in 1998. It would have been difficult for the modeller to confidently assert that imports would continue to surge and decimate *Knitfabric*. It is also unlikely the modeller would have seen cause to adjust domestic-import twist factors, or even to sensibly estimate the magnitude of any such adjustment. However, it is clear that improvements could have been made to the import-price forecasts. Basic import prices for commodities in this sector were heavily tied to policy. From 1992 to 1998 the (nominal) landed-duty-paid import price for *Knitfabric* fell slightly; but fell considerably in real terms. It is sensible to assume that policy-makers would allow real basic import prices to continue to fall at the same annual rate. (Compare this to a highly unlikely rise in nominal basic import prices; being driven by also unlikely rising foreign-currency import prices.) In re-running the simulation, import-price forecasts were generated by extrapolating the *real* price change from 1992 to 1998. This was done for all textile, clothing and footwear (TCF)

			industries, resulting in more realistic import-price projections and less erroneous domestic-import relative (basic) price movements. For *Knitfabric* this produced an improved forecast for output growth of 7.1% and reduced the USAGE error from 139% to 106%. The absolute size of the error remained quite large due to the ongoing underestimation of *impftwist*, and the projection of the impact on output for even higher factor input cost reductions. The latter is discussed further below.
	After running the improved simulation some more thought was given to the large reductions seen (from 1992-1998) in total primary-factor input costs. In USAGE this term is referred to as "all-factor-augmenting technical change" and can be interpreted as follows: the industry could *potentially* produce the same output in 1998 as it did in 1992 with less primary-factor inputs and the same other inputs. It is potential because actual output will also depend on other factors such as relative-price changes. The large falls, sector wide, in all-factor-augmenting technical change were having a significant impact on output via cost effects (by stifling domestic basic prices and thereby improving competitiveness). In forecast, the contribution to total costs of all-factor-augmenting technical change is projected forward. It became clear that for the TCF sector this ought not to be baked in to the forecast. Why? Because the share of total primary-factor input costs to total costs was declining significantly throughout these industries. In this relatively labour-intensive sector, output-boosting cost savings from shedding workers (in particular) were likely to be getting smaller; and this effect could be reinforced by possibly higher unit labour costs that might arise from increased labour scarcity (especially as companies were shifting operations abroad). To see how this would pan out the improved forecast simulation was rerun (denoted as improved forecast: *version 2*) with the single change of no additional potentially output-boosting primary-factor cost savings for the TCF commodities. The results were very promising, e.g., for *Knitfabric* output contracted 35.4% on the back of rising costs, and its USAGE error fell significantly, to 24%.		

***Apparel* – Apparel Made From Purchased Materials** <u>Growth: 1998-2005</u> Forecast: +15.8% Actual : -47.6% USAGE error = 121%	Once more, the source of the forecast error was multifaceted. The model extrapolated household preferences from the historical run resulting in tastes moving further in favour of *Apparel*. There was a large share of sales to consumers and this projection proved very inaccurate. More important was the model's underestimation of the impact of domestic-import preference twists (the nature of this effect has been described previously). Furthermore, as was the case for all TCF commodities, the foreign-currency price increase of imported *Apparel* that occurred between 1992 and 1998 was projected forward. This strongly contributed to a higher basic price of imported *Apparel* than turned out to be the case (in fact, the basic import price fell sharply). This impacted relative basic prices in a way that was incorrectly favourable to domestic producers. Finally, the impact on output of the sharp cost reductions relating to primary-factor input that occurred from 1992 to 1998 were also projected forward; but instead of these intensifying they failed to materialise.	The Uruguay Round of multilateral trade negotiations (MTN) was implemented over the period 1995-2000 for developed countries. As part of this the U.S. lowered tariffs and commenced the phase-out of quotas but reserved the right to impose safeguards once the phase-out was complete. However, the U.S. refused to agree to accelerated quota growth and tariff reductions. Furthermore under the terms of the Uruguay Round agreement, developing countries were afforded much higher tariff rates than developed countries, potentially hurting some export markets. In addition, reduced protection coincided with the increasing emergence of China and India as super-cheap producers and exporters of *Apparel.* This was clearly reflected in the trade data.	By late 1998 it was not clear that consumer tastes would begin to sour overall, whilst taking an increased liking to imports—well beyond that which could be explained by changes in relative prices. Furthermore, the modeller could not have been sure that reductions in protection would not subsequently be reversed. However, as was the case for all TCF commodities, improvements could have been made to the import-price forecasts because basic import prices were heavily tied to policy. As a result (as explained earlier) real basic import prices were projected forward, generating more realistic relative basic price changes. For *Apparel* this produced an improved forecast for output growth of 3.8% and reduced the USAGE error from 121% to 98%. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings (i.e., no further all-factor-augmenting technical change) gave better results. (See earlier comments for elaboration.) In this case, higher costs meant that output contracted 24.7% and the USAGE error improved to 44%.

Luggage – Luggage Growth: 1998-2005 Forecast: -12.1% Actual : -61.9% USAGE error = 131%	There were several factors contributing to the erroneous forecast. On the supply side, primary factors comprised about half of total input costs. The material cost savings that occurred from 1992 to 1998 were projected to continue. In reality, this efficiency measure sharply deteriorated, and its contribution to total input costs rose significantly. On the demand side, households were responsible for about two-thirds of sales of domestically-produced *Luggage*. For the period from 1992 to 1998 the model deduced that household tastes had shifted towards the consumption of more *Luggage* at any given set of prices and per capita income. This was projected to continue when, in reality, household tastes towards *Luggage* soured considerably. An analogous outcome occurred with foreign demand preferences, though the impact was much less significant. In addition, import twist factors worked overwhelmingly against the domestic commodity in the period from 1998 to 2005—well beyond that which was projected.	An external forecast was found, dated February 1995, which reported that the U.S. luggage market experienced improved growth trends over the 1990s due to sharper gains in personal income and favourable demographics. Demand was also stimulated by the introduction of more innovative products and casual luggage lines, and the growing need for lifestyle products such as backpacks, sports bags, and computer cases. Stronger growth, higher labour productivity and moderating material costs resulted in expanded profit margins. Furthermore, U.S. manufacturers were able to boost plant profit margins despite rising competition from foreign-sourced products and relatively weak product price gains. The external forecast was for stronger growth through to the end of the decade as the key baby boomer market moved through its prime luggage buying years. Turning to the trade data, it was clear that overall imports were growing strongly from 1992 to 1998. Exports also grew strongly as foreign markets became more open, but this growth was off a relatively low base.	*Luggage* output increased modestly over the period from 1992 to 1998. (The bullish external forecast may well have changed by 1998, but any further reports could not be located.) *Luggage* is an example of a commodity with a very large import share. This makes it especially difficult to accurately forecast domestic output in the absence of specialised knowledge. By late 1998 it was not clear that consumer tastes would begin to sour overall, whilst taking an increased liking to imports—well beyond that which could be explained by changes in relative prices. However, as was the case for all TCF commodities, knowing that basic import prices were heavily tied to policy an improved forecast could have been produced by projecting real basic import prices. This generated more realistic relative basic price changes, resulting in a 19.1% contraction in forecast output. The USAGE error fell from 131% to 112%. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings saw forecast output contract 38.4% and the USAGE error improved to 62%.

***BootCutStock* – Boot and Shoe Cut Stock and Findings** <u>Growth: 1998-2005</u> Forecast: +44.7% Actual : -30.6% USAGE error = 108%	Exports were by far the largest share of domestic output. Hence, the accuracy of the forecast for output hinged on the foreign demand forecast. In simplified terms, USAGE relates foreign demand for a commodity to overseas activity; foreign currency prices; and to several autonomous variables that determine the position of the export-demand curve. From 1992 to 1998 the export-demand curve moved considerably higher. This upward shift in foreign demand was projected forward, which had a highly expansionary impact on forecast output. However, this proved to be a vast overestimation because in reality a very sharp downward shift occurred. The collapse in foreign preferences dominated any offsetting effects from a reduction in export prices. Hence the expected strong increase in export volumes did not eventuate—instead export volumes virtually halved. On the supply side, the material primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these did not materialise.	By 1996 U.S. manufacturers began to shift operations to lower cost countries. Many of the footwear plants that remained eventually closed, and plant openings slowed to a trickle by the late 1990s. Pricing was under intense pressure due to competition from imported shoes. The drop in domestically produced footwear depressed the business of companies that supply shoe manufacturers. Leather sole makers also had to contend with a shift by consumers to more casual footwear and the rising cost of leather. While there remained a market for fine leather shoes, many Americans no longer required several pairs of dress shoes. During the recession of the early 1990s, the repair trade picked up more slowly than in previous downturns (consumers have traditionally mended old shoes during difficult times). There was also concern about longer term trends in the repair market. The trade data showed a cyclical pattern for imports, but strong growth in exports until 1997. Export growth peaked in 1996 at around 50%, and exceeded 10% in 1997. In 1998 exports fell by about 10%.	Whilst there was some evidence that exports of *BootCutStock* were beginning to slow, the modeller is unlikely to have imagined that export volumes would halve over the forecast period. Industry conditions were getting tougher as evidenced by a slowdown of plant openings in the late 1990s; the "offshoring" of the industry; and rising competition from low wage nations more generally. This could have indicated that further expansion would be unlikely. This is an instance where the modeller, on balance, probably would have made *ad hoc* changes to the forecast parameters, such as by nullifying export demand shifts and/or domestic output—though this was not implemented. Rather, the TCF industries were treated with a broad brush by projecting real basic import prices. This generated more realistic relative basic price changes, resulting in 24.7% output growth. The USAGE error fell from 108% to 79%. A subsequent simulation differing only by the forecast of no further primary-factor cost savings saw forecast output contract 27.0% and the USAGE error improve to just 5%.

***LeatherTan* – Leather Tanning and Finishing** Growth: 1998-2005 Forecast: -4.6% Actual : -56.4% USAGE error = 119%	Several factors contributed to the erroneous forecast. The main buyers of the commodity were other TCF industries. As was seen earlier, these industries generally underperformed forecasts in the period from 1998 to 2005. Furthermore, there was a larger than expected preference shift away from use of *LeatherTan* in production. In addition, the USAGE prediction for foreign preferences was also off the mark. Given foreign preferences from 1992 to 1998 the export-demand curve was forecast to shift slightly upward; when it in fact shifted strongly downward. As has been the norm in these industries, import twist factors worked overwhelmingly against the domestic commodity. In particular, the impact of these twists did significantly more damage to the domestic producers than was anticipated. On the supply side, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these were reversed over the seven years from 1998 to 2005.	In the U.S., automotive upholstery and casual footwear make up most of the leather market. The number of companies engaged in leather tanning and finishing had declined since the 1980s, as a result of takeover activity. The number of U.S. tanning and finishing establishments was also decreasing, albeit slowly. Competition from overseas leather tanners, especially in developing nations, had adversely affected the industry in the U.S. Leather tanning in the U.S. is primarily the work of privately held companies, where the vast majority of the leather processed is cattle hide. So-called specialty leathers—including deer, calf, pig, goat, sheep, lamb, kangaroo, and various reptiles—comprised only about 5%. Turning to the trade data the rebound in exports that occurred in the mid 1990s had stalled by 1998. Overall, the growth patterns for both imports and exports seemed cyclical but fairly sharp and out of sync. This created a degree of volatility that made it difficult pinpoint any long term trend.	Great volatility was evident in the trade data, so there seemed to be no convincing argument that overall trade volumes would fall away. With no *a priori* view that the TCF sector was facing a gloomy period ahead, the modeller is unlikely to have imagined that output would more than halve. However, an improved forecast could be generated by treating the TCF industries with a broad brush—by projecting real basic import prices. This typically generated more realistic relative-price changes—though this wasn't the case for *LeatherTan*. However, the larger divergence in relative prices placed more pressure on sales and choked off exports, thereby muting output. The resultant 15.3% contraction in forecast output saw the USAGE error fall to 94%. The error remained large due to the overestimation of foreign demand and underestimation of import-favouring twist factors. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 31.9% and the USAGE error improve markedly, to 56%.

***Hosierynec* – Hosiery, Not Elsewhere Classified** <u>Growth: 1998-2005</u> Forecast: +19.3% Actual : -46.1% USAGE error = 122%	There were several drivers behind the erroneous forecast. Firstly, the model projected a change in relative prices favouring the domestically produced commodity, when in reality, there was an unfavourable move. There was a high degree of substitutability between domestic and imported *Hosierynec*. The significant fall in import prices and a much larger than forecast preference twist towards the imported commodity drove the spike in imports. Given that imports held just 22% of the U.S. *Hosierynec* market there was plenty of room for these to grow. The error would have been larger if not for an unforeseen swing away in consumer tastes from *Hosierynec.* Households were by far the largest buyer. Exports were much weaker than forecast, however, these comprised a relatively minor segment of production and were not as an important determinant of the results. Finally, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these prevailed only in part in the seven years from 1998 to 2005.	The biggest impact on the commodity's lamentable performance over the 1998-2005 period was the replacement of domestic production by surging imports. While other countries such as Taiwan and South Korea were already exerting pressure on domestic production, the entry of China into the WTO in 2001 and phasing out of the MFA quotas by 2005 amplified these pressures. The Multifibre Agreement, or Agreement on Textiles and Clothing, covered the period 1974-2004, replacing earlier agreements. The phase-out of import quotas took place over ten years (1995-2005) in four phases. At each stage, the percentage of goods not limited by quotas increased, while the quotas for goods still protected also increased. However, as mentioned previously, the U.S. had recourse to special safeguard provisions in the case that imports from China caused or threatened to cause market disruptions to local industry. The trade data from 1992 to 1998 showed strong growth in both imports and exports.	Even with the strong growth in imports and the impact of trade reform, it is unlikely that the modeller could have imagined that output would almost halve over the forecast period. The import favouring twists and the household preference shift away from *Hosierynec* also could not have been predicted. However, an improved forecast could be generated by treating the TCF industries with a broad brush—by projecting real basic import prices. This produced more realistic relative-price changes for *Hosierynec* that placed more pressure on sales of the domestically produced commodity. The resultant 11.3% output growth in forecast output saw the USAGE error fall to 107% from 122%. The error remained large due to the ongoing underestimation of import-favouring twist factors and overestimation of cost savings from primary-factor inputs. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 21.0% and the USAGE error improve markedly, to 47%.

***Leathrgloves* – Leather Gloves & Mittens** <u>Growth: 1998-2005</u> Forecast: -16.7% Actual : -61.0% USAGE error = 114%	There were several key drivers behind the erroneous forecast. Firstly, from 1992 to 1998 there was a strong preference twist towards the imported commodity as the reduction in output could not be explained by changes in relative prices. The forecast projected this forward but grossly underestimated the actual impact of this phenomenon. Partly offsetting this, the forecast also underestimated the extent that the change in relative prices favoured the domestic commodity. Furthermore, consumers were by far the largest buyer of *Leathrgloves* and overall household demand rose by less than was predicted. This arose because the USAGE forecast failed to account for a large swing away in consumer tastes from *Leathrgloves.* In fact, USAGE projected forward the slightly favourable preference/taste shift that occurred from 1992 to 1998. Finally, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these actually reversed in the seven years from 1998 to 2005.	This is a very small industry which has been squeezed by cheaper imports since WWII. Historical data shows that the domestic industry was relatively stagnant between 1992 and 1998. Any growth in demand was met typically by rising imports. This strength in imports is also consistent with the solid growth in absorption in the historical period. Other than commentary in relation to rising import penetration and a chronological history of industry consolidation, it was difficult to source external projections around 1998 that were specifically for the U.S.	The import-favouring taste twist and the household preference shift away from *Leathrgloves* could not have been predicted. However, an improved forecast could be generated by treating the TCF industries with a broad brush—by projecting real basic import prices. This typically produced more realistic relative-price changes—though this wasn't the case for *Leathrgloves*. However, the inaccurate relative-price forecast had the impact of placing more pressure on total sales of the domestically produced commodity, thereby further negating output growth. The resultant 17.5% contraction in forecast output saw the USAGE error fall only slightly, to 112%. The error remained large mostly due to the ongoing mis-estimation of the change away from the commodity in household tastes and preferences and the underestimation of import-favouring twist factors. A subsequent simulation that included the forecast of no further primary-factor-input cost savings saw forecast output contract 26.6% and the USAGE error improve to 88%.

***WmnsHandbag* – Women's Handbags** <u>Growth: 1998-2005</u> Forecast: +18.9% Actual : -42.2% USAGE error = 107%	From 1992 to 1998 the increase in domestic sales of U.S.-produced *WmnsHandbag* could not be fully explained by relative-price movements between the domestic good and its imported equivalent, and by growth in the U.S. *WmnsHandbag* market. This led the model to infer that there must have been a change in preferences towards the domestically produced good and away from imports. This is referred to as a *domestic-import twist*. The <u>impact</u> of this twist on output was projected forward, resulting in a strong boost to domestic production in the forecast. In reality, these domestic-import twist factors sharply reversed. This depressed output. If not for a foreign demand driven rise in exports and a positive taste/preference move by households, domestic output would have fallen by even more. On the supply side, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these sharply reversed over the seven years from 1998 to 2005.	What distinguishes *WmnsHandbag* from the other TCF sectors that were examined above is that in the period from 1992 to 1998 the quantity of sales into the U.S. market of the domestically produced commodity grew faster than the imported equivalent. The trade data showed that imports peaked in 1996, and that sales growth of the local product was rapid enough for domestic producers to increase their market share from 1992 to 1998. However, similar to many of the TCF industries, *WmnsHandbag* experienced significant outsourcing of manufacturing to China. An example of this is the high-end American label "Coach", which outsourced and shifted production to lower cost markets, while retaining responsibility for design and marketing. In 1998, only around 25% of "Coach" products were produced by independent manufacturers; two years later, around 80% of the products were made by outsourcers.	Given that domestic producers gained market share over the period from 1992 to 1998, and that imports appeared to have peaked in 1996, it is unlikely that the modeller could have imagined that output would slump over the forecast period—even though outsourcing of the commodity was already taking place. However, an improved forecast could be generated by treating the TCF industries with a broad brush—by projecting real basic import prices. This generated more realistic relative-price changes for *WmnsHandbag* that placed additional pressure on sales. The resultant 14.3% output growth in forecast output saw the USAGE error fall from 107% to 99%. The error remained large due to the ongoing mis-estimation of domestic-import twist factors and overestimation of cost savings from primary-factor inputs. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 8.7% and the USAGE error improve rather markedly, to 59%.

AccStrucSMD – Access Structures for Solid Mineral Development Growth: 1998-2005 Forecast: -13.1% Actual : +41.5% USAGE error = 39%	*AccStrucSMD* derives its demand exclusively from investment demand by industries in the resource sector, in particular, from the coal industry (*Coal*). To understand the key driver behind the erroneous forecast there must be an examination of *Coal's* expected rate of return and its subsequent investment. Over the period 1992-1998 investment in *Coal* increased strongly. This drove the solid rise in *AccStrucSMD* output during that period. By 1998, the capital-weighted average expected rate of return for all industries was more than double what it was for *Coal*. With only modest growth predicted for the coal industry, USAGE translated the low rate of return into what turned out to be relatively weak investment. On this basis the model forecast a double-digit contraction in output for *AccStrucSMD*. In reality, there was a strong increase in coal prices, which led to surging investment in *Coal*. This made the single largest contribution to output growth in *AccStrucSMD*, overwhelming the demand reductions from the various other *AccStrucSMD* -using industries.	The general commentary emerging from this sector in the late 1990s was that there was an increase of mining services as an industry in its own right largely due to cost-cutting measures on the part of the mining industry. With specific services contracted out, firms could avoid a large commitment of capital investment. In January 1997, the outlook for the coal industry according to the Energy Information Administration (EIA) included a discussion about long term price pressures and the increasing emergence of renewable energy sources. By December 1998, the outlook had been revised very sharply downward. This seemed to be congruent with the trade data for *Coal*. International trade was dominated by exports, and these were clearly falling from the mid-1990s. Meanwhile, overall *Coal* output rose modestly during the period.	Whilst the resources sector is highly cyclical by nature, it probably would have been too tough for the modeller to form a reliable long term view without taking in external forecasts. In 1998, could the modeller have predicted the economic gloom of 2002, and the sharp surge in global activity from 2004? *AccStrucSMD* provides inputs to capital creation in *Coal*. As seen in the EIA outlook statements from that time, alternative energy sources to coal were being touted, so the forecast for moderate growth is unlikely to have appeared unreasonable. In reality there was overall strong demand for the coal industry, due mostly to the resources boom that occurred during the latter part of the forecast period. In concluding, it would be unlikely that the modeller could have produced a better forecast.

***PetNgExplor* – Petroleum, Natural Gas, and Solid Mineral Exploration** <u>Growth: 1998-2005</u> Forecast: -18.0% Actual : +43.4% USAGE error = 42%	*PetNgExplor* derives its demand solely from investment demand by industries in the resource sector—mainly Natural Gas (*NatGas*) and Crude Petroleum (*Crude*). Over the period 1992-1998 investment in *NatGas* more than doubled, while in *Crude* it grew solidly. This drove the strong rise in *PetNgExplor* output. In 1998, the capital-weighted average expected rate of return for all industries was considerably higher than for *NatGas* and *Crude*. With only modest growth predicted for *NatGas* and a decline in *Crude*, USAGE translated the low expected rates of return into a vast slowdown in investment overall across those industries. In fact, investment was predicted to be negative in *Crude*. On this basis the model forecast an 18.0% contraction in output for *PetNgExplor*. In reality, there was a huge spike in natural gas prices. This led to stronger than expected investment in *NatGas*. Crude petroleum prices rose stronger still, which led to an acceleration in investment demand growth as opposed to the predicted modest contraction.	Much of the discussion relating to *AccStructSMD* applies here, except the focus is on exploration rather than development. The EIA’s Annual Energy Outlook for 1998 (published December 1997), showed that total U.S. energy consumption was projected to increase just 26 percent by 2020 from its 1996 level, with world average crude oil prices rising (in the reference case) to $22.32 per barrel (1996 dollars) in 2020. As expected, growing demand and falling production would be met by rising net imports. The forecasts were then updated in the Annual Energy Outlook for 1999 (published December 1998) and again did not predict an impending surge in energy prices. The trade data for the main users of *PetNgDrill* showed falling import demand for Natural Gas and Crude Petroleum. Separately, it was noted that crude oil prices were trending downward throughout 1997 and 1998 and prior to this had traded within a relatively narrow band.	As previously noted, it is not easy to forecast commodity cycles without the expertise of dedicated outlook providers. Even then it is no guarantee the forecast will be accurate. On balance, it is likely that the modeller would have been satisfied with a weak forecast for the commodity as there was nothing to suggest good prospects. A cursory glance at oil prices post-1998 shows the sudden, sharp reversal that occurred. In the case of natural gas prices, there was a huge spike post-1998, perhaps as the industry began to benefit from market deregulation in the early 1990s. Again, this would have been difficult to predict. Overall, it would be unlikely that the modeller could have produced a better forecast.

PetNgDrill – Petroleum & Natural Gas Well Drilling <u>Growth: 1998-2005</u> Forecast: -14.9% Actual : +45.3% USAGE error = 41%	*PetNgDrill* derives its demand solely from investment demand by industries in the resource sector—mainly Natural Gas (*NatGas*) and Crude Petroleum (*Crude*). Over the period 1992-1998 investment in *NatGas* more than doubled, while in *Crude* it grew solidly. This drove the strong rise in *PetNgDrill* output. In 1998, the capital-weighted average expected rate of return for all industries was considerably higher than for *NatGas* and *Crude*. With only modest growth predicted for *NatGas* and a decline in *Crude*, USAGE translated the low expected rates of return into a vast slowdown in investment overall across those industries. In fact, investment was predicted to be negative in *Crude*. On this basis the model forecast a 14.9% contraction in output for *PetNgDrill*. In reality, there was a huge spike in natural gas prices. This led to stronger than expected investment in *NatGas*. Crude petroleum prices rose stronger still, which led to an acceleration in investment demand growth as opposed to the predicted modest contraction.	Much of the discussion relating to *PetNgExplor* and *AccStructSMD* applies here, except the focus is on oil & gas well drilling rather than exploration and development, respectively. Again turning to the EIA's Annual Energy Outlook for 1998 (published December 1997), it is found that total U.S. energy consumption was projected to increase just 26 percent by 2020 from its 1996 level, with world average crude oil prices rising (in the reference case) to $22.32 per barrel (1996 dollars) in 2020. As expected, growing demand and falling production would be met by rising net imports. The forecasts were then updated in the Annual Energy Outlook for 1999 (published December 1998) and again did not predict an impending surge in energy prices. The trade data for the main users of *PetNgExplor* showed falling import demand for Natural Gas and Crude Petroleum. Separately, it was noted that crude oil prices were trending downward throughout 1997 and 1998 and prior to this had traded within a relatively narrow band.	It is reiterated that it is not easy to forecast commodity cycles without the expertise of dedicated outlook providers. Even then it is no guarantee the forecast will be accurate. On balance, it is likely that the modeller would have been satisfied with a weak forecast for the commodity as there was nothing to suggest good prospects. A cursory glance at oil prices post-1998 shows the sudden, sharp reversal that occurred. In the case of natural gas prices, there was a huge spike post-1998, perhaps as the industry began to benefit from market deregulation in the early 1990s. Again, this would have been difficult to predict. Overall, it would be unlikely that the modeller could have produced a better forecast.

***Nonferrores* – Nonferrous Metal Ores, except Copper** <u>Growth: 1998-2005</u> Forecast: +9.2% Actual : -38.0% USAGE error = 75%	Despite a larger than projected outward shift of the export-demand curve, strong production-efficiency related cost rises translated into a surge in export prices (which were more than double what was predicted). This had an overwhelmingly negative impact on export volumes. Furthermore, the intermediate use of *Nonferrores* (i.e., as an input into production of other commodities) was much lower than expected. With import penetration only minimal, overall intermediate demand fell by almost one third as rising costs helped drive prices substantially higher for the domestic commodity. The *Nonferrores* industry purchased a significant portion of its own output and saw its demand slump, versus the USAGE prediction for modest growth.	At noted in previous discussions, metals and mining-related commodities exhibit volatile cyclical demand patterns. This was certainly the case from 1992 to 1998 for *Nonferrores* as evidenced by the behaviour of gold and silver prices. Gold had been trending downwards from about 1996, whereas silver, exhibited a sharp price spike in early 1998. Gold prices moved sharply higher in the forecast period. It is not surprising that this sort of volatility was also reflected in the trade data, with very large movements observed in the annual growth rate of exports from 1992 to 1998.	This is another example of where the modeller is unlikely to have been able to do much better in forecast. As mentioned previously, the modeller would have been hard pressed to predict the resources boom that had a very big impact on the tail end of the forecast. Furthermore, exports were the largest share of domestic output. The value of exports for the commodity often moved quite dramatically during the period from 1992 to 1998.
***Copperore* – Copper Ores** <u>Growth: 1998-2005</u> Forecast: +5.2% Actual : -18.7% USAGE error = 29%	Most of the sales of this commodity were to copper manufacturers and chemical producers. In 1992, exports comprised 15% of sales. Between 1992 and 1998 exports slumped by 90%. In the USAGE simulation for 1992-1998, there was a significant inward movement of the foreign demand curve, and this was accompanied by rising export prices. At	In 2000, the U.S. was the world's second largest copper producer and a net	The longevity of falling prices and the higher stockpiles might have indicated to the modeller that Copperore faced a bleak outlook. Hence, one might have mounted the argument that the USAGE forecast of 5.2% growth was somewhat bullish. But given the way copper prices

	the same time there was strong growth in imports, albeit off a low base. Output of the commodity between 1992 and 1998 fell by 11%. However, with strong import growth and apparent diversion of exports back to the domestic market, the USAGE simulation for 1992-1998 showed weak growth in supplies on the domestic market relative to demands by the *Copperore* -using industries. In these circumstances, the model implied that during the period 1992 to 1998 there was *Copperore*-using technical change in the using industries. In the forecast for 1998 to 2005, this *Copperore*-using technical change was projected forward. The inward movement in the export-demand curve was also projected forward, but with exports in 1998 at very low levels, this did not significantly affect the forecast output for *Copperore*. The *Copperore*-using industries in the 1998-2005 forecast showed moderate contractions. This provided some offset to the projected *Copperore*-using technical change, but not enough to predict a contraction in the USAGE forecasts.	importer of copper, obtaining 37 percent of refined copper from abroad. Global demand for copper had grown steadily since the late 1970s, but in the late 1990s copper producers, including many located in Chile, the world's largest copper-producing country, ramped up new mining capacity faster than the market could absorb their production. The economic weakness in Asia and Latin America in the late 1990s left global demand growth at a slower pace than some producers anticipated. The downward trend in copper prices from the mid-1990s started to translate into rising stockpiles by the end of the decade. It is also noteworthy that in 1998 the U.S. went from being a net exporter to a net importer. However, by 1998 exports became a relatively insignificant component of total sales of domestic output.	were trending in the late 1990s it is not clear why demand would shift so strongly away from copper—particularly given that price reductions were being driven by boosted mining capacity. The most obvious copper substitutes are aluminium, plastics and fibre. The Primary aluminium industry was also facing a bleak outlook with USAGE predicting a steady decline in output of that commodity. The various plastics and fibre commodities in USAGE all exhibited relatively modest outlooks. On this basis, it is perhaps arguable that the modeller could have done better. However, counter-arguments would point to the cyclical and volatile nature of this commodity, meaning that the forecast 5.2% expansion over seven years may well not have appeared to be unreasonable (this is the rationale accepted in this thesis for not re-projecting *Copperore*). In all likelihood, any strategy to re-implement forecasts for *Copperore* would have revolved around setting domestic output growth to zero. Hence, the gains from such an exercise would have been minimal.

***CutStone* – Cut Stone and Stone Products** <u>Growth: 1998-2005</u> Forecast: -14.3% Actual : +12.2% USAGE error = 24%	From 1992 to 1998 growth in domestic demand for *CutStone* was driven by households. Intermediate input demand for the domestically produced commodity was relatively flat during this period, reflecting low growth in outputs by purchasing industries. USAGE calculated modest rises in the taste and preference indicators for households and producers, which were projected forward. In the case of households, USAGE predicted household demand for domestically-produced *CutStone* to rise at a modest pace. However, the model vastly underestimated producer demand in the four largest intermediate purchasers of *CutStone*. Given that production demand was the larger share of output, the model forecast an overall reduction in *CutStone* output. The actual output that eventuated was largely driven by a strong increase in tastes for *CutStone* by producers and households. Finally, the primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue. However, these reversed throughout 1998 to 2005, thereby preventing a larger USAGE error.	Any forward looking comments that were sourced from the 1990s were reasonably cautious, and generally emphasised a lacklustre long-term industry outlook. There were limited opportunities for further productivity gains, and rising foreign competition was expected to hurt the construction sector. Superior synthetic substitutes continued to make inroads into the U.S. construction market. Due to the strength of the construction industry in the late 1990s the cut stone industry experienced steady growth in 1997 and 1998, as evidenced by a rise in shipments. Because of stone's weight-to-value ratio opportunities for export growth were limited to niche specialty stones. A bright spot for the industry was the expected continued surge in historical restoration projects that require considerable amounts of stone to replace damaged pieces from the original construction. However, this seemed to comprise a relatively small part of total output.	The modeller may have viewed this overall cautious outlook as being consistent with the downbeat USAGE forecast for the commodity. Moreover, the building and construction boom that occurred mostly during the second half of the forecast period played a key role in the forecast error. Excessive borrowing across many sectors was fuelled by exceptionally low interest rates post the events of "September 11"; lax lending standards; piecemeal regulation; and financial product innovation. The extent and longevity of this boom did not seem to have been expected by industry experts. However, a track record of overly accommodative monetary policy from the mid-1990s and steady industry growth in 1997 and 1998 may have provided some clues that the general outlook was overly guarded. On balance, it is difficult to say, conclusively, that the modeller could have produced a better forecast for *CutStone*. Perhaps, if negative growth was seen to be too pessimistic, a zero growth forecast—at most—might have been worked into the model.

2.1.1 Results Summary of Improved Forecast Simulations

Figure C charts the results of *version 1* of the improved pure USAGE forecast. In *version 1*, *ad hoc* modelling strategies are implemented for *AsbestosPrd, ComFishing, ElectronTube, Dolls, Theatres,* and *Recordmedia.* In addition, a broad-brush strategy of projecting forward real basic import prices is implemented for USAGE's 31 TCF commodities (recall that eight of these featured among the twenty largest USAGE forecast errors). In *version 1*, there is no change to the standard treatment in the model of projecting forward the contribution to costs arising from all-factor-augmenting technical change (these cost effects typically boosted TCF output from 1992 to 1998).

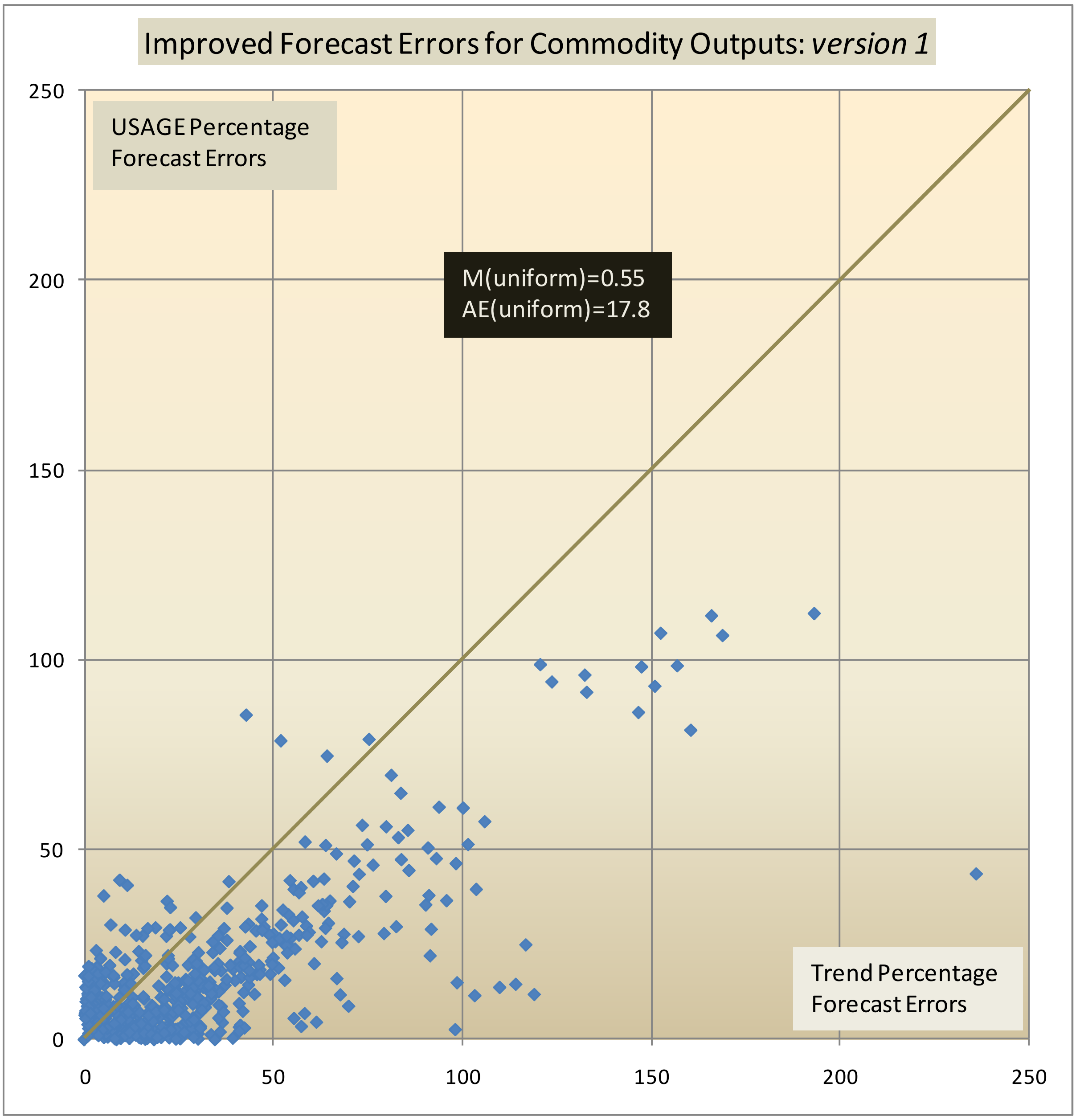

Figure C: Percentage forecast errors for all commodity outputs 1998-2005—extrapolated 1992-1998 trend forecast versus *version 1* of the improved USAGE pure forecast, which, *inter alia*, assumes the standard treatment of projecting forward the contribution to costs of all-factor-augmenting technical change

This improved forecast reduces the unweighted average error (AE) to 17.8% from 18.9% in the original USAGE pure forecast. In other words, the forecast error for a typical industry is 17.8% in *version 1* of the improved forecast. With every commodity treated as equally important the ratio of average errors between the pure USAGE forecast and the extrapolation-based trend forecast (denoted by *M*) indicates that USAGE reduces the forecast error by 45% (*M* = 0.55) relative to a simple non-modelling extrapolation approach. This compares favourably to the 42% reduction (*M* = 0.58) in the original USAGE pure forecast.

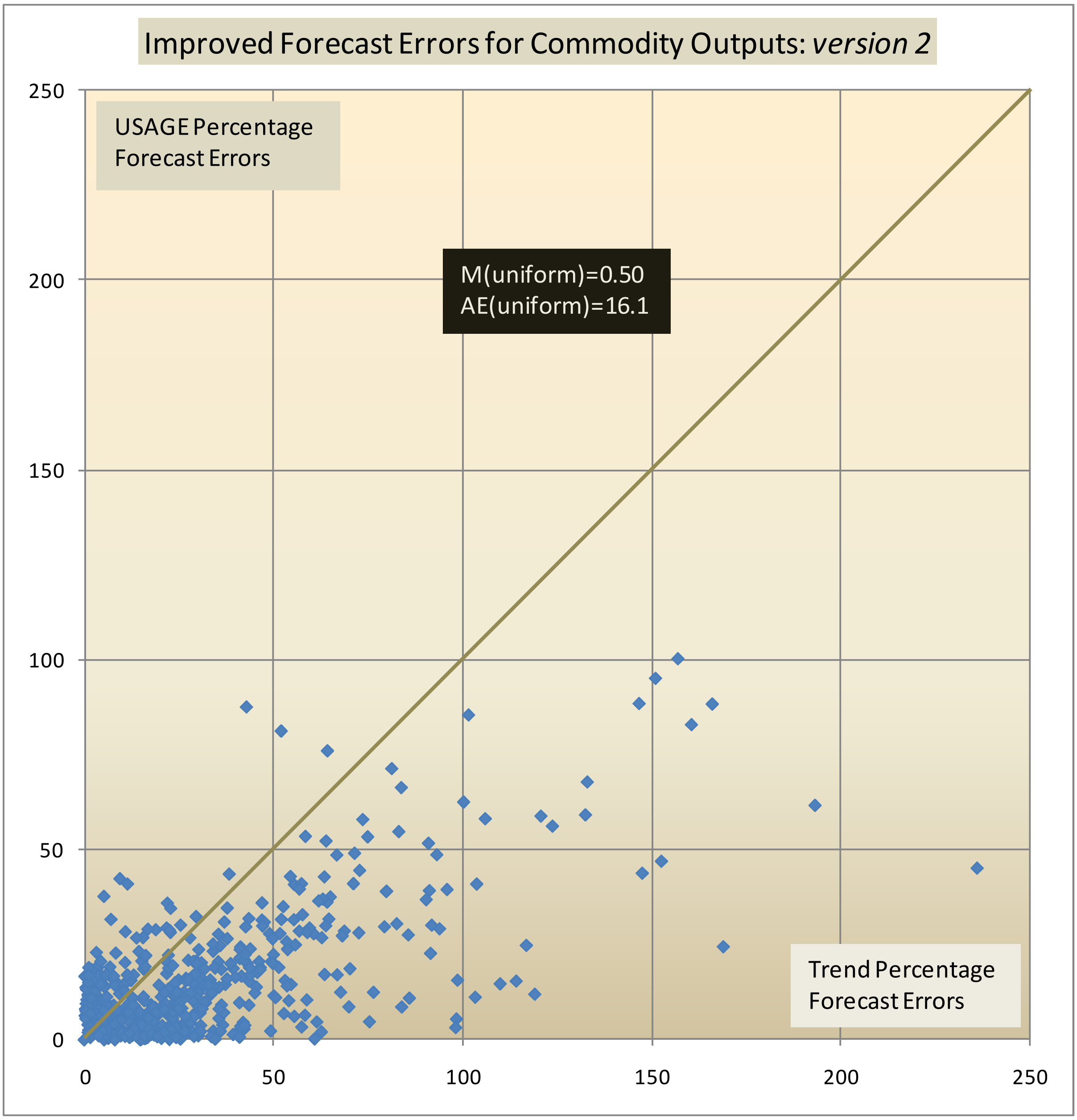

Figure D: Percentage forecast errors for all commodity outputs 1998-2005—extrapolated 1992-1998 trend forecast versus *version 2* of the <u>improved</u> USAGE pure forecast, which, *inter alia*, does not project forward the contribution to costs of all-factor-augmenting technical change for all TCF commodities

2.1.1 Results Summary of Improved Forecast Simulations

Figure D charts the results of *version 2* of the improved pure USAGE forecast. As is the case in *version 1*, the improved forecast adopts identical *ad hoc* modelling strategies for *AsbestosPrd, ComFishing, ElectronTube, Dolls, Theatres,* and *Recordmedia.* Likewise, the strategy of projecting forward real basic import prices is implemented for TCF commodities. However, unlike in *version 1*, the contribution to costs of all-factor-augmenting technical change is <u>not</u> projected forward for any of USAGE's 31 TCF commodities. Through the removal of unrealistic improvements to competitiveness in the TCF sector (thereby damping output growth), *version 2* of the improved forecast reduces the AE to 16.1%. Meanwhile, the *M* coefficient improves to 0.5, indicating that USAGE reduces the forecast error by 50% relative to a simple non-modelling extrapolation approach.

Aggregation	Forecast Type	*M*	AE
Whole economy	Original Forecast	0.58	18.87
	Improved Forecast: *version 1*	0.55	17.79
	Improved Forecast: *version 2*	0.50	16.11
Improvable 'large-error' Commodities ex TCF sector	Original Forecast	1.37	90.54
	Improved Forecast: *version 1*	0.52	34.21
	Improved Forecast: *version 2*	0.53	34.90
TCF sector	Original Forecast	0.74	66.18
	Improved Forecast: *version 1*	0.62	55.40
	Improved Forecast: *version 2*	0.28	25.21
Improvable 'large-error' Commodities inc. TCF sector	Original Forecast	0.82	70.13
	Improved Forecast: *version 1*	0.61	51.97
	Improved Forecast: *version 2*	0.31	26.78
Non-Improvable 'large-error' Commodities	Original Forecast	2.82	41.64
	Improved Forecast: *version 1*	2.85	42.11
	Improved Forecast: *version 2*	2.90	42.76

Table C: *M* coefficients and percentage average errors for the extrapolated 1992-1998 trend forecast versus:
(a) the original USAGE pure forecast;
(b) *version 1* of the <u>improved</u> USAGE pure forecast, which, *inter alia*, assumes the standard treatment of projecting forward the contribution to costs of all-factor-augmenting technical change;
(c) *version 2* of the <u>improved</u> USAGE pure forecast, which, *inter alia*, does not project forward the contribution to costs of all-factor-augmenting technical change for all TCF commodities

Table C provides a summary of *M* coefficients and percentage unweighted average errors for the various simulations that were undertaken for this thesis. The original USAGE pure forecast outperformed the extrapolated 1992-1998 trend forecast by 42% (1 – *M*) across all industries. The introduction of error-reducing *ad hoc* modelling strategies for *AsbestosPrd, ComFishing, ElectronTube, Dolls, Theatres,* and *Recordmedia*, as well as a broad brush modelling strategy for the 31-commodity TCF sector (where real basic import prices were projected forward) saw the degree of outperformance improve to 45%. The AE was reduced by 108 basis points. This is *version 1* of the improved pure forecast. *Version 2* differs only by the addition of no forward projection of cost savings from all-factor-augmenting technical change for the TCF sector. This improved the model's outperformance by a further 500 basis points to 50%, and reduced the AE by an additional 168 basis points to 16.11%.

At the more micro level, for an aggregation of *AsbestosPrd, ComFishing, ElectronTube, Dolls, Theatres,* and *Recordmedia*, the original USAGE pure forecast underperformed the extrapolated 1992-1998 trend forecast by 37%, with an AE of 90.54%. *Version 1* of the improved forecast slashed the AE to 34.21%, driving 48% outperformance. Notice that in *version 2* of the improved forecast the results are slightly worse for this aggregation of commodities despite no direct modelling impact (*version 2* is targeted at the TCF sector). This is a general equilibrium model, and as in the real world significant changes in one part of the economy can have broader indirect effects. With the exception of *ComFishing*, where forecast output is exogenously fixed (and the USAGE error is unchanged), impacts on output were driven by small changes in areas such as wage-rental rates, capital-labour ratios, etc. In the case of the other five commodities in this aggregation, the sum of the percentage forecast errors turned out to be slightly larger. For the sake of completeness, *AsbestosPrd, ElectronTube,* and *Recordmedia*, had slightly larger forecast errors (all by less than 2%), while *Dolls* and *Theatres* had slightly smaller forecast errors (both by less than 0.4%).

For the TCF sector aggregation, the original USAGE pure forecast outperformed the extrapolated 1992-1998 trend forecast by 26%. However, this was accompanied by an AE of 66.18%; the size of which reduced the usefulness of this forecast. While the model outperformed trend overall in this 31-commodity sector, eight of these commodities were among the twenty worst errors listed in Table A. *Version 1* of the improved forecast reduced the AE to 55.40%, driving 38% outperformance. The biggest performance gains were seen in *version 2* of the improved forecast, where the modelling strategy specifically targeted the TCF sector. In this case the AE fell significantly, to 25.21%; while the model's outperformance spiked to 72%. Analogous results are reported for the combined six-commodity aggregation and TCF sector.

Among the twenty worst errors featured in Table A were five commodities that could be described as resources related. These are essentially energy and mining related commodities: *AccStrucSMD, PetNgExplor, PetNgDrill, Nonferrores,* and *Copperore*. Without great foresight it is probably unlikely that a better forecast could have been generated for these commodities or sectors in general. The same is perhaps true for the construction-related commodity, *CutStone*, where it is not clear cut whether an improved forecast could have been generated. Analysis of these commodities generally found that their volatile and cyclical nature would require great faith in even the most well-regarded sector experts for projections extending beyond a couple of years. In 1998 could the modeller have confidently predicted the economic gloom of 2002 and the strength of the rebound from 2004? It seems unlikely. Table C reports that USAGE underperformed trend extrapolation by 182% in the original pure forecast. This was accompanied by an AE of 41.64%. Furthermore, both versions of the improved forecast had slightly deleterious effects on this aggregation of commodities.

Moreover, while large improvements in forecast accuracy can be obtained for some industries and sectors, the average forecast error across industries does not fall greatly due to the sheer volume of commodities. While it is disappointing that the average error is not very reducible, it is also reassuring because it implies that the default implementation of the model is quite powerful. In all, the twenty worst errors on a relative and/or absolute basis (about 4% of all commodities) were specifically examined to assess the potential for error reduction [20/503 = 4%]. After extending the improved method of the model’s implementation to all TCF commodities, about 7.4% of commodities were in some way directly re-projected [37/503 = 7.4%]. To generate a large reduction in the forecast error (and hence improvement in model performance) would require an extensive amount of work and probably call for the input of numerous industry specialists.

2.2 Error Reduction Strategies for the 1998-2005 USAGE Forecast

2.2.1 *Ad Hoc* Approach: Specific Knowledge for Specific Commodities

Reductions in the magnitude of forecast errors are attainable for certain commodities where specialist knowledge of industry trends and conditions are implemented into the model. For instance, if close examination of an industry provides clear evidence that prospects are likely to be poor, the modeller ought to be suspicious of a forecast result that opposes this. Among the top twenty errors listed in Table A there were six instances where this approach could be sensibly applied. These USAGE commodities were: *AsbestosPrd, ComFishing, ElectronTube, Dolls, Theatres, and Recordmedia.* The approach is *ad hoc* because the response is made on a case-by-case basis. Sometimes it meant nullifying the projection of large values for the impact of domestic-import twist factors; other times it required nullification of domestic and foreign preference variables; or some combination of the above.

Figure E shows that the average error for these commodities under the original forecast was 90.5% (AE = 90.5) and that USAGE had underperformed the trend forecast by 37% (M = 1.37). The degree of underperformance would have much greater had the trend forecast *ElectronTube* not been so terrible. Implementation of specific modelling strategies, consistent with all available evidence by 1998, resulted in a dramatic improvement in the baseline forecast for these commodities. The AE fell to 34.2%, and the model delivered 48% outperformance. The arrows in Figure E point to the new position of the percentage error coordinate for each commodity; the longer the arrow, the larger the improvement in the USAGE forecast.

Further below detailed analysis is shown for these commodities (except *AsbestosPrd*). In each instance this is divided into several parts, *typically* as follows:

- Why the model gave erroneous prospects to the commodity, i.e., what key drivers generated the error in the original pure USAGE forecast.
- Analysis of industry conditions as they were known by December 1998.
- Conclusion or explanation of why the original forecast ought to have been rejected.
- Strategy to improve the forecast.

Please note that descriptions for Standard Industry Classifications (SIC) are sourced from the Occupational Safety & Health Administration webpage:
http://www.osha.gov/pls/imis/sic_manual.html.

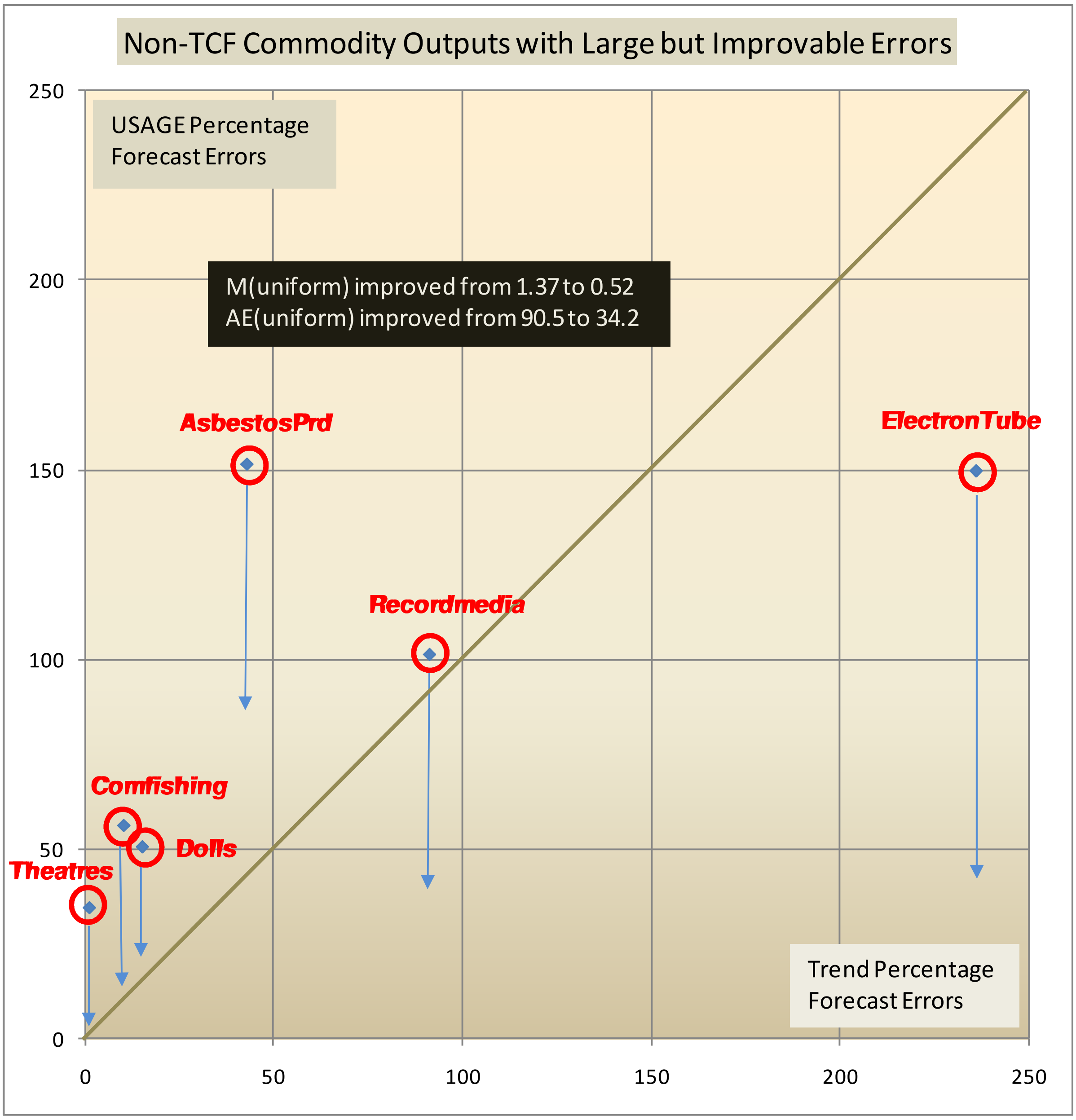

Figure E: Percentage forecast errors for 'large-error' non-TCF commodity outputs 1998-2005—extrapolated 1992-1998 trend forecast versus the original USAGE pure forecast

ComFishing → Commercial Fishing (Industry Group 091)

This is part of Fishing, hunting, and trapping, and includes establishments primarily engaged in commercial fishing (including crabbing, lobstering, clamming, oystering, and the gathering of sponges and seaweed), and the operation of fish hatcheries and fish and game preserves, in commercial hunting and trapping, and in game propagation.

Industry Group 091: Commercial Fishing

- *0912 Finfish*
- *0913 Shellfish*
- *0919 Miscellaneous Marine Products*

ComFishing - Commercial Fishing	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	0.6	-2.5	7.6	7.5
All-factor-augmenting technical change	*a1prim*	12.5	14.8	13.0	13.0
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	7.8	10.5	9.2	9.2
Combined change in household tastes	*a3com*	9.2	10.2	10.9	10.9
Commodity-using technical and taste change	*ac*	13.7	5.5	13.0	13.0
Contribution to output of commodity-using technical & taste change	*cont_ac*	7.7	3.8	9.0	9.0
Vertical shift of the export demand curve	*cont_fepc*	-21.5	0.6	-24.6	-9.7
Import/domestic twist by commodity	*ftwist_src*	-61.5	274.8	-76.7	0.0
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	98.6	-68.3	122.6	0.0
Twist caused by strong growth	*twist_eff*	-10.2	-8.0	4.3	-3.5
Basic price of domestic goods	*p0dom*	48.3	10.7	40.6	29.2
Basic price of imported goods	*p0imp*	14.6	14.5	30.2	31.7
Ratio of basic prices: domestic to import	*fpdm*	29.7	-3.4	8.2	-1.9
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	29.5	24.8	16.4	17.6
Total supplies of domestic goods	***x0dom***	**-18.9**	**-12.8**	**36.4**	**0.0**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	71.1	-53.9	99.7	7.2
Total supplies of imported goods	*x0imp*	17.8	58.0	-19.8	22.4
Household demands undifferentiated by source	*x3*	28.0	39.4	15.8	17.6
Export volumes	*x4*	-55.9	50.9	-57.3	-9.7
Change in net import share to domestic output	*dtradeshare*	46.4	87.7	-35.2	37.1

Table 1: *ComFishing* results

1. Why did the model erroneously give good prospects to Commercial Fishing?

The model predicted 36.4% growth for the 1998-2005 period. This is highlighted in Table 1 and can be seen in the row containing “Total supplies of domestic goods” (*x0dom*), along with several other key results. The actual outcome was a 12.8% decline, which followed an 18.9% decline between 1992 and 1998. In trying to explain these results, it is worth pointing out some characteristics of the initial database as at 1992. The main users, cost structure and other information of interest can be seen in Table 2, which has been divided into six sections. The model allows for commodities to be produced in multiple industries. Sections 1 and 2 illustrate the main producers of the commodity, along with the overall output of the industry that is the chief producer of the commodity. In this case the commodity is only produced by the Commercial Fishing industry (USAGE industry 19: *ComFishing*). Some of the key features of the Commercial Fishing database include the following:

- 71% of production measured at basic prices[26] was exported. This can be seen in the last column of Section 3 in Table 2 [71% = 2265/3735].
- The remaining output was sold into the domestic market. Table 2, Section 5 (Market Share) includes these sales and shows them at purchasers' prices, along with the sum of intermediate and final demands. The row referring to "Current Production" indicates that 82% of domestically-produced Commercial Fishing sold domestically was purchased for intermediate use. The residual was purchased by domestic households (19%). A small reduction in inventories accounted for -1%.
- 81% of total domestic sales came from imports. This can be seen in the last row of the third column of Section 5 in Table 2 [81% = 5469/6753].

During the period from 1992 to 1998 there was a 71.1% increase in domestic sales of domestic production of *ComFishing* (see row containing *x0dom_dom* in Table 1). The spike in domestic sales took place despite a materially unfavourable change in relative prices (see row containing *fpdm* in Table 1). In particular, the basic price of domestic *ComFishing* (see *p0dom* in Table 1) increased 29.7% more than the basic price of its imported equivalent (see *p0imp* in Table 1).[27]

Imported *ComFishing* became relatively more attractive but rose *only* 17.8% (see *x0imp* in Table 1). On the basis of relative-price changes alone, the ratio of imported to domestic *ComFishing* being sold into the domestic market would have increased by 107%.[28] [107% = $1.297^{2.8}$ – 1]. Instead it fell 31% [= 1.178/1.711 – 1]. As domestic sales surged 71%, exports declined sharply (*x4* fell 55.9% as shown in Table 1) as these were being diverted into the domestic market; and overall domestic output fell *only* 18.9%.

[26] Basic prices are prices received by producers. In USAGE, supplies of commodities respond to basic prices while demands for commodities respond to purchasers' prices. Purchasers' prices include sales taxes and various margins including wholesale, retail and transport.

[27] The model reported *fpdm*—the change in the relative-price ratio—to be 29.7% for *ComFishing* [p0dom/p0imp → 1.483/1.146 - 1 = 29.4%, which is very close to the model's estimation].

[28] The parameters in the model known as the Armington elasticities were set at 2.8. C*eteris paribus,* this indicates a good degree of substitution between the domestically produced commodity and the imported equivalent.

2.2.1 *Ad Hoc* Approach: Specific Knowledge for Specific Commodities

Given the observed historical values for *ComFishing* from 1992 to 1998 and given the unfavourable change in relative prices, the model inferred that there must have been a large preference twist favouring domestic production. Examining the results listed in Table 1, this can be seen in the form of *impftwist* (up 98.6%). According to the model, there was in essence a twist away from imports that resulted in a 98.6% boost to domestic output sold domestically (*x0dom_dom*). Table 3 shows a back-of-the-envelope estimation to help explain how this is calculated.[29]

As can be seen in Table 3, *ComFishing* is only used by *BAS1* (production) and *BAS3* (households) and in the same proportion by source (import-domestic). It can also be seen that the share of sales at basic prices of domestically-produced *ComFishing* in 1992 was 19.4%.[30] Given the model inferred an import-domestic twist (*ftwist_src*) of -61.52% as shown in Table 1 and the top left corner of Table 3, *ceteris paribus*, this would have had the impact of growing domestic market share from 19.4% to 38.5% by 1998. In other words, the contribution to output of the shifter on the twist (*impftwist*) was in the order of 98% [= 38.5/19.4 – 1].

However, unfavourable changes in relative prices and rising costs stifled the rise in forecast market share, instead growing to 30.9% rather than 38.5% as shown in Table 3.[31] In fact, the strong domestic-production-boosting *impftwist* was projected forward (at 122.6% in the forecast run as can be seen in Table 1).[32] Given high import penetration there was lots of room for domestic output to grow and replace imports. This outcome was reflected in the forecast for 1998-2005. The result was twist factors contributed a 122.6% boost to the domestic sales of domestically-produced *ComFishing* (*x0dom_dom* spiked by 99.7%) in forecast. This is the key reason for the erroneous forecast of a 36.4% increase in domestically-produced *ComFishing*.

[29] Note the estimation method used in the Microsoft Office Excel excerpt only works if there is only one user in each BAS category (or all users in that BAS use it at the same intensity). So if there are several industries using e.g., *AsbestosProducts* in BAS1 (which there are) and they use it in different ratios then the Excel spreadsheet won't be accurate; whereas *ComFishing* is only used (demanded) as an input in the *ComFishing* industry (as opposed to many industries using it in different ratios, etc).

[30] This can also be found in Table 2 Section 4 (Sales of Commodity to Domestic Users) in the last column along the "domestic" row.

[31] 30.9% is not shown, but was reflected by the post-simulation values of *BAS1* and *BAS3* for *ComFishing*.

[32] The extrapolation is calculated as follows: $1.986^{7/6} - 1 = 122.6\%$.

Commercial Fishing (*ComFishing*) - 1992 Database

1. Main Producers of the Commodity at Basic Prices

Industries	19 ComFishing: 3735	**Total: 3735**
Proportion	19 ComFishing: 1.000	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	18 ComFishing: 3735	**Total: 3735**
Proportion	18 ComFishing: 1.000	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	926	3838	4764	**0.25**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	160	665	825	**0.04**
Exports	BAS4	2665	0	2665	**0.71**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	-16	0	-16	**0.00**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**3735**	**4503**	**8238**	
Source/Total		**0.45**	**0.55**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	67 PreparedFish: 484	457 EatDrinkPlce: 296	Rest: 146	Total: 926	**Total: 0.194**
Imported	67 PreparedFish: 2011	457 EatDrinkPlce: 1227	Rest: 600	Total: 3838	**Total: 0.806**
Total	**67 PreparedFish: 2495**	**457 EatDrinkPlce: 1523**	**Rest: 746**	**Total: 4764**	
Proportion	**67 PreparedFish: 0.524**	**457 EatDrinkPlce: 0.320**	**Rest: 0.157**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	1058	4451	5509	**0.82**	**0.16**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	242	1018	1260	**0.19**	**0.04**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	-16	0	-16	**-0.01**	**0.00**
Total	**1284**	**5469**	**6753**		
Source/Total	**0.19**	**0.81**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	1286	**0.34**	LABOUR	1379	**0.58**
Factor	2374	**0.64**	CAPITAL	995	**0.42**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	75	**0.02**	**Total**	**2374**	
Total	**3735**				

Source	c. Intermediate Inputs				Proportion
Domestic	195 LubricatOils: 349	46 OthMRconst: 303	Rest: 578	Total: 1230	**Total: 0.957**
Imported	110 CordageTwine: 36	18 ComFishing: 8	Rest: 12	Total: 56	**Total: 0.043**
Total	**195 LubricatOils: 349**	**46 OthMRconst: 303**	**Rest: 634**	**Total: 1286**	
Proportion	**195 LubricatOils: 0.271**	**46 OthMRconst: 0.236**	**Rest: 0.493**		

Table 2: The key attributes of *ComFishing* in 1992

ftwist_src	-61.52%	*ComFishing*: 1992-1998 (Historical Simulation)				
		start		end		
Import	3838	80.57	2.60	61.47	1.60	
Domestic	926	19.43		38.53	1.60	98.28
Total	**4764 = BAS1**					
		start		end		
Import	0	0	0	0	0	
Domestic	0	0		0	0	0.00
Total	**0 = BAS2**					
		start		end		
Import	665	80.56	2.59	61.46	1.59	
Domestic	160	19.44		38.54	1.59	98.25
Total	**825 = BAS3**					
				Weighted Average =		98.28
Sales	5588			versus USAGE *impftwist*		98.58
		The difference is due to b.o.t.e. estimation error				

Table 3: 1992-1998—The impact of the shifter on the import preference twist on *ComFishing*

2. **Given industry conditions it ought to have been realised that domestic output is *unlikely* to have expanded**

A rudimentary examination of the industry in 1998 would have revealed that a restrictive regulatory regime had been imposed just two years earlier on commercial fishing activities; and that this would likely have resulted in lower catches (output) going forward, as well as relatively strong upward pressure on prices of the domestic product (*p0dom*) versus the imported commodity (*p0imp*).

The NOAA (National Oceanic & Atmostpheric Administration) is charged with protecting and preserving the nation's living marine resources; while NOAA Fisheries is responsible for the stewardship of the nation's offshore living marine resources and their habitat.[33] According to its webpage: "NOAA Fisheries works within the Magnuson-Stevens Act, the Marine Mammal Protection Act and the Endangered Species Act to fulfill its mission of promoting healthy ecosystems."[34]

On October 11, 1996 the Sustainable Fisheries Act (SFA) became law.[35] This marked a significant change in the requirements to prevent overfishing and rebuild overfished fisheries. The SFA amended the Magnuson Fishery Conservation and Management Act (renamed the Magnuson-Stevens Fishery Conservation and Management Act). SFA amendments and changes to the

[33] http://www.noaa.gov/fisheries.html, visited 14 July 2009.
[34] http://www.noaa.gov/fisheries.html, visited 14 July 2009.
[35] http://www.nmfs.noaa.gov/sfa/magact/, visited 14 July 2009.

Magnuson Act include numerous provisions requiring science, management and conservation action by the National Marine Fisheries Service (NMFS).[36]

The 'SFA Update' was published periodically from June 1997 to April/May 1998 by the National Marine Fisheries Service (NMFS) Office of Sustainable Fisheries. The 'SFA Update' contained information on actions taken by NMFS to implement Sustainable Fisheries Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act. In the June 1997 edition of the 'SFA Update' (p. 1) it is stated that:

> "Some key provisions of the Sustainable Fisheries Act include:
>
> - Preventing overfishing, and ending overfishing of currently depressed stocks;
> - Rebuilding depleted stocks;
> - Reducing bycatch and minimizing the mortality of unavoidable bycatch;
> - Designating and conserving essential fish habitat;
> - Reforming the approval process for Fishery Management Plans and regulations;
> - Reducing conflict-of interest on Regional Councils; and
> - Establishing user fees".[37]

This seems to make it fairly clear that several measures would be implemented that would likely impede growth in the *ComFishing* industry. It seems that armed with this knowledge it would have been difficult to foresee industry expansion during the forecast horizon. The annual 'Status of U.S. Fisheries' report to Congress in September 1998 (p. 1), identified: "a substantial number of stocks that are overfished..."[38], and anticipated that the list would likely be expanded in 1999 as the provisions of the SFA were to be fully implemented. In June 2003, a separate report by NOAA Fisheries reflected upon the success of the implementation of the SFA. The report noted (p. 26):

> "In the half dozen years prior to passage of the SFA [this would include the 1992-1998 period of the historical simulation], the councils and NOAA Fisheries developed and implemented several individual transferable quota (ITQ) programs. ITQs were established in the surf clam/ocean quahog fishery in the Mid-Atlantic, the wreckfish fishery in the South Atlantic, and the fixed gear halibut and sablefish fisheries in the North Pacific ... The movement toward ITQs prompted a heated debate and, responding to concerns about consolidation of quota ownership and other social impacts, Congress

[36] http://www.nmfs.noaa.gov/sfa/, visited 14 July 2009.
[37] http://www.nmfs.noaa.gov/sfa/update.html, visited 14 July 2009.
[38] http://www.nmfs.noaa.gov/sfa/statusoffisheries/Archives/StatusofFisheriesReportCongress1998.pdf, visited 14 July 2009.

> changed the name of this program from ITQ to individual fishing quotas (IFQ) and included a four-year (1996-2000) moratorium on new IFQs in Section 303(d) of the SFA (later extended to September 30, 2002)."[39]

The moratorium lapsed in 2002 and old rules again applied (and it seems to great effect given the 12.8% decline in ComFishing output from 1998 to 2005).

3. Conclusion

In concluding, the crucial factor for *ComFishing* was the domestic production boost via *impftwist*, which was projected forward. This overwhelmed the impact of lower foreign demand because by 1998 producers and households had a 60% of total output (up from 29% in 1992). Meanwhile, the share of exports in total output had fallen to 39% from the 71% share in 1992. Had the model been tweaked to account for the impact of industry-impeding legislative change in the mid to late 1990s it seems likely that a more accurate forecast would have emerged.

For instance, in these circumstances a modeller would find it hard to believe that any projected domestic expansion would be so large as to squeeze out or replace such a large volume of imports. This is because the regulatory/environmental restrictions would have suggested a shortage that could only be met by higher imports, which is in fact what appears to have happened, and had started happening in the 1992-1998 period. The relatively fast-rising domestic-import price ratio was a symptom of when the bans started to apply more widely and when the regulatory change started to gather pace.

Overall, there is little doubt that in these types of situations the modeller should apply a specialised strategy to avoid projecting forward the domestic market share impact of *large* import twists. It appears that a similar idea should apply to exports as it is notoriously difficult to predict foreign demand. Perhaps very large shifts in foreign preferences should be closely investigated, in terms of likely sustainability, rather than be automatically projected forward. Given that the focus of the USAGE forecasts is on commodity output, it would be preferable to further examine the expected trade balance for an industry (and in turn, absorption) and treat exports as a residual. Hence, rather than try to explain trade at the gross level, we report the net level.

[39] http://www.nmfs.noaa.gov/sfa/SFA-Report-FINAL7_1.pdf, visited 14 July 2009.

4. Strategy to improve the forecast

Based on industry conditions between 1992 and 1998 a better forecast for *ComFishing* could have been produced. Given the restrictive nature of the regulations it is unlikely that output would have expanded. Knowing this, the strategy in re-running the simulation was to fix output growth (*x0dom*) at zero and endogenize export volumes (*cont_fepc*), as no clear view could be formed on likely changes to foreign demand. The model was prevented from projecting forward the impact on domestic production of the domestic-import preference twist. By setting *impftwist* to zero, this prevented the unlikely large boost to domestic sales of U.S.-produced output versus imports. Overall, forcing zero output growth for *ComFishing* reduced the USAGE error from 56% to 15%.

The result more generally is shown in the last column of Table 1. The model-imposed constraint on overall domestic output meant that a domestic-commodity-favouring 1.9% change in forecast relative prices could not fully filter through into local sales of domestically-produced *ComFishing*. With strong demand from households and producers there was a 22.4% rise in imports. Despite the overall *ComFishing* output growth constraint, *x0dom_dom* rose 7.2% as exports (down 9.7%) were diverted back into the domestic market. This compares favourably to the 99.7% rise in the original forecast. Actual *x0dom_dom* was a 53.9% decrease due to strong import penetration on the back of a sharp reversal of *impftwist* that resulted in significant damage to domestic sales of domestically-produced *ComFishing*. Absorption rose 17.6% versus 16.4% in the original forecast—the actual result was a 24.8% increase driven by very strong import growth. In terms of *net* trade, net imports as a proportion of domestic output rose 37.1% (*dtradeshare*) versus a 35.2% reduction in the original forecast. The actual result was an 87.7% increase due to the surge in imported *ComFishing*.

ElectronTube → Electron Tubes (SIC 3671)

Establishments primarily engaged in manufacturing electron tubes and tube parts. Not x-ray tubes. Includes cathode ray tubes, light sensing and emitting tubes, and television tubes.

ElectronTube - Electron Tubes	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-20.3	-20.8	-19.0	-21.0
All-factor-augmenting technical change	*a1prim*	-55.4	-16.8	-67.9	-67.9
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-23.6	-5.0	-26.9	-26.9
Combined change in household tastes	*a3com*	57.2	35.4	69.5	69.5
Commodity-using technical and taste change	*ac*	12.4	-8.9	17.3	0.0
Contribution to output of commodity-using technical & taste change	*cont_ac*	10.2	-6.4	12.0	0.0
Vertical shift of the export demand curve	*cont_fepc*	41.5	-31.7	49.9	0.0
Import/domestic twist by commodity	*ftwist_src*	-76.3	16.3	-94.5	0.0
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	26.8	-2.0	31.9	0.0
Twist caused by strong growth	*twist_eff*	19.4	-8.4	17.2	1.7
Basic price of domestic goods	*p0dom*	-19.3	-19.5	-11.8	-14.4
Basic price of imported goods	*p0imp*	-30.7	-27.8	-25.4	-24.5
Ratio of basic prices: domestic to import	*fpdm*	16.2	11.2	18.0	13.2
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	92.8	14.0	91.4	60.0
Total supplies of domestic goods	***x0dom***	**148.0**	**-14.3**	**114.3**	**23.3**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	112.6	14.4	119.3	51.8
Total supplies of imported goods	*x0imp*	40.2	15.2	-39.3	104.2
Household demands undifferentiated by source	*x3*	98.4	75.7	102.2	102.3
Export volumes	*x4*	282.3	-72.4	106.8	-33.0
Change in net import share to domestic output	*dtradeshare*	-28.1	24.8	-10.0	21.8

HldAudioVid - Household Audio & Video Equipment	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-2.8	0.0	-3.0	
All-factor-augmenting technical change	*a1prim*	-32.6	-18.4	-40.1	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-6.7	-3.2	-7.7	
Combined change in household tastes	*a3com*	18.2	45.9	21.5	
Commodity-using technical and taste change	*ac*	-25.6	-6.5	-32.5	
Contribution to output of commodity-using technical & taste change	*cont_ac*	-4.0	-0.8	-4.6	
Vertical shift of the export demand curve	*cont_fepc*	12.4	-14.5	14.6	
Import/domestic twist by commodity	*ftwist_src*	-23.9	118.3	-28.2	
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	21.0	-46.0	24.9	
Twist caused by strong growth	*twist_eff*	7.7	-4.8	9.9	
Basic price of domestic goods	*p0dom*	-5.8	-2.8	-1.8	N/A
Basic price of imported goods	*p0imp*	-5.1	0.6	7.7	
Ratio of basic prices: domestic to import	*fpdm*	-0.7	-3.4	-8.8	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	41.3	80.0	33.8	
Total supplies of domestic goods	***x0dom***	**66.3**	**0.1**	**67.0**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	64.3	5.5	52.8	
Total supplies of imported goods	*x0imp*	34.6	105.0	25.2	
Household demands undifferentiated by source	*x3*	44.3	88.1	37.6	
Export volumes	*x4*	90.2	-9.5	96.8	
Change in net import share to domestic output	*dtradeshare*	-44.0	191.2	-37.4	

Table 4: *ElectronTube* & *HldAudioVid* results

ElectronTube had a USAGE error of 149%. However, it was situated well below the 45-degree line due to the extremely erroneous trend forecast—the forecast trend error was 236%. Actual growth was a 14.3% decline over the 1998-2005 period, which has been highlighted in the top section of Table 4. This followed a 148.0% rise from 1992-1998—the extrapolated trend was therefore 189%, versus the USAGE forecast of 114% growth.

1. **Why did the model predict 114.0% growth for 1998-2005 when the true outcome was a 14.3% decline?**

Following the protocols used in the section on *ComFishing,* key results appear in Table 4, while certain characteristics of the 1992 database (such as main users, cost structure, market share, etc.) appear in Table 5. These include the following:

- This is a multi-industry commodity, mostly produced by the Electron Tubes industry (USAGE industry 355: *ElectronTube*). This industry also produces other commodities. These observations can be confirmed in Sections 1 and 2 of Table 5.
- 78% of output was sold into the domestic market and all of this was to producers; 21% of production was exported and there were minimal inventories. These observations can be confirmed in Section 3 of Table 5.
- The Household Audio & Video Equipment industry was the main buyer of Electron Tubes. This is USAGE industry 351: *HldAudioVid* and appears in Section 4 of Table 5.
- About 27% of total domestic sales came from imports, which can be seen in Section 5 of Table 5.

There were several contributing factors to the erroneous forecast. Perhaps the main reason was the poor forecast for the main purchaser of Electron Tubes: *HldAudioVid*. Indeed, there were a number of similarities in the results for *ElectronTube* and *HldAudioVid* that can be seen in Table 4, such as:

1. The large upward shift in the export-demand curve in the 1992-1998 period was projected forward thereby overestimating foreign demand, which in fact slumped in 1998-2005 (see results for *cont_fepc* in Table 4).
2. The strong domestic-import twist trend in 1992-1998 (that favoured domestic producers) had its impact on domestic sales of U.S. output projected forward, when it in fact moved sharply in the opposite direction in 1998-2005 (see results for *impftwist* in Table 4).

With overall domestic market supplies growing faster than demands by the main users of the commodity, the model implied fairly strong *ElectronTube*-using technical change (*ac*), and the contribution to output of this term was projected forward (*cont_ac*). To see this, start by looking in Table 4, from 1992-1998, at the row labelled "Quantity of sales of domestically produced in U.S." (*x0dom_dom*). For *ElectronTube* this shows growth of 112.6%. However, in results not shown here demand for inputs of domestically-sourced *ElectronTube* for current production by *HldAudioVid* (the main user) grew by only 97.7%.

As can be seen in Section 5 of Table 5, *ElectronTube* derives its demand from the demand for "other" goods, such as televisions, which is an important component of *HldAudioVid.* Furthermore, these "other" goods were subject to rapid changes in technology that did not require any *ElectronTube* input. Sales of domestically-produced *ElectronTube* were forecast to more than double and to replace imports (see *x0dom_dom* in Table 4), even as relative-price changes favoured imports. The basic price of imported *ElectronTube* was expected to fall by 25.4%, while the basic price of domestically-produced *ElectronTube* was expected to fall by just 11.8%. In light of this, *impftwist* must have had an enormous influence on the projection of sales of domestically-produced *ElectronTube* in the U.S. market (*x0dom_dom*). In forecast, the 18.0% import-favouring move in relative prices (*fpdm*) implied, *ceteris paribus*, that the import-domestic sales ratio should have increased 59.0% [= $1.18^{2.8} - 1$]; but it in fact *fell* 72.3% [= 0.607/2.193 – 1] due to:

- the 31.9% boost to sales of domestically-produced *ElectronTube,* which already dominated the U.S. market (see *impftwist* in Table 4); and
- strong commodity-using technical change that made a 12% contribution to domestic output of *ElectronTube* (see *cont_ac* in Table 4);

Total output (*x0dom*) was further boosted by the reinforcing effect of another strong rise in the export demand function—this was extrapolated in the forecast as a 49.9% upward shift in the export-demand curve (see *cont_fepc* in Table 4). This produced the dubious and material impact of a further doubling (+106.8%) in export volumes, having almost quadrupled (+282.3%) during the period from 1992 to 1998.

Electron Tubes (*ElectronTube*) - 1992 Database

1. Main Producers of the Commodity at Basic Prices

Industries	355 ElectronTube: 2970	351 HldAudioVid: 292	Rest: 218	**Total: 3480**
Proportion	355 ElectronTube: 0.853	351 HldAudioVid: 0.084	Rest: 0.063	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	345 ElectronTube: 2970	347 OthElectronC: 72	Rest: 68	**Total: 3110**
Proportion	345 ElectronTube: 0.955	347 OthElectronC: 0.023	Rest: 0.022	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	2715	1015	3730	**0.78**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	736	0	736	**0.21**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	29	0	29	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**3480**	**1015**	**4495**	
Source/Total		**0.77**	**0.23**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	351 HldAudioVid: 1505	494 FGCEnatdef: 203	Rest: 1007	Total: 2715	**Total: 0.728**
Imported	351 HldAudioVid: 442	355 ElectronTube: 285	Rest: 289	Total: 1015	**Total: 0.272**
Total	**351 HldAudioVid: 1947**	**355 ElectronTube: 350**	**Rest: 1434**	**Total: 3730**	
Proportion	**351 HldAudioVid: 0.522**	**355 ElectronTube: 0.094**	**Rest: 0.384**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	2976	1129	4105	**0.99**	**0.72**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	29	0	29	**0.01**	**0.01**
Total	**3005**	**1129**	**4134**		
Source/Total	**0.73**	**0.27**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	2027	**0.65**	LABOUR	1004	**0.95**
Factor	1057	**0.34**	CAPITAL	53	**0.05**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	26	**0.01**	**Total**	**1057**	
Total	**3110**				

Source	c. Intermediate Inputs				Proportion
Domestic	214 Glass: 593	262 SheetMtlWork: 129	Rest: 761	Total: 1483	**Total: 0.731**
Imported	345 ElectronTube: 318	214 Glass: 170	Rest: 57	Total: 545	**Total: 0.269**
Total	**214 Glass: 763**	**345 ElectronTube: 389**	**Rest: 875**	**Total: 2027**	
Proportion	**214 Glass: 0.376**	**345 ElectronTube: 0.192**	**Rest: 0.432**		

Table 5: The key attributes of *ElectronTube* in 1992

2. **Given industry dynamics it ought to have been realised that domestic output was *unlikely* to expand**

The general flow of the commentary in this space was that despite improvements in technology throughout the 1990s, direct view cathode ray tubes (CRTs) and rear projection tubes suffered from the major disadvantage of their overall size—they occupied large parts of a room (floor space), or desk space in the case of a computer monitor. These products dominated the television and monitor (display) market during the 1992-1998 period and falling prices (a process that was accelerated by the arrival of Chinese imports), as well as the strong uptake of computers and the internet, resulted in a surge in demand.[40]

However, during the 1998-2005 period the increased penetration of newer technologies (such as plasma and LCD flat panels) in the television and 'visual' industry more generally, revolutionised the type of television or monitor that people could view. It is worth noting that these types of flat panels (called TFT LCD) were already being used in notebook computers. The key question here is: in 1998 would the modeller have been sufficiently aware of this revolution? If so, then it would be difficult to believe that *ElectronTube* could continue to grow as strongly as in the historical period. To shed light on this question, according to online information provider, referenceforbusiness.com:

> "Despite its continued popularity in the 1990s, the CRT was by no means a perfect piece of technology. In a world increasingly permeated by digital solid state electronics technology, the CRT remained the last holdover of the old analog glass vacuum tube, which in fact it essentially was. The CRT was bulky, hot, and heavy, used large amounts of power, and was prone to disruptions of glare and magnetic and electrical fields. By the mid-1990s, in fact, few experts doubted that for mainstream computer and TV uses the CRT's days were numbered. In their place, came the advent of high definition liquid crystal display (LCD) screens for computers. These displays utilized an active matrix view panel. Display resolution often surpassed the capabilities of traditional CRT displays. While such technology was often far more expensive, the promise of ever-decreasing manufacturing costs and higher consumer demand marked LCD technology as the heir-apparent to traditional CRT use for computer displays."[41]

[40] http://www.referenceforbusiness.com/industries/Electronic-Equipment-Components/Electron-Tubes.html, visited 2 August 2009.
[41] http://www.referenceforbusiness.com/industries/Electronic-Equipment-Components/Electron-Tubes.html, visited 2 August 2009.

2.2.1 *Ad Hoc* Approach: Specific Knowledge for Specific Commodities

In 1992, Fujitsu introduced the world's first 21-inch (53-centimetre) full-colour plasma display.[42] In December 1994, the International Technology Research Institute at Loyola College in Maryland, produced a publication on display technologies that included an insightful appendix: "World View Of Liquid Crystal Flat Panel Displays" by Dr Patricia E. Cladis. As can be viewed at wtec.org, Dr Cladis wrote:

> "In TFT LCDs, 16.7 million colors are now possible (shown, for example, by the Sharp Corporation at the 1992 Japan Electronics Show in Osaka, Japan).
>
> Once a true color display is seen, multicolor and monochrome displays are unacceptable to many customers in the same way black-and-white TV is unacceptable to viewers of color television. A brightly-colored display is cheerful and friendly. Product enhancement from a color display can outsell an equivalent monochrome product in the consumer market.
>
> About 90% of the world supply of LCDs (and virtually 100% of TFT LCDs) are manufactured by Japanese leaders in the semiconductor industry. According to a Nikkei Microdevices survey, since 1989 LCD production of both passive and active LCDs has grown in Japan at a staggering 35% annual rate (in yen) to about $3.5 billion (435.5 billion yen) in 1991. In 1992, the total LCD growth rate slowed somewhat to a still phenomenal 20%, reaching $4.7 billion (516.5 billion yen), with the TFT LCD sector reporting an outstanding 161% growth (to $1.2 billion or 132.2 billion yen) (Nikkei 1992). According to NEC and Sharp executives, "Nothing has changed the outlook for a 1 trillion yen liquid crystal market (in Japan) by 1995" (Nikkei 1992).
>
> Indeed, Figure F.1 [shown in Figure 1] shows that Asada (a Sharp vice-president) was right on track (Asada 1990) for the LCD world market, where the 1 trillion yen mark [about US$8.5b at the time] is expected by the turn of the century."[43]

Hence, as early as 1990 projections were readily available that showed expected global sales of LCD technology would exceed CRTs before 2000. Furthermore, a concise summary of the state of global LCD manufacturing in 1994 could be found at: http://www.wtec.org/loyola/displays/c3_s1.htm.

[42] http://en.wikipedia.org/wiki/Plasma_display, visited 2 August 2009.

[43] http://www.wtec.org/loyola/displays/af_world.htm, visited 2 August 2009. Further references of interest in this article are: Asada, Atsushi. 1990. "Electronic Displays: A Revealing Look at the Latest in LCDs." Display Devices Dempa Publications, Inc. Jul.:30. Also: Nikkei Microdevices. 1992. Flat Panel Display 1993. Dec. 10.

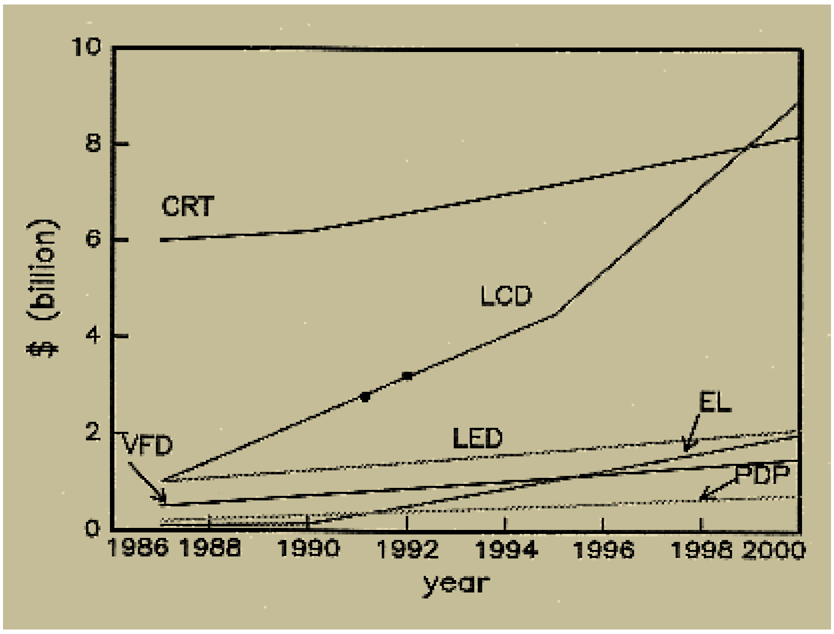

Figure 1: Early projections for the LCD world market

In 1998 flat panel displays were relatively expensive versus a tube television. Though, it appears that by 2002 the price of a plasma display had fallen by enough to allow for increased market penetration.[44] According to Wikipedia:

> "In 1997, Fujitsu introduced the first 42-inch (107 cm) plasma display; it had 852x480 resolution and was progressively scanned. Also in 1997, Philips introduced a 42-inch (107 cm) display, with 852x480 resolution. It was the only plasma to be displayed to the retail public in 4 Sears locations in the U.S. The price was 14 999 US$ and included in-home installation. Later in 1997, Pioneer started selling their first plasma television to the public."[45]

That information from Wikipedia was referenced from a website that was in existence pre-1998: www.tech-notes.tv. Upon visiting the webpage the following commentary was noted from one of the site's owners (Jim Mendrala: J.Mendrala@ieee.org) dated 15 June 1997:

> "...It is estimated that by the year 2000, large wide screen TVs will account for one third of the total television market and plasma displays for 10% of that market, or 303 million sets annually. Fujitsu Plasma Displays are already in use at airports, stock exchanges, and other locations worldwide ... Sony says it will have an HDTV receiver using the 42 inch diagonal Plasma Display from Fujitsu available here in the U.S. around the last

[44] http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01002519, see pdf: "Scanning the Issue: Special Issue on Flat-Panel Display Technology" out of PROCEEDINGS OF THE IEEE, VOL. 90, NO. 4, APRIL 2002.
[45] http://en.wikipedia.org/wiki/Plasma_Display, visited 24 July 2009.

> quarter of 1998. It will have a starting list price of $2,500 but that price is expected to drop rapidly as sales increase."[46]

This then raises the questions of: who was making these kinds of estimations and how widely known were they; and were any forecasts subsequently updated by the end of 1998?

However, it seems that there were some analysts expecting CRTs to continue to dominate for some time yet, at least in the computer monitor market as indicated by the following quote from an online tech publication in 1998:

> "CRT monitors will continue to dominate the data display market for the next seven years, despite "mounting competitive pressure" from flat panel displays. Worldwide CRT sales will produce $17 billion revenues from 90.5 million units, according to research firm Stanford Resources. By 2004, the worldwide CRT monitor market will reach 134.7 million units, but market value will edge up only slightly to $18.9 billion, as average selling prices continue to decline, Stanford forecasts in the twelfth edition of Monitor Market Trends. The 19-inch CRT monitor is the fastest growing screen size, with expected shipments of 2.4 million units leaping to 23.2 million units in 2004. "With the introduction of new CRTs featuring flatter faceplates, shorter necks, and larger viewing area, CRT-based monitors continue to offer the best price/performance equation for computer applications", Stanford Resources analyst Rhoda Alexander said. "Both 17- and 19-inch CRTs are the focal point for growth in the CRT monitor industry into the next decade, while formerly price-prohibitive 20- and 21-inch monitor markets are now becoming increasingly affordable for general computer users", Alexander said."[47]

Stanford Resources, referred to in the quote immediately above, was a market research firm on the global electronic display industry. It produced a publication called Monitor Market Trends. This publication focused on computer monitors rather than televisions (the difference being that monitors do not have an integrated tuner and are typically much smaller). The reader should notice the strong focus on size in the above quotation. This is in line with the bigger is better motto and was indicative of how consumers had a strong preference for larger viewable areas.

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[46] http://www.tech-notes.tv/Archive/tech_notes_004.htm, visited 24 July 2009.

[47] "CRTs beat back flat panel challenge", by 'a staffer'; posted in Business, 21 October 1998, 12:50 GMT: http://www.theregister.co.uk/1998/10/21/crts_beat_back_flat_panel/. The Register began publishing online daily in 1998.

2.2.1 *Ad Hoc* Approach: Specific Knowledge for Specific Commodities

According to the data (in nominal dollars) from the U.S. International Trade Administration in Figure 2, the value of imports of *ElectronTube* had started to decline in the mid 1990s.[48] This was also borne out in the trade data for *HldAudioVid*, and was driven by sharp price falls in the basic prices of imports. At the same time the value of exports was rising even as f.o.b. export prices fell. In terms of volumes, these were rising across the board. However, domestic output grew much more strongly than the imported equivalent. This was reflected by the rise in the domestic-import supply ratio in both industries, which can be seen in Table 4 by comparing growth rates of *x0dom* and *x0imp*.

In light of the rising competitive pressure from flat panel technology, and with the U.S. generally regarded as an early adopter of high-tech audio visual products, falling prices was a sign of the old technology making way. It is a regular occurrence for new product release strategies to focus on launching in the world's largest economy, where virtually all of the world's largest companies have a presence. In relation to new technologies, the annual International Consumer Electronics Show in Las Vegas is often the centrepiece for product releases and previews.[49] According to Wikipedia, a notable product introduction at the January 1998 show was High Definition Television (HDTV). The natural implication of this was that 'big' televisions would ultimately display high resolution images.

3. Conclusion

Flat panel technology (such as TFT LCD) was already being used in notebook computers. In 1992, Fujitsu introduced the world's first 21-inch full-colour plasma display. As early as 1990, projections were readily available that showed expected global sales of LCD technology would exceed CRTs before 2000. In light of the rising competitive pressure from flat panel technology, and with the U.S. generally regarded as an early adopter of high-tech audio visual products, falling prices during period from 1992 to 1998 signalled the decline of the CRT technology used in the Electron Tubes industry. The demand for *ElectronTube* is essentially derived from the demand for other goods, such as televisions, monitors and displays. As sleeker, larger screen replacements had already started to appear on the market, it is plausible that a substantial growth slowdown in *ElectronTube* could have been expected to occur during the 1998-2005 period; and at the very least, output more than doubling (as was predicted in the original forecast) would have been seen to be a most unlikely scenario.

[48] All data used in the various industry trade diagrams (such as Figure 2) shown throughout this thesis are sourced from the U.S. International Trade Commission, unless otherwise specified.

[49] http://en.wikipedia.org/wiki/Consumer_Electronics_Show visited 2 August 2009.

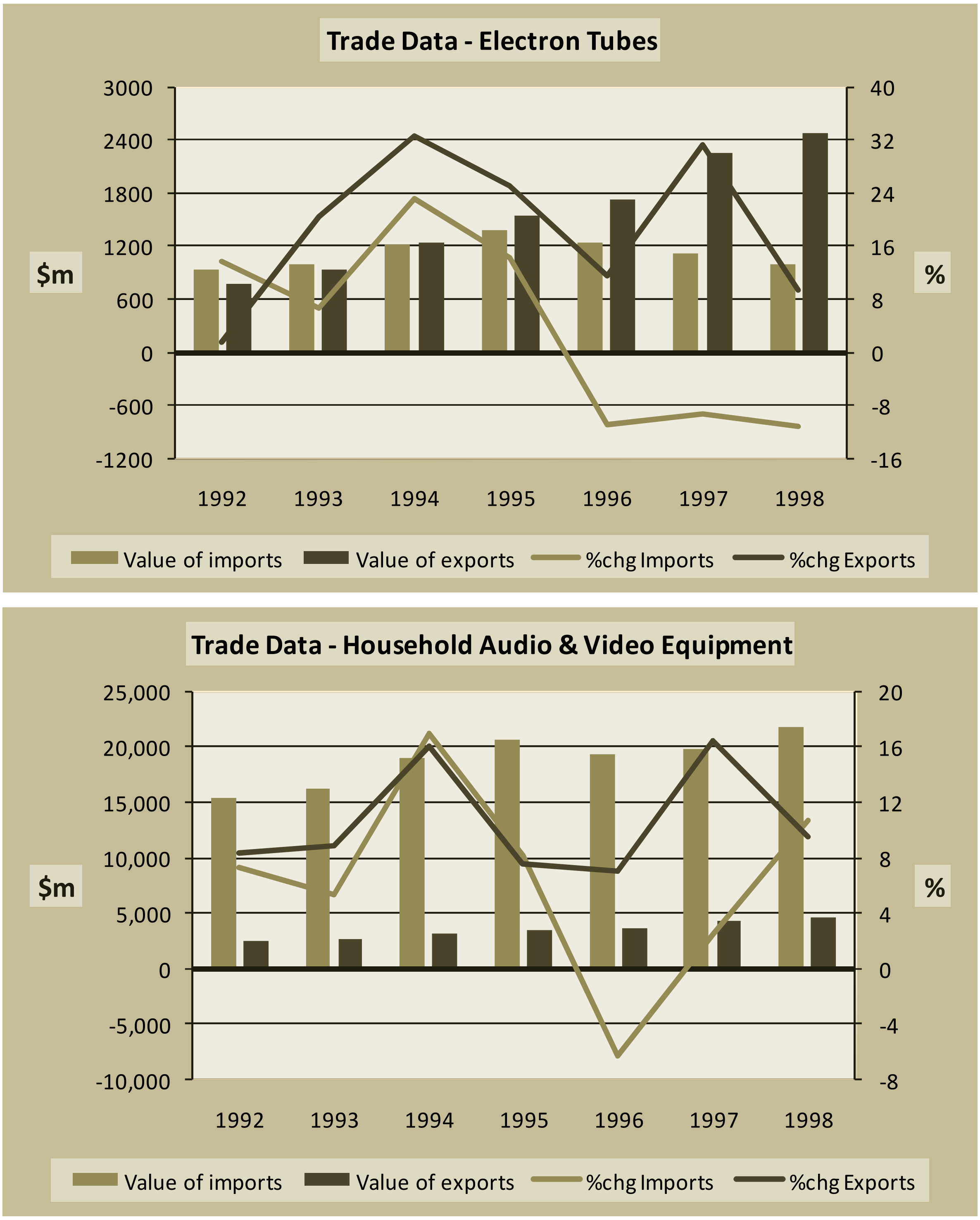

Figure 2: 1992-1998—U.S. trade by the Electron Tubes and Household Audio & Video Equipment industries

4. Strategy to improve the forecast

In the historical simulation, a large upward shift in the export-demand curve was observed for *ElectronTube*; as well as a strong twist trend impact favouring domestic sales of U.S.-produced *ElectronTube*; and *ElectronTube*-using technological change. The discussion above suggests that these factors ought not to have been projected forward. As a result, the strategy was to zero out contributions to output from: *ElectronTube*-using taste changes, foreign preference changes, and domestic-import preference twists. This simulation markedly reduced the USAGE error from 149% to 17%. The overall outcome (shown in the last column of Table 4) is a more plausible forecast for *ElectronTube.* Output of the commodity rises 23.3% rather than the originally-projected 114.3%; sales of domestically-produced *ElectronTube* into the U.S. market rise 51.8% instead of the initial forecast of 119.3%. The actual result of *x0dom_dom* was a 14.4% rise—lower growth than in the improved forecast—as a result of lower than expected supply-side cost savings (see *cont_a1prim*).

The improved forecasts for gross exports and gross imports were directionally accurate; however, the errors were too great for these to be of much use. It is again worth noting the difficulty in trying to predict trade flows at the gross level. Given that the overall focus of the forecasts is on commodity output, changes in *net* trade are considered. Net imports as a proportion of domestic output rose 21.8% (*dtradeshare*) versus a 10.0% reduction in the original forecast. The actual result was a 24.8% increase.

Dolls → Dolls & Stuffed Toys (SIC 3942)

This is part of Miscellaneous Manufacturing Industries and covers establishments primarily engaged in manufacturing dolls, doll parts, and doll clothing, except doll wigs. Establishments primarily engaged in manufacturing stuffed toys are also included in this industry.

Dolls - Dolls & Stuffed Toys	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-8.6	-10.8	-8.9	-5.6
All-factor-augmenting technical change	*a1prim*	-38.5	-28.8	-49.4	-49.4
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-17.3	-10.6	-19.9	-19.9
Combined change in household tastes	*a3com*	9.8	-13.9	11.5	11.5
Commodity-using technical and taste change	*ac*	65.5	-36.2	66.6	66.6
Contribution to output of commodity-using technical & taste change	*cont_ac*	2.0	-1.9	2.3	2.3
Vertical shift of the export demand curve	*cont_fepc*	1.1	-27.3	1.3	1.3
Import/domestic twist by commodity	*ftwist_src*	119.6	-30.5	137.4	0.0
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-53.0	39.4	-58.6	0.0
Twist caused by strong growth	*twist_eff*	-1.8	3.7	-12.0	-1.0
Basic price of domestic goods	*p0dom*	-1.3	1.8	4.9	9.7
Basic price of imported goods	*p0imp*	-10.0	5.5	4.5	5.8
Ratio of basic prices: domestic to import	*fpdm*	9.7	-3.6	0.4	3.7
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	74.9	29.0	40.1	39.8
Total supplies of domestic goods	***x0dom***	**15.9**	**40.4**	**-30.8**	**11.0**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	-20.1	76.4	-45.1	15.4
Total supplies of imported goods	*x0imp*	83.8	25.8	45.4	41.6
Household demands undifferentiated by source	*x3*	70.1	30.5	38.9	38.1
Export volumes	*x4*	11.8	-55.4	9.4	0.9
Change in net import share to domestic output	*dtradeshare*	354.8	-63.6	1,188.7	265.9

Table 6: *Dolls* results

1. Why did the model erroneously give poor prospects to Dolls & Stuffed Toys?

Dolls had a USAGE error of 51% and was the third-highest observation above the 45-degree line. The forecast trend error was just 15%. Actual growth was 40.4% over the 1998-2005 period (highlighted in Table 6 in the row containing "Total supplies of domestic goods"). This followed a 15.9% rise from 1992-1998—the extrapolated trend was therefore about 19% growth—yet USAGE forecast a 31% decline. The main users, cost structure and other information of interest can be seen in Table 7, which has been divided into six sections. Key characteristics of the 1992 database include:

- 90% of total U.S. sales came from imports, and the vast majority of all sales were to consumers (Section 3).
- 28% of domestic production was exported (Section 3).

During the period 1992-1998 there was a 20.1% decrease in domestic sales of domestically-produced *Dolls* (see *x0dom_dom* in Table 6). This fall was larger than could be explained by the unfavourable change in relative prices [*p0dom*/*p0imp* → 0.987/0.9 – 1 = 9.7%]. A circa 10% relative-price change against U.S.-made *Dolls* somehow translated to an 83.8% rise in imported *Dolls* (see *x0imp* in Table 6) despite limited substitutability between foreign and domestic sources. On the basis of relative-price changes alone, the ratio of imported to domestic *Dolls* being sold into the domestic market would have increased by 9.7%.[50] [$1.097^1 - 1 = 9.7\%$]. Instead it surged 130% [= 1.838/0.799 – 1].

Technological change[51] could only explain a small part of the disparity, so the model inferred that there must have been a large preference twist against domestically-produced *Dolls*. An examination of the results listed in Table 6 shows this in the form of *impftwist* falling 53.0%. According to the model, there was a twist towards imported *Dolls* that resulted (*ceteris paribus*) in 53.0% damage to U.S. output sold domestically (*x0dom_dom*). After all other factors are taken into consideration, domestic sales of U.S.-produced *Dolls* fell 20.1%. With an overall 15.9% rise in domestic output (*x0dom*), this would normally mean that the difference was exported. Indeed foreign markets were important to U.S. producers of *Dolls* because exports comprised 28% of production in 1992. However, export volumes rose 11.8% (see *x4* in Table 6); not enough to fully explain the rise in *x0dom*. The remainder was driven by the change in inventories during the period. At the end of 1992 there were negative inventories of *Dolls* to the tune of $100m (see Section 3 of Table 7). This meant that 33% of demand at that time was met by running down inventories. In results not reported here, inventories increased to (positive) $2m by the end of 1998. With domestic basic prices falling only slightly during this period, inventories made a $102m contribution to domestic output. This overwhelmed the 20.7% or circa $65m decline in demand by households for the domestic product.[52]

[50] The parameters in the model known as the Armington elasticities were set at 1.0 for *Dolls*. C*eteris paribus,* this indicates minimal substitution between the domestically produced commodity and the imported equivalent.

[51] Table 6 shows that the average of technical change terms in production (*a*) was -8.6%, and the contribution of *Dolls*-using technical and taste change (*cont_ac*) was 2.0% for the period 1992-1998.

[52] This is also not reported in the results table, which instead shows total household demand, undifferentiated by source. Total household demand rose 70.1% on the back of an 82.4% increase in consumption of imported *Dolls*—and that was driven by a strong non-price related import-favouring preference twist (*impftwist* = -53.0%), as well as an import-favouring change in relative prices (*fpdm* = 9.7%).

Dolls & Stuffed Toys (*Dolls*) - 1992 Database

1. Main Producers of the Commodity at Basic Prices

Industries	397 Dolls: 243	396 Games: 47	Rest: 10	**Total: 301**
Proportion	397 Dolls: 0.809	396 Games: 0.156	Rest: 0.035	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	387 Dolls: 243	386 Games: 5	Rest: 6	**Total: 254**
Proportion	387 Dolls: 0.957	386 Games: 0.020	Rest: 0.024	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	14	86	100	**0.05**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	303	2255	2558	**1.01**
Exports	BAS4	84	0	84	**0.28**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	-100	0	-100	**-0.33**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**301**	**2341**	**2642**	
Source/Total		**0.11**	**0.89**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	397 Dolls: 5	508 Holiday: 3	Rest: 6	Total: 14	**Total: 0.138**
Imported	508 Holiday: 20	397 Dolls: 19	Rest: 48	Total: 86	**Total: 0.862**
Total	**397 Dolls: 24**	**508 Holiday: 22**	**Rest: 54**	**Total: 100**	
Proportion	**397 Dolls: 0.237**	**508 Holiday: 0.222**	**Rest: 0.541**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	20	128	148	**0.04**	**0.00**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	553	4182	4734	**1.17**	**0.12**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	-100	0	-100	**-0.21**	**-0.02**
Total	**472**	**4310**	**4782**		
Source/Total	**0.10**	**0.90**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	151	**0.59**	LABOUR	95	**0.95**
Factor	101	**0.40**	CAPITAL	5	**0.05**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	3	**0.01**	**Total**	**101**	
Total	**254**				

Source	c. Intermediate Inputs				Proportion
Domestic	416 WholesleTrde: 17	202 MiscPlPrdnec: 16	Rest: 88	Total: 121	**Total: 0.802**
Imported	387 Dolls: 23	479 NoncompImps: 5	Rest: 2	Total: 30	**Total: 0.198**
Total	**387 Dolls: 29**	**416 WholesleTrde: 17**	**Rest: 105**	**Total: 151**	
Proportion	**387 Dolls: 0.192**	**416 WholesleTrde: 0.113**	**Rest: 0.695**		

Table 7: The key attributes of *Dolls* in 1992

2. What happened in the forecast?

In the USAGE forecast, inventories are set to move back to zero by the end of the simulation period. With only minimal inventories on hand by 1998, this output component could repeat the large boost it gave to domestic production from 1992 to 1998.

Furthermore, (as seen in the case of *ComFishing*) where there are strong twist factors affecting imports this can result in large forecast errors for domestic output of a commodity because the *impact* of the twist is projected forward. The results of the original forecast simulation that appear in Table 6 show that virtually every variable (except *impftwist*) moved in a way that favoured increasing the output of *Dolls*—producers were becoming more efficient (*a* = -8.9%); consumers, who were by far the main user, preferred to purchase more dolls in 2005 versus 1998 at any given set of prices and per capita income (*a3com* = 11.5%); there was a favourable preference shift in intermediate use of dolls (*cont_ac* = 2.3%); and the export-demand curve was projected to shift slightly upwards (*cont_fepc* = 1.3%). At the same time, relative prices (domestic to import) were virtually unchanged. [*p0dom*/*p0imp* → 1.049/1.045 – 1 = 0.4%]. Given that the domestic-import substitution elasticity for *Dolls* was set to 1, *ceteris paribus*, this suggests the import-domestic sales ratio should have increased slightly. Instead, total supplies of domestic goods were forecast to fall 30.8% (*x0dom*), driven by an expected 45.1% reduction in sales of domestically-produced *Dolls* in the U.S. (*x0dom_dom*). With only minimal changes in relative prices, the decline in *x0dom_dom* was the result of projecting *impftwist* forward.

Table 8 compares the effect of *impftwist* on *Dolls* between the original forecast and the actual result using a back-of-the-envelope estimation. For simplicity the table is divided into three parts—sales to producers (*BAS1*); sales to investors (*BAS2*) and sales to consumers (*BAS3*). Focusing on the *BAS3* section (where the vast majority of sales took place) it can be seen that domestic market share in the consumer market was 6.00%. As a result of projecting *impftwist* forward, *ceteris paribus*, market share was forecast to more than halve to 2.62% (left hand side of Table 8). In this case, *impftwist* did nearly 60% damage to domestic market share of U.S.-produced *Dolls* (*x0dom_dom*) by over-estimating the strength of import preferences. In actual fact, *ceteris paribus*, domestic market share would have *increased* to 8.42% (right hand side of Table 8)—more than three times higher than in the original forecast. In any case, with U.S. supplies of *Dolls* moving off such a low base, generating an accurate projection for *x0dom* was always going to be difficult.

ftwist_src	137.40%	*Dolls* (Forecast: 1998-2005)		
		start	end	
Import	172	93.09	96.97	
Domestic	13	6.91	3.03	-56.12
Total	**185**	**=BAS1**		
		start	end	
Import	0	0	0	
Domestic	0	0	0	0.00
Total	**0**	**=BAS2**		
		start	end	
Import	3714	94.00	97.38	
Domestic	237	6.00	2.62	-56.36
Total	**3951**	**=BAS3**		
			Weighted Average =	-56.35
Sales	4136		*Impftwist*	-58.55
The difference is due to b.o.t.e. estimation error				

ftwist_src	-30.52%	*Dolls* (Actual: 1998-2005)		
		start	end	
Import	172	93.09	90.35	
Domestic	13	6.91	9.65	39.69
Total	**185**	**= BAS1**		
		start	end	
Import	0	0	0	
Domestic	0	0	0	0.00
Total	**0**	**= BAS2**		
		start	end	
Import	3714	94.00	91.58	
Domestic	237	6.00	8.42	40.23
Total	**3951**	**= BAS3**		
			Weighted Average =	40.20
Sales	4136		*Impftwist*	39.42
The difference is due to b.o.t.e. estimation error				

Table 8: The relative impacts of import twist factors on *Dolls*—Forecast versus Actual

3. **Given industry conditions it ought to have been realised that domestic output is *unlikely* to have collapsed in forecast**

The doll market is segmented between play dolls and collectible dolls; each characterised by totally different sales distributions. Consumers are by far the largest users of dolls, with gifting by parents and grandparents to young girls being the key driver behind purchases.[53] As a result of competition from computer and electronic games targeted to girls, manufacturers brought out more interactive dolls and updated their current products.[54] Furthermore:

> "...in the late 1990s it was expected that imports would continue to displace domestic production. China, Japan, and Taiwan were major suppliers. Exports were being helped by an increased interest in products made in the United States and the lifting of trade barriers."[55]

According to an article that originally appeared in Business Wire[56] on 16 September 1997, the collectibles market was growing very strongly as an increasing number of baby boomers entered the market:

> "The U.S. collectible-dolls market, led by character-collectibles manufacturers such as Exclusive Toy Products Inc., has exploded into a $1.7 billion-a-year industry, according to

53 http://www.mindbranch.com/listing/product/R395-0009.html, visited 28 July 2009.
54 http://www.answers.com/topic/dolls-and-stuffed-toys, visited 28 July 2009.
55 http://www.answers.com/topic/dolls-and-stuffed-toys, visited 28 July 2009.
56 Business Wire is a distributer of press releases and regulatory disclosures.

> recently released collectibles-industry figures. Considering that the overall collectibles sector [this is broader than the *Dolls* industry] generated more than $9.1 billion in consumer sales in 1996, it becomes apparent that collectibles, and especially collectible dolls, are hotter than ever. The study also found that the increasing popularity of collectibles is being fuelled by new collectors, especially in the baby-boomer category. The infusion of mature newcomers into an already-stable industry was cited as the primary reason for the solid 11.9 percent sales increase in 1996, up from $8.2 billion the previous year. Moreover, 88 percent of the nation's dolls retailers pointed to new collectors as the top industry trend destined to impact store sales over the next five years."[57]

By 1998, total sales (domestic and imported) in the U.S. market for Dolls & Stuffed Toys valued at purchases prices was $7.9b (up from $4.8b in 1992; see Section 5 of Table 7). Thus, collectibles was about 22% of the market, and growing strongly. If inventory changes are excluded, households accounted for more than two-thirds of sales of domestically-produced *Dolls*, with most of the remainder exported. Had the modeller been aware of the dynamics in the fast-growing collectibles market it is expected that any sharp decline in forecast would have been queried.

4. Conclusion

In the historical simulation for 1992-1998, the model inferred that there was a large preference twist towards imports. By projecting already-large import twist factors forward the risk of generating a poor forecast is magnified, especially where high import penetration prevails. The doll market is segmented between play dolls and collectible dolls; each characterised by different sales distributions. A Business Wire report from 1997 highlighted the fast-growing collectibles market that was being driven by an increasing number of baby boomers that had entered the *Dolls* market. By 1998, total sales (domestic and imports) in the U.S. doll market valued at purchases prices had grown to $7.9b. Thus, collectibles comprised about 22% of the market and were growing strongly. U.S. producers were well positioned to meet this demand and were already making more innovative products. Excluding inventory changes, households accounted for more than two-thirds of sales of domestically-produced *Dolls*, with most of the remainder exported. Given the dynamics in the fast-growing collectibles market, a sharp decline in forecast would have seemed unlikely. In light of this, a better forecast could have been produced for *Dolls*.

[57] http://www.thefreelibrary.com/FEATURE%2FExclusive+Toy+Products+Targets+Lucrative+Collectible-Dolls...-a019753614, visited 28 July 2009.

5. Strategy to improve the forecast

In re-running the simulation, the strategy was to set *impftwist* to zero on the basis of improving market dynamics. This prevented the model from projecting forward the negative impact on domestic production of the domestic-import preference twist—thus barring the unlikely large contraction to domestic sales of U.S.-produced output versus imports. The results are shown in the last column of Table 6, which is denoted “Improved Forecast”. This reduced the USAGE error from 51% to 21%.

The key focus in the re-projection of *Dolls* is on *x0dom* and *x0dom_dom*. In the case of *x0dom_dom*, this rises 15.4% versus the 45.1% slump in the original forecast. The actual result between 1998 and 2005 was a 76.4% rise (off a low base) due to a strong reversal in *impftwist*, which gave a 39.4% boost to the market share of domestic producers. In reality, the turnaround was so strong that a significant volume of exports was diverted back into the U.S. market (*x4* fell 55.4%). For *x0dom,* the actual rise was 40.4%, compared to the original forecast contraction of 30.8%. The improved forecast was for 11.0% growth with the differences explained by changes in *impftwist* and *a3com* and an unfavourable movement in relative prices.

In terms of *net* trade, net imports as a proportion of domestic output rose 265.9% (*dtradeshare*) versus a 35.2% reduction in the original forecast. The actual result was a 63.6% decrease due to more muted import growth, which again was impacted by a negative preference shifts.

Theatres → Part of Major Group 78: Motion Pictures (excludes Video Rentals)

This major group includes establishments producing and distributing motion pictures, exhibiting motion pictures in commercially operated theaters, and furnishing services to the motion picture industry. The term motion pictures, as used in this major group, includes similar productions for television or other media using film, tape, or other means.

Industry Group 781: Motion Picture Production And Allied Services

- *7812 Motion Picture and Video Tape Production*
- *7819 Services Allied to Motion Picture Production*

Industry Group 782: Motion Picture Distribution And Allied Services

- *7822 Motion Picture and Video Tape Distribution*
- *7829 Services Allied to Motion Picture Distribution*

Industry Group 783: Motion Picture Theaters

- *7832 Motion Picture Theaters, Except Drive-In*
- *7833 Drive-In Motion Picture Theaters.*

Theatres - Motion Pictures ex Video Rentals	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	10.0	2.3	20.1	19.7
All-factor-augmenting technical change	*a1prim*	77.2	12.4	101.6	101.6
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	27.9	4.8	33.3	33.3
Combined change in household tastes	*a3com*	64.6	-21.0	78.8	0.0
Commodity-using technical and taste change	*ac*	-0.3	-7.5	-0.3	0.0
Contribution to output of commodity-using technical & taste change	*cont_ac*	-0.2	-5.5	-0.2	0.0
Vertical shift of the export demand curve	*cont_fepc*	10.2	-7.0	12.0	0.0
Import/domestic twist by commodity	*ftwist_src*	232.7	0.0	8.9	8.9
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-0.7	0.0	-0.9	-0.9
Twist caused by strong growth	*twist_eff*	-3.8	-3.3	5.7	-2.7
Basic price of domestic goods	*p0dom*	93.2	21.9	58.5	53.7
Basic price of imported goods	*p0imp*	29.1	18.5	49.5	51.3
Ratio of basic prices: domestic to import	*fpdm*	50.5	2.8	6.2	1.6
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	12.3	11.6	29.3	4.2
Total supplies of domestic goods	***x0dom***	**6.8**	**6.5**	**43.5**	**3.5**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	9.5	12.1	28.7	4.4
Total supplies of imported goods	*x0imp*	512.0	14.5	87.0	33.7
Household demands undifferentiated by source	*x3*	48.3	-3.1	66.2	-5.3
Export volumes	*x4*	-18.7	-46.8	205.5	-0.4
Change in net import share to domestic output	*dtradeshare*	3.6	4.5	-9.8	0.6

Table 9: *Theatres* results

Motion Pictures ex Video Rentals (*Theatres*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries		461 Theatres: 73861	Rest: 367	**Total: 74228**
Proportion		461 Theatres: 0.995	Rest: 0.005	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	451 Theatres: 73861	416 WholesleTrde: 1012	Rest: 117	**Total: 74990**
Proportion	451 Theatres: 0.985	416 WholesleTrde: 0.013	Rest: 0.002	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	53326	792	54118	**0.72**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	14015	0	14015	**0.19**
Exports	BAS4	6556	0	6556	**0.09**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	330	0	330	**0.00**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**74228**	**792**	**75019**	
Source/Total		**0.99**	**0.01**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	461 Theatres: 20377	420 RadioTVbroad: 12473	Rest: 20477	Total: 53326	**Total: 0.985**
Imported	461 Theatres: 472	420 RadioTVbroad: 214	Rest: 106	Total: 792	**Total: 0.015**
Total	**461 Theatres: 20849**	**420 RadioTVbroad: 12686**	**Rest: 20583**	**Total: 54118**	
Proportion	**461 Theatres: 0.385**	**420 RadioTVbroad: 0.234**	**Rest: 0.380**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	56275	817	57092	**0.78**	**0.77**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	15861	0	15861	**0.22**	**0.22**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	330	0	330	**0.00**	**0.01**
Total	**72467**	**817**	**73284**		
Source/Total	**0.99**	**0.01**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	30242	**0.40**	LABOUR	19433	**0.64**
Factor	30306	**0.40**	CAPITAL	10873	**0.36**
Other	13512	**0.18**	LAND	1	**0.00**
Production Taxes	929	**0.01**	**Total**	**30306**	
Total	**74990**				

Source	c. Intermediate Inputs				Proportion
Domestic	451 Theatres: 21443	443 Advertising: 2654	Rest: 5363	Total: 29460	**Total: 0.974**
Imported	451 Theatres: 496	479 NoncompImps: 157	Rest: 129	Total: 782	**Total: 0.026**
Total	**451 Theatres: 21939**	**443 Advertising: 2680**	**Rest: 5623**	**Total: 30242**	
Proportion	**451 Theatres: 0.725**	**443 Advertising: 0.089**	**Rest: 0.186**		

Table 10: The key attributes of *Theatres* in 1998

1. Why did the model erroneously give good prospects to Motion Pictures ex Video Rentals?

Theatres had a USAGE error of 35% and was the fourth highest observation above the 45-degree line. The forecast trend error was just 1%. The results for this commodity appear in Table 9. Actual growth was 6.5% over the 1998-2005 period. This followed a 6.8% rise from 1992-1998—the extrapolated trend was therefore about 8%—yet USAGE forecast a 43.5% rise. The main users, cost structure and other information of interest can be seen in Table 10. As usual, this table has been divided into six sections. However, the key characteristics of the 1998 database[58] are presented so that the reader can see the industry structure at the beginning of the forecast period; these include:

- Domestic production accounts for 99% of total sales in the U.S. (Section 5 of Table 10).
- 9% of production was exported (Section 3 of Table 10).
- 72% of U.S.-destined output was sold to producers and the remainder (28%) to consumers (Section 5 of Table 10).

Table 9 shows that domestic sales of the U.S. produced commodity (*x0dom_dom*) rose 9.5% between 1992 and 1998. This took place despite a materially unfavourable change in relative prices. In particular, the basic price of domestic *Theatres* increased 50.5% more than the basic price of its imported equivalent (see *fpdm* in Table 9). Imported *Theatres* became relatively more attractive and spiked 512.0% (see *x0imp* in Table 9). However, such a large number should be put into context—by 1998 there was still only 1% import penetration into the U.S. market. Since *x0dom_dom* rose faster than overall domestic output (*x0dom*), exports must have declined (*x4* = -18.7%). These were being diverted into the domestic market despite an upward shift in the export demand function (*cont_fepc* = 10.2%). How did domestic sales grow so strongly in the face of soaring prices?

Between 1992 and 1998 household tastes moved strongly in favour of *Theatres*, i.e., by 1998 consumers preferred to purchase more *Theatres* at any given set of prices and per capita income than was the case in 1992 (*a3com* = 64.6%). Given insignificant imports, this drove prices sharply higher for the domestically produced commodity (*p0dom* = 93.2%). The price rise hurt export volumes. However, as was the case for U.S. households, foreigners increased their liking to the commodity at any given price, thereby preventing a larger fall in exports (*cont_fepc* = 10.2%).

As shall be seen further below, by 1998 the industry was beginning to experience the impact of piracy and other negative dynamics such as rising costs. The forward projection of strongly positive

[58] The previous commodities were presented alongside the 1992 database. The 1998 database seems most relevant for explaining the remaining 'large-error' commodities and is shown accordingly.

preference and taste changes for households and foreigners during the period from 1992 to 1998 resulted in a strong growth forecast that was unlikely to eventuate.

2. What happened in the forecast?

In the original forecast for 1998-2005, both domestic and foreign preferences shifted higher, and their contributions to output were projected forward. This had the effect of grossly overestimating household and foreign demand and overall output (*x3*, *x4* and *x0dom*, respectively). The left hand side of Table 11 provides a rundown of the approximate contributions to the change in the total supplies of the domestic commodity (*x0dom*). In the original forecast simulation, producers, households and exports made fairly even contributions to the overall output result. The actual result tells a different story with the contributions to the 6.5% rise in *x0dom* as follows: producers (*BAS1*) 178%; households (*BAS3*) -9%; exports (*BAS4*) -63%; and inventory changes (*BAS6*) -6%.

***Theatres:* 1998-2005**							
Contribution to Growth				**Back-of-the-envelope Growth Calculation**			
	Actual	**Original Forecast**	**Improved Forecast**		**Actual**	**Original Forecast**	**Improved Forecast**
Producers	178%	31%	105%	***BAS1***	16%	19%	52%
Households	-9%	29%	-3%	***BAS3***	-3%	66%	-5%
Exports	-63%	42%	-1%	***BAS4***	-47%	206%	-4%
Inventories	-6%	-1%	-1%	***BAS6***	-84%	-100%	-100%
Total	**100%**	**100%**	**100%**	***x0dom***	**6.5%**	**43.5%**	**3.5%**

Table 11: Estimated contributions to *x0dom* and growth in BAS_i components for the 1998-2005 simulations

Looking at the right hand side of Table 11 it is immediately apparent that the forecast had vastly overestimated household demand and export demand. This is confirmed in Table 9.

3. Given industry headwinds it ought to have been realised that domestic output is *unlikely* to have surged in forecast

According to an industry report released in the late 1990s by the "Labor Market & Economic Analysis" (LMEA) division of the Washington State Employment Security Department[59], by 1998, in many of the 100+ countries that screen U.S. films, videos and television tape, U.S. films had acquired a share of box office receipts at least equal to that of domestic films. The LMEA interpreted this situation as likely to encourage protectionism. However, by the same time, foreign markets had

[59] Most of the LMEA's industry information was obtained via the "Motion Picture Association of America".

begun to increase their own domestic production—this was reflected in an increased share of box office receipts and admissions. During the 1992-1998 period there were a number of mergers and acquisitions leaving the largest entertainment companies accounting for about three-quarters of the industry's revenues."[60] Furthermore, the LMEA[61] summarised the industry overview by the Motion Picture Association of America (MPAA) as follows:

a. The average cost of producing a motion picture was about $53 million in 1998, nearly double of what it was in 1992.
b. Growth in the number of new releases by MPAA member companies slowed dramatically in the late 1990s.
c. Releases by all U.S. companies rose from 460 in 1997 to 490 in 1998, an increase of 6 percent.
d. The cost of distributing films (especially printing and advertising) rose sharply in the late 1990s—the combined average cost per film to MPAA member companies for advertising and printing rose 13.5 percent in 1998; distribution costs increased every year from 1986 to 1998.
e. From 1996 to 1998 box office receipts showed strong growth and growth in admissions rebounded (see Figure 3). Specifically, box office receipts increased 8.6 percent (in real terms) in 1998 and 6 percent growth was expected in 1999.
f. Theatrical exhibition of films remains the principal method for introducing new movies to the public. The number of screens grew 8 percent during 1998, and the number of screens had increased every year from 1990 to 1998; similar small increases were expected over the next few years, driven by growth in multiplex theatres.
g. Worldwide demand for U.S. entertainment was expected to grow in the long run. Sales of U.S. entertainment both domestically and abroad were expected to depend in part on how new technologies were to be used for the delivery of entertainment and the barriers that U.S. companies were likely to encounter in foreign markets, in addition to general economic conditions. New technologies at the time included:
    i. the internet
    ii. DVD and
    iii. satellite delivery systems for programming.
h. Many industry observers believe that within a decade the Internet will play a major role in delivering filmed entertainment to homes. [This seems particularly pertinent.]

[60] http://www.wa.gov/esd/lmea/sprepts/indprof/motionp.htm, visited 20 August 2009.
[61] http://www.wa.gov/esd/lmea/sprepts/indprof/motionp.htm, visited 20 August 2009.

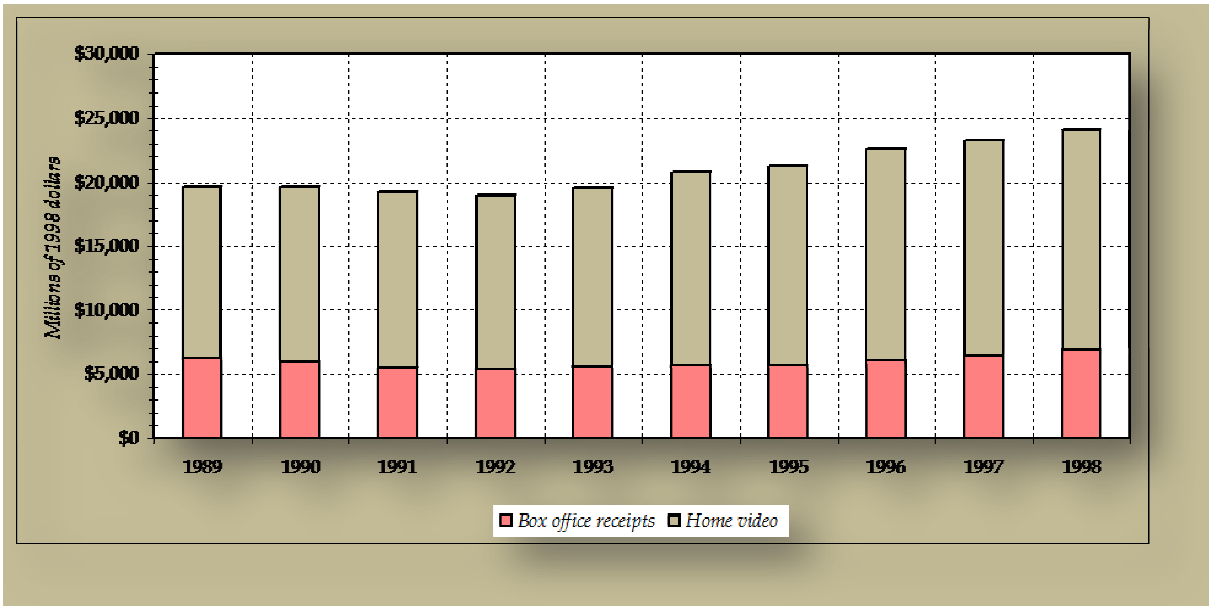

Figure 3: U.S. Box Office Receipts and Home Video Sales & Rental Receipts, 1989-1998 *(Source: MPAA)*

The above analysis and forecasts, that mostly emanated from the MPAA, were unsurprisingly glowing about the industry's prospects. They were, however, silent about movie piracy. In 1998 music piracy was a common feature of the internet, and movie piracy was perhaps less of a concern because it involved larger amounts of data and bandwidth was still relatively expensive in most countries:

> "When dial-up was common in early and mid 1990s, movies distributed on the Internet tended to be small. The techniques that were usually used to make them small were to use compression software and lower the video quality ... However, along with the rise in broadband internet connections beginning around 1998, higher quality movies began to see widespread distribution—with the release of DeCSS, ISO images copied directly from the original DVDs were slowly becoming a feasible distribution method."[62]

Where faster broadband connections were available (e.g., universities, businesses, and government departments, etc.) the downloading of television shows and movies (that had made it to the video stores) was not unusual. Monash University became *in*famous for unwittingly hosting the very latest episodes of South Park in 1997, well before they were scheduled to air in Australia.[63] Before long, pirates were also making new release movies available on the internet. In an article appearing at ehow.com (an online information provider) about the history of internet piracy, it can be read that:

> "Movie piracy started with pirates using camcorders to copy movies shown in a theater, a process known as 'ripping'. The sound, via the camera's microphone, was of poor

[62] http://en.wikipedia.org/wiki/Warez, visited 21 August 2009.
[63] This was the cunning work of a former student at the university.

> quality because audience noises were also recorded. These cam rips were put on the Internet, usually after a film premiere ... Another common movie pirate method is copying screener DVDs. Movie companies often release promotional copies of a film for critics and industry people to review in advance. Pirates remove the Promotional Copy Only message and release it as a DVD rip. The digital age has ushered in a plethora of ways to steal."[64]

Based on the way that the music industry had reacted to piracy, this should have set the warning bells ringing to the forecaster that growth in *Theatres* could be blunted by growing movie piracy during the 1998-2005 period. The problem is that it would have been nigh on impossible to have estimated the impact. For instance, the forecaster could not have relied on the music industry to provide an indication of the impending damage because the figures it released during the 1990s made it impossible to determine sales displacement. In any case, according to the Recording Industry Association of America (RIAA) music sales grew 14% in 1998 alone, and by 52% from 1992-1998—at the same time new releases were down 2% and up 80%, respectively.[65] On this basis, it would be difficult to believe that the projected 5.35% p.a. growth for *Theatres* over the 1998-2005 period would necessarily be unattainable.

From most of the reading covered in this area (not all cited) it seems apparent that from the late 1990s (when internet piracy issues began to be more broadly discussed) right up until now there is still no general consensus of the true cost of piracy in terms of lost demand for the legitimate item (irrespective of intent). Hui & Png (2003) developed and tested hypotheses from theoretical models of piracy on international data for music CDs over the period 1994-98:

> "Empirically, we find that the demand for music CDs decreased with piracy, suggesting that "theft" outweighed the "positive" effects of piracy. However, the impact of piracy on CD sales was considerably less than estimated by industry. We estimated that, in 1998, actual losses amounted to about 6.6% of sales, or 42% of industry estimates. But, we found evidence that publishers would have raised prices in the absence of piracy, suggesting that the actual revenue loss would have been higher."[66]

The positive effects are that many illegal 'downloaders' use this technique as a way of screening for potential purchases and are typically exposed/alerted to a broader range of items that might have

[64] http://www.ehow.com/about_5107851_history-movie-piracy.html, visited 21 August 2009.
[65] http://www.azoz.com/music/features/0008.html, visited 21 August 2009.
[66] Hui, Kai-Lung and Png, Ivan (2003) "Piracy and the Legitimate Demand for Recorded Music," Contributions to Economic Analysis & Policy: Vol. 2: Iss. 1, Article 11. Available at: http://www.bepress.com/bejeap/contributions/vol2/iss1/art11, visited 21 August 2009.

otherwise been the case. In other words, piracy may raise legitimate demand through positive demand-side externalities, sampling, and sharing; though this is outweighed by the impact of theft.

4. Conclusion

By 1998, as U.S. films had acquired a share of box office receipts equal to or higher than that of domestic films in numerous countries, this may have encouraged protectionism on the grounds of "cultural sovereignty". Sales of U.S. entertainment both domestically and abroad were expected to depend, in part, on how new technologies were to be used for the delivery of entertainment and the barriers that U.S. companies were likely to encounter in foreign markets. New technologies at the time included: the internet; DVD and satellite delivery systems for programming. Many industry observers believed that within a decade the Internet would play a major role in delivering filmed entertainment to homes. In 1998 music piracy was a common feature of the internet. However, with the rise in broadband internet connections beginning around 1998, higher quality movies began to see widespread distribution—and ISO images copied directly from the original DVDs were slowly becoming a feasible distribution method. Where faster broadband connections were available (e.g., universities, businesses, and government departments, etc.) the downloading of television shows and movies was not unusual. Based on the way that the music industry had reacted to piracy it is clear that growth in *Theatres* could have been blunted by growing movie piracy during the 1998-2005 period. In the historical simulation for 1992-2005 an upward shift in the export-demand curve was observed. In the case of household demand, the model computed a large positive value for taste change (a3com). It must have seemed highly likely at the time that movie piracy would have a strong negative impact on these parameters. Furthermore, the model calculated a taste shift away from *Theatres* in the actual results for 1998-2005. It is quite conceivable that this is the impact of movie piracy.

5. Strategy to improve the forecast

In re-running the simulation, the strategy was to set *cont_ac* and *a3com* and *cont_fepc* to zero on the basis of negative industry dynamics and the likely impact of piracy. This reduced the USAGE error from 35% to just 3%. The results are shown in the last column of Table 9, denoted "Improved Forecast". For *Theatres*, the key focus is on outcomes for *x0dom* and *x3* and *x4*. In the case of the re-projection for *x0dom*, this rises 3.5% versus 43.5% in the original forecast. The actual result between 1998 and 2005 was a 6.5% rise on the back of strong producer demand; but offset by a downward shift in the export-demand schedule and a sharp reduction in household tastes. The improved forecast has household demand (*x3*) falling 5.3% versus the original 66.2% forecast expansion. The actual result was a decline of 3.1%. Export volumes almost halved in the actual result off a low base (*x4* fell 46.8%). The difficulty of forecasting trade movements at the gross level has already been noted. This was originally forecast to surge by 205.5%, but improved to a 5.3% decline. In terms of *net* trade, net imports as a proportion of domestic output rose 0.6% (*dtradeshare*) in the improved forecast versus a 9.8% reduction in the original forecast. The actual result for *dtradeshare* was a 4.5% increase due to lower exports.

***Recordmedia* → Magnetic & Optical Recording Media (SIC 3695)**

This classification comprises establishments primarily engaged in manufacturing blank tape, disk, or cassette magnetic or optical recording media for use in recording audio, video, or other signals. Excluded from this classification are establishments primarily engaged in manufacturing blank or recorded records and prerecorded audio tapes, prepackaged computer software, prerecorded video tape cassettes and disks.

Recordmedia - Magnetic & Optical Recording Media	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-3.7	-2.0	-2.5	-6.1
All-factor-augmenting technical change	*a1prim*	-24.0	-10.9	-28.7	-28.7
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-9.6	-4.0	-11.1	-11.1
Combined change in household tastes	*a3com*	7.0	44.5	8.2	8.2
Commodity-using technical and taste change	*ac*	-7.2	-6.7	-8.3	-8.3
Contribution to output of commodity-using technical & taste change	*cont_ac*	-5.1	-4.8	-5.9	-5.9
Vertical shift of the export demand curve	*cont_fepc*	19.3	-14.2	22.9	0.0
Import/domestic twist by commodity	*ftwist_src*	-61.8	423.9	-73.7	0.0
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	31.2	-45.9	37.3	0.0
Twist caused by strong growth	*twist_eff*	0.9	-12.8	5.3	-4.2
Basic price of domestic goods	*p0dom*	4.3	7.8	10.0	3.7
Basic price of imported goods	*p0imp*	-16.7	5.8	-6.2	-5.1
Ratio of basic prices: domestic to import	*fpdm*	24.9	1.9	17.3	9.2
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	37.8	19.2	34.1	25.0
Total supplies of domestic goods	*x0dom*	**29.1**	**-29.8**	**41.7**	**-2.8**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	36.5	-33.6	50.8	6.1
Total supplies of imported goods	*x0imp*	34.9	110.3	3.2	61.3
Household demands undifferentiated by source	*x3*	56.4	112.9	31.7	36.7
Export volumes	*x4*	12.6	-21.3	25.0	-20.0
Change in net import share to domestic output	*dtradeshare*	-2.2	63.1	-9.8	24.1

Table 12: Key results for *Recordmedia*

1. **Why did the model erroneously give good prospects to Motion Pictures ex Video Rentals?**

Recordmedia had a USAGE error of 101% versus the smaller trend forecast error of 91%. The key results for this commodity are shown in Table 12. The actual outcome for *Recordmedia* output (*x0dom*) was a 29.8% contraction over the 1998-2005 period. This followed 29.1% growth from 1992-1998. The extrapolated trend was therefore 35% growth versus the USAGE forecast of 41.7% growth. Table 13 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- The commodity was mostly produced by the *Recordmedia* industry (74.6%); and Computer Peripheral Equipment (*ComPerEquip*: 14.4%) (Section 1 of Table 13).

- Import penetration was 34% of the domestic market (Section 5 of Table 13).
- Producers purchased 52% of domestic output; foreigners 32%; investors 10%; and households 6% (Section 3 of Table 13).

There were two key drivers behind the erroneous forecast. These were domestic-import twist factors, and foreign demand impacts. From 1992 to 1998, USAGE calculated significant relative-price changes between domestic and imported *Recordmedia* favouring imports to the tune of 24.9%. The Armington import-domestic substitution elasticity parameter was set quite high in the model (i.e., $\sigma_{ARM\ (i=351)}$ = 3.8). Yet imported *Recordmedia* rose *only* 34.9% (see *x0imp* in Table 12). On the basis of relative-price changes alone, the ratio of imported to domestic *Recordmedia* being sold into the domestic market would have increased by 132.8% [= $1.249^{3.8}$ – 1]. Instead it fell 1.2% [= 1.349/1.365 – 1]. In the absence of large-scale technological change, given the observed historical values for *Recordmedia* from 1992 to 1998 and given the unfavourable change in relative prices (positive *fpdm*), the model inferred that there must have been a large preference twist favouring domestic production. Examining the results listed in Table 12, this is seen in the form of *impftwist* (up 31.2%). According to the model, from 1992 to 1998, there was a twist away from imported *Recordmedia* that resulted in a 31.2% boost to domestic output sold domestically (*x0dom_dom*). Furthermore, between 1992 and 1998 there was a strong upward shift in the export-demand curve (*cont_fepc* = 19.3%). This did not translate into a boom in export volumes (*x4* = 12.6%) because exports were being diverted back into the domestic market, where preferences had moved against the imported *Recordmedia*.

2. What happened in the forecast?

The output-boosting impact of the domestic-import twist factors (*impftwist*) was projected forward to the tune of 37.3% but the true outcome had reversed to -45.9%. As a result, local sales of domestically-produced *Recordmedia* that were forecast expand 50.8%, in fact fell 33.6%. The effect of the disparity in *impftwist* was magnified by a larger than expected change in relative prices favouring imported *Recordmedia*. A similar situation happened in relation to the position of the export-demand curve. The large upward shift that occurred between 1992 and 1998 was projected forward (*cont_fepc* = 22.9%), however, a significant downward shift took place between 1998 and 2005 (*cont_fepc* = -14.2%). As shall be seen below, this could have been anticipated.

Magnetic & Optical Recording Media (*Recordmedia*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	361 Recordmedia: 4523	329 ComPerEquip: 874	Rest: 669	**Total: 6066**
Proportion	361 Recordmedia: 0.746	329 ComPerEquip: 0.144	Rest: 0.110	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	351 Recordmedia: 4523	380 PhotoEquip: 342	Rest: 248	**Total: 5113**
Proportion	351 Recordmedia: 0.885	380 PhotoEquip: 0.067	Rest: 0.049	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	3122	1752	4874	**0.52**
Industry Investment	BAS2	620	342	961	**0.10**
Private Consumption	BAS3	340	48	388	**0.06**
Exports	BAS4	1955	0	1955	**0.32**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	29	0	29	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**6066**	**2142**	**8207**	
Source/Total		**0.74**	**0.26**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	461 Theatres: 584	352 RecordTapes: 314	Rest: 2225	Total: 3122	**Total: 0.641**
Imported	446 ComputerServ: 219	428 Banking: 151	Rest: 1382	Total: 1752	**Total: 0.359**
Total	**461 Theatres: 587**	**446 ComputerServ: 480**	**Rest: 3808**	**Total: 4874**	
Proportion	**461 Theatres: 0.120**	**446 ComputerServ: 0.098**	**Rest: 0.781**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	461 Theatres: 314	418 TelephonCom: 217	Rest: 89	Total: 620	**Total: 0.645**
Imported	461 Theatres: 174	418 TelephonCom: 119	Rest: 49	Total: 342	**Total: 0.355**
Total	461 Theatres: 487	418 TelephonCom: 336	Rest: 138	**Total: 961**	
Proportion	**461 Theatres: 0.507**	**418 TelephonCom: 0.349**	**Rest: 0.144**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	3335	1929	5264	**0.73**	**0.48**
Industry Investment	669	381	1049	**0.15**	**0.10**
Private Consumption	556	86	643	**0.12**	**0.08**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	29	0	29	**0.01**	**0.00**
Total	**4588**	**2397**	**6985**		
Source/Total	**0.66**	**0.34**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	3300	**0.65**	LABOUR	1193	**0.66**
Factor	1802	**0.35**	CAPITAL	609	**0.34**
Other	-19	**0.00**	LAND	0	**0.00**
Production Taxes	30	**0.01**	**Total**	**1802**	
Total	**5113**				

Source	c. Intermediate Inputs				Proportion
Domestic	202 MiscPlPrdnec: 842	184 Plastics: 199	Rest: 1771	Total: 2812	**Total: 0.852**
Imported	319 ComPerEquip: 88	479 NoncompImps: 88	Rest: 312	Total: 488	**Total: 0.148**
Total	**202 MiscPlPrdnec: 920**	**184 Plastics: 231**	**Rest: 2149**	**Total: 3300**	
Proportion	**202 MiscPlPrdnec: 0.279**	**184 Plastics: 0.070**	**Rest: 0.651**		

Table 13: Key attributes of the *Recordmedia* database in 1998

3. **Given the advent of new competing technologies and falling export volumes after 1996 it ought to have been realised that domestic output was *unlikely* to surge in forecast**

The magnetic and optical recording media industry manufactures blank audio and video recording tape, computer tape, and both rigid and floppy computer disks, utilizing either magnetic or optical recording technology. According to online information provider, answers.com, there were conflicting forecasts for this industry stretching throughout the 1990s:

> "Conflicting forecasts pelted the industry. Some called for its collapse in anticipation of competing technology that would render magnetic and optical recording technology obsolete, while others promised a meteoric rise in sales. Without question, financial success in the industry is predicated on a manufacturer's continued ability to remain at the forefront of technology, to consistently develop new products to stimulate public interest, and to keep pace with the evolving sophistication of audio, video, and computer equipment. This industry is characterized by frenetically evolving technologies that, some have argued, are still in their infancy. Thus, manufacturers in the industry throughout the 1990s and early 2000s were challenged by not only an undetermined future but also often by an undecided present."[67]

Blank tape technologies (such as VHS and Mini-DV) were jostling for market share in the mid 1990s. However, in November of 1996, Sanyo-Verbatim CD Company announced the onset of Digital Versatile Disc (DVD) production in the first quarter of 1997. DVD had the potential to store seven times the capacity of a CD-ROM.[68] In 1998 the unit shipments of all types of blank tapes were in decline except 8mm videotapes, which increased by 8% in 1997.[69] Part of this was due to mounting foreign competition, particularly from China. Although Chinese products were of inferior quality they had the impact of blunting industry prices.

In relation to exports, by 1998 these comprised 32% of total sales of domestic output (Section 3 of Table 13). The trade data in Figure 4 makes it clear that exports were trending downward after peaking in 1996.

[67] http://www.answers.com/topic/magnetic-and-optical-recording-media, visited 14 September 2009.
[68] http://www.answers.com/topic/magnetic-and-optical-recording-media, visited 14 September 2009.
[69] http://www.answers.com/topic/magnetic-and-optical-recording-media, visited 14 September 2009.

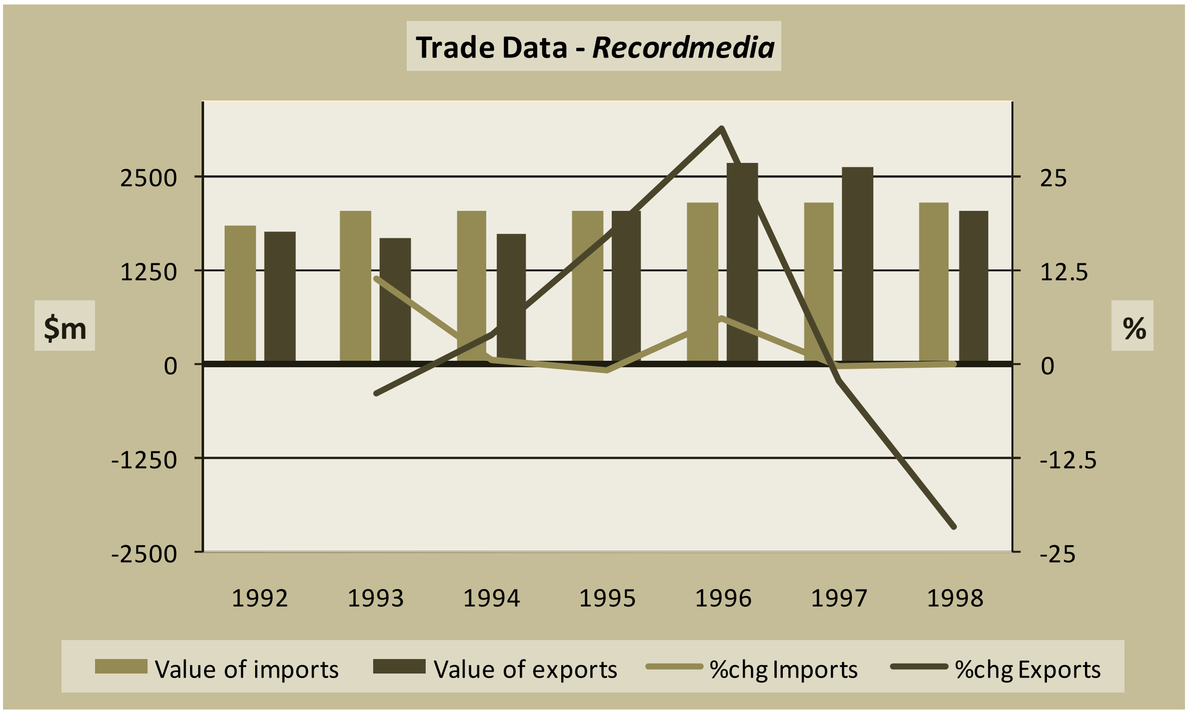

Figure 4: 1992-1998—U.S. trade by the *Recordmedia* industry in nominal dollars

4. Conclusion

Based on industry conditions and trade information the modeller could have anticipated that further strong swings against imports were unlikely. With Chinese imports appearing in the U.S. market during the period 1992-1998, their inferior quality might explain the strong twist against imports during this period. However, as China began to export CDs and DVDs, quality attributes became more difficult to distinguish—perhaps explaining the twist towards imports during the 1998-2005 period. As for exports, the demand function was projected to shift outward, when trade data showed exports trending downward in 1997 and 1998. Hence the modeller could have reduced the size of the error. In any case, as noted earlier, it is quite difficult to predict foreign demand. Perhaps very large shifts in foreign preferences should be closely investigated, in terms of likely sustainability, rather than be automatically projected forward.

5. Strategy to improve the forecast

In re-running the simulation, the strategy was to set *impftwist* and *cont_fepc* to zero on the basis of new competing technologies and falling export volumes. This reduced the USAGE error from 101% to 38%. The results are shown under “Improved Forecast” in the last column of Table 12. This shows that *x0dom* fell 2.8% versus a 41.7% rise in the original forecast. The small output decline in the improved forecast was driven by an unfavourable move in relative prices and would have been a larger decline if not for the projected rise in household demand. The actual result between 1998 and 2005 was a 29.8% decline on the back of a strong preference twist towards imports and a downward shift in the export demand schedule (this contributed to the 21.3% fall in export volumes). The original forecast of 25.0% export growth was improved to a 20.0% decline. In terms of *net* trade, net imports as a proportion of domestic output rose 24.1% (*dtradeshare*) in the improved forecast versus a 9.8% reduction in the original forecast. The actual result for *dtradeshare* was a 63.1% increase due to surging imports and lower exports.

2.2.2 Broad Brush Approach: Textiles, Clothing & Footwear (TCF)

In the previous section it was seen that large values for domestic-import twist factors were being projected forward despite overwhelming evidence against such moves. This meant that one could reasonably be expected to have made *ad hoc* error-reducing adjustments to the forecast by the end of 1998. In the case of the textile, clothing and footwear (TCF) industries large forecast errors were often generated by underestimating the size of domestic-import twist factors that heavily favoured imported commodities. Based on the evidence that obtained, it seems very unlikely that the modeller would have seen cause to make adjustments for the impact of domestic-import twist factors (*impftwist*). Even so, and assuming the modeller believed that the general trend of twist factors favouring imports would continue, it would have been most difficult to sensibly estimate the magnitude of any such adjustment.

In general, it was very difficult to reliably pin down macro evidence that would have instilled sufficient confidence to tweak the model in various *ad hoc* ways (as was possible for some of the other 'large-error' commodities). For instance, it was difficult to source evidence that was publicly available prior to the end of 1998 that could provide a convincing argument that output of any of these commodities would likely be directionally-biased during the forecast period. Among the investigations undertaken, official industry data was examined; however, it was often scant, or, 1998 data would not have been available until well after these simulations would have notionally been conducted. For example, in the case of Knit Fabric Mills: the 1997 Economic Census Manufacturing Industry Series reports were not issued until 1999 by the U.S. Census Bureau; time-series data was limited; and manufacturing shipments for the specific SIC categories from separate reports published pre-1999 could not be sourced.

The modeller would, however, have been aware of the TCF industry dynamics as they related to the removal of protectionist policies. The Uruguay Round was the 8th round of multilateral trade negotiations (MTN) conducted within the framework of the General Agreement on Tariffs and Trade (GATT), spanning from 1986-1993. The Round transformed the GATT into the World Trade Organization and came into effect in 1995. It was implemented over the period 1995-2000 for developed countries.

> "From 1990 to 1995, the effective U.S. tariff rate for imported apparel declined from 18.6 to 14.2 percent, a drop of 4.4 percentage points. This occurred as more apparel was imported through preference programs, taking advantage of lower duty rates through the NAFTA and CBTPA programs. During that same period, the U.S. apparel industry lost 93,000 production jobs. Likewise, total imports (by volume) climbed by

3,242 million square meter equivalents (SMEs). However, from 1995 to 2000, when the effective rate dropped at a slower pace—losing only 1.7 percentage points to end up at 12.5 percent—total apparel production job losses equalled 280,000. During that same period, imports jumped an additional 6,000 million SMEs. The record of this period suggests that as the pace of liberalization of the effective U.S. tariff rate on apparel dropped in half, the rate of job losses and imports actually doubled or tripled."[70]

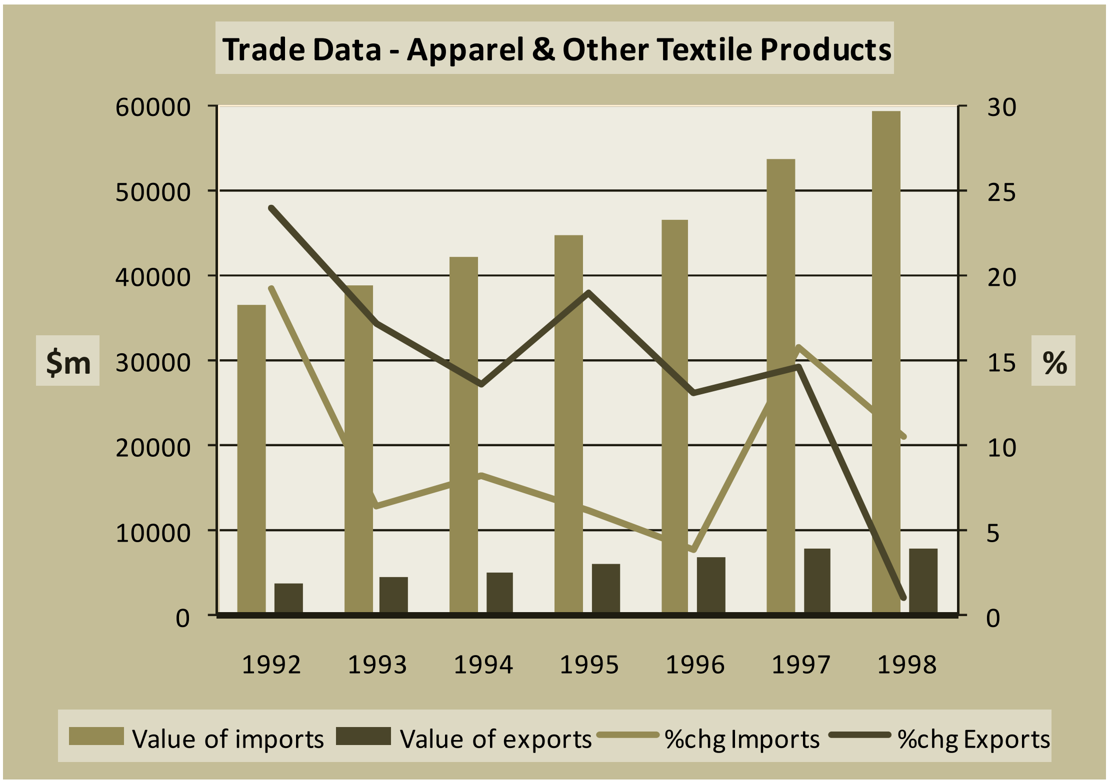

Figure 5: 1992-1998—U.S. trade by the Apparel & Other Textile Products industries in nominal dollars

While the comments above ignore the heavy impact of quota reductions, it is clear that trade liberalisation was starting to have a big impact by 1998, at least on the apparel industries (*Apparel*). This is reinforced by the strong growth in the value of apparel imports, which is displayed in Figure 5.

Pressure to remove protection in the form of tariffs and quotas was in place well before the beginning of the historical simulation period. Indeed this seemed to be a stumbling block on many occasions as the Uruguay Round progressed. In December 1991, the CBO released a study that commented:

"...the Uruguay Round of negotiations to expand the General Agreement on Tariffs and Trade (GATT) has focused on, in addition to other issues, proposals to phase out the

[70] http://www.apparelandfootwear.org/letters/AAFAComments-ITCTariffStudy020520.pdf visited 28 July 2009.

> Multifiber Arrangement (MFA). This arrangement exempts textile and apparel trade from the standard GATT prohibitions on import quotas. Also, the proposed North American Free-Trade Area will probably reduce or eliminate tariffs and other restrictions on textile and apparel trade between the United States and Mexico."[71]

The Multifibre Arrangement was originally established in 1974 as a temporary quota program designed to allow governments to control imports of specific products from specific countries. This was eventually expanded and applied to an ever-increasing number of products. During the 1990s the U.S. lowered tariffs and commenced the phase-out of quotas as agreed in the Uruguay Round under the Agreement on Textiles and Clothing (or ATC, the pre-cursor of which was the MFA) but reserved the right to impose safeguards once the phase-out was complete. However, the U.S. refused to agree to accelerated quota growth and tariff reductions. Furthermore under the terms of the Uruguay Round agreement, developing countries were afforded much higher tariff rates than developed countries.[72] This had the potential to hurt export markets for U.S. producers.

> "The ATC called for reductions of 16% (January 1, 1995), 17% (January 1, 1998), 18% (January 2002), and 49% (January 1, 2005) of the quotas pertaining to specified textile and clothing products based upon 1990 volumes. In addition, the growth rates of quotas of products not liberalized as above or of products otherwise restrained were increased during the first three steps of the phase-out period. There were numerous exceptions; and, in the four-stage process of liberalization, importing countries had the choice of how much of each (defined) product category to liberalize at which step; and they could, and did, defer liberalization of the most "sensitive" products until the final stage of the ATC."[73]

Furthermore, a forecast was found for *Apparel* (made pre-1999) that was used in an industry report by the "Labor Market & Economic Analysis" division of the Washington State Employment Security Department:

> "Continued global competition for textiles and apparel markets are expected to spur changes in the domestic industries for the next decade ... Industry experts forecast that

[71] http://www.cbo.gov/ftpdocs/100xx/doc10075/1991_12_traderestraints.pdf, visited 1 September 2009.
[72] http://www.tx.ncsu.edu/jtatm/volume2issue1/articles/antoshak/antoshakcomplete.pdf, visited 1 September 2009.
[73] http://docs.google.com/gview?a=v&q=cache:IuD6L3nlSgsJ:opencrs.com/rpts/RS20889_20050610.pdf+1995+quotas+apparel&hl=en&gl=au, visited 1 September 2009.

> between 1999 and 2006, global sales of most textiles and apparel will increase between 2-3 percent a year."[74]

While this provided a positive global outlook, the prospect of ongoing foreign competition didn't seem to augur well for U.S. producers. Overall, the above commentaries perhaps gave danger signs for domestic producers of *Apparel.* While the modeller might have been suspicious of steady growth over the forecast horizon, it is concluded that this was not sufficiently compelling to drive *ad hoc* adjustments to the forecast of each of these industries throughout the TCF sector.

Figure F shows how the USAGE pure forecast errors for the 31 TCF commodities compares to the extrapolated 1992-1998 trend forecast errors. With the exception of *BootCutStock* USAGE outperforms trend extrapolation for each commodity. Overall, USAGE outperforms the trend forecast by 26% (M = 0.74). However, the model's AE for the TCF sector is very high, at 66.2%. It is interesting to note that (visually) there seems to be a high degree of proportionality in the plot of the percentage errors. In other words, both forecast methods seem to make quite similar errors for any given commodity. For example, large errors were made for both *Knitfabric* and *Luggage*, etc.

In thinking about the broader issues associated with modelling the TCF sector it was noticed that, in the original forecast results, the model had performed poorly when it came to projecting basic import prices for these commodities. To elaborate, there are different types of prices in the model but output growth rates (the main focus here) are partly driven by changes in relative basic prices such as the landed-duty-paid import price for a commodity. This is a function of the foreign-currency price, the exchange rate, and any tariffs on the commodity. From 1992 to 1998 the foreign-currency price of TCF commodities invariably increased, and the main driver of the increase was projected forward.[75] This strongly contributed to a higher basic price of imported TCF commodities than turned out to be the case (in fact, from 1998 to 2005 basic import prices for these commodities most often fell).

[74] http://www.wa.gov/esd/lmea/sprepts/indprof/textiles.htm, visited 1 September 2009.

[75] The model estimates the foreign-currency import price by summing several component price changes, including a broad change (from 1992-1998 this was -2.0%) that impacts all commodities as well as a change that is specific to the commodity in question (e.g., +16.9% for *Knitfabric*). In the forecast, the historical move in the commodity-specific foreign-currency price is projected forward (this was +20.0% for *Knitfabric*).

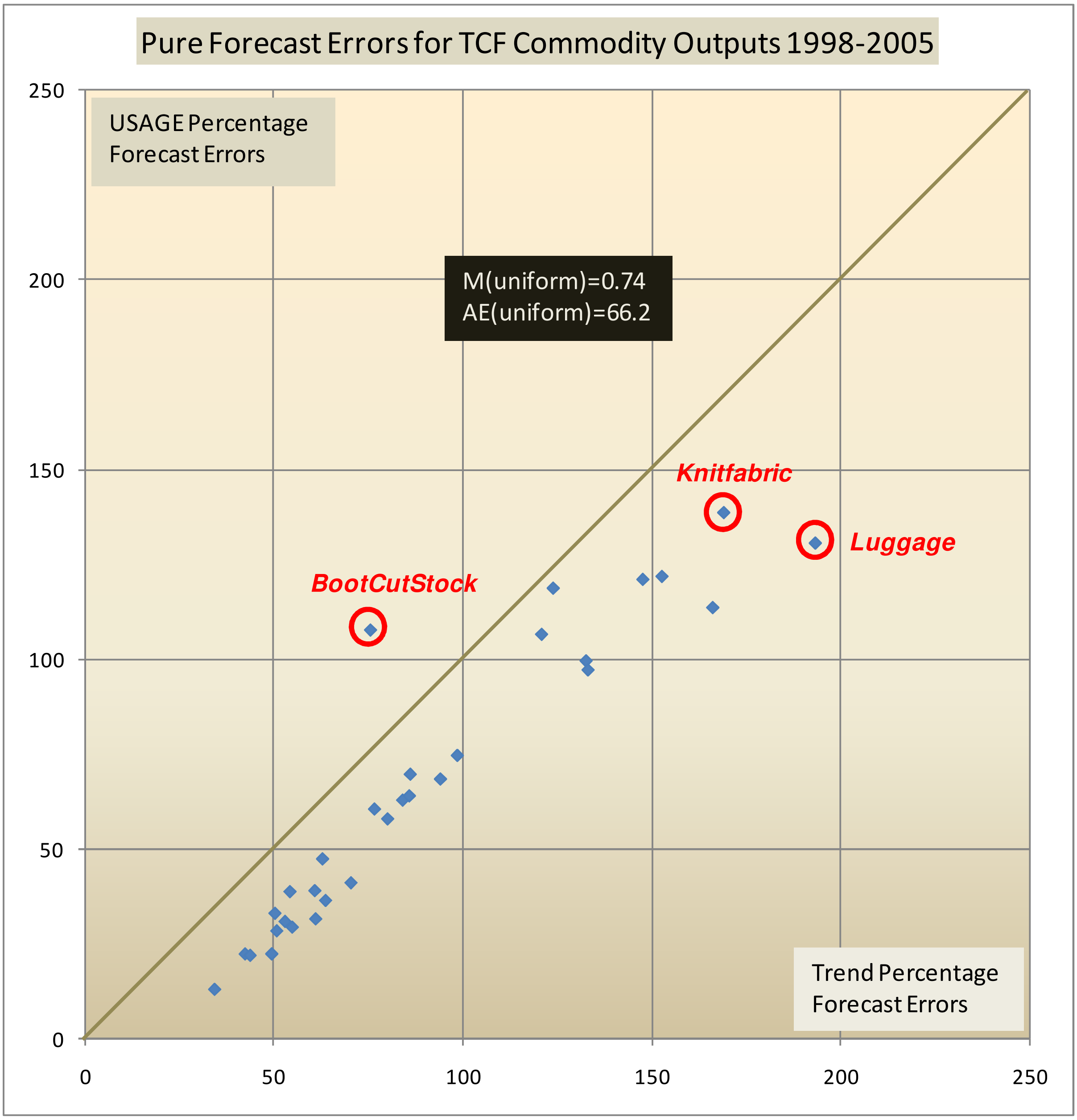

Figure F: Percentage forecast errors for TCF commodity outputs in the original USAGE pure forecast for 1998-2005 relative to the extrapolated 1992-1998 trend forecast

In reviewing the macro environment for the TCF sector it was evident that *basic* import prices for these commodities were heavily tied to policy. From 1992 to 1998 (nominal) landed-duty-paid import prices (*p0imp*) for most TCF commodities typically fell slightly or increased by only small amounts—but usually fell considerably in real terms after accounting for the rise in the CPI. As such, it seemed sensible to assume that policy-makers would allow <u>real basic import prices</u> to continue to fall at the same rate. (Compare this to the highly unlikely rises in nominal basic import prices that were being driven by, also unlikely, projected rises in foreign-currency import prices.) This seemingly more intuitive approach to projecting import prices is congruent with macro environmental factors as they stood by the end of 1998. It is clear that trade liberalisation was starting to have a big impact on this sector by 1998 as evidenced by the strong growth in the value of imports. The ATC (later MFA) called for significant reductions in the number of quotas pertaining to specified textile and clothing products based upon 1990 volumes. At the time of the original forecast simulations USAGE did not adequately cater for this type of situation.

To further elaborate, in light of the key role of trade policy in the TCF sector during this period, it is not unreasonable for the modeller to attempt to reflect this by deviating from the standard implementation of the model, e.g., to implement import-price forecasts in a way that is more aligned with outcomes that are consistent with the historical operation of U.S. trade policy. In the above discussion relating to trade liberalisation, it would have been known that even though the U.S. had been reducing trade barriers throughout the 1990s, policy-makers reserved the right to impose safeguards once the phase-out was complete. In addition, the U.S. refused to agree to accelerated quota growth and tariff reductions. Consistent with this stance, by 1998, U.S. policy-makers had traditionally behaved in a way that allowed TCF import prices to fall at a rate that delicately balanced the interests of domestic TCF producers and U.S. households. Under the default application of the model, there is no attempt to embody this “balanced” approach to TCF-related trade policy. Instead, the standard implementation of the forecast for 1998 to 2005 merely projects forward the historical growth in the foreign-currency price of imports—even though what appears to have been the force behind an important growth factor for this variable was no longer present during the forecast period.

An important outcome of the 1998 to 2005 forecast for the TCF sector was that ratios of landed-duty-paid import prices to basic prices of domestic commodities were systematically overestimated. This had the effect of understating the competitiveness of imported TCF commodities and, hence, overstating domestic output growth. The overestimation of import-domestic relative-price movements resulted from a confluence of events in the period from 1992 to 1998, which allowed for rapid growth in a particular determinant of landed-duty-paid import prices, namely foreign-currency prices. In essence, an appreciation of the nominal exchange rate and a reduction in tariffs—a combination that alone would weigh heavily on landed-duty-paid import prices—effectively induced strong growth in the foreign-currency prices of TCF imports. In the absence of these foreign-currency price rises, it is doubtful that U.S. policy-makers would have stomached the extent of the (likely) negative impact on domestic TCF producers (though households would have been thrilled). Had such a situation unfolded, restrictive trade policies may have been implemented (or threatened) such as a suspension of tariff reductions, more widespread use of quotas and the launching of anti-dumping actions.

In light of the potential for this kind of policy response, exporters of TCF commodities to the U.S.—keen to avoid higher barriers to an important destination—prevent their product prices from plummeting on the U.S. market. They do this by adjusting their foreign-currency prices to take into account movements in the foreign exchange rate and in import duties.

For example, consider the behaviour of import prices for the Apparel industry. Between 1992 and 1998, the power of the tariff on apparel (i.e., 1 + tariff rate) declined by 9%. Foreign producers of Apparel were also favoured by an appreciation in the foreign exchange rate of more than 13%. These two factors alone would have delivered a substantial competitive advantage to the foreigners. Had the foreigners taken full advantage of their increased competiveness, this would likely have incurred a response by U.S. policy makers in the form of higher import barriers to protect domestic producers. To avert such a situation from arising, foreign producers increased their prices, i.e., the foreign-currency price of the commodity was adjusted higher. In the case of Apparel, the foreign-currency price ultimately rose by 15% from 1992 to 1998. The increase in the foreign-currency price, combined with the effects of the tariff reduction and the currency appreciation, culminated in an 8% reduction in the basic price of imported Apparel on the domestic market; and the change in domestic-import relative prices resulted in a more palatable competitive outcome for domestic producers and policy makers.

A practical way to capture the outcome of this phenomenon in the model (thereby avoiding unrealistic forecasts in foreign-currency price movements for TCF commodities) while simultaneously placating households, is to project forward movements in real import prices, or more specifically, the CPI-deflated landed-duty-paid prices of TCF imports. This was implemented by adding the following equation to USAGE and switching it on only for TCF commodities:

$$\mathrm{realp0imp}(i) = \mathrm{p0imp}(i) - \tilde{c}\mathrm{pi} \quad , i = 1, 2, \ldots, N_{COM} \tag{2.2.1}$$

where

$\mathrm{p0imp}(i)$ is the percentage change in the landed-duty-paid basic price of imported goods;

$\mathrm{realp0imp}(i)$ is the percentage change in CPI-deflated landed-duty-paid prices; and

cpi is the percentage change in the consumer price index.

In particular, we make a swap where a shifter variable used to apply import-price observations and forecasts [$\mathrm{fpmcr}(i)$ in (1.3.26)] is endogenized for all TCF commodities; and $\mathrm{realp0imp}(i)$ is exogenized and shocked with the values implied by the TCF real import-price projections. Thus, for TCF commodities, $\mathrm{p0imp}(i)$, is determined by (2.2.1).

Hence, in re-running the simulation, import-price forecasts were generated by extrapolating the *real* or inflation-adjusted duty-paid price change from 1992 to 1998 for all TCF industries. This resulted in more realistic import-price projections and less erroneous domestic-import relative (basic) price movements. This particular re-run is *version 1* of the improved USAGE pure forecast for 1998-2005. The analysis of the 'large-error' TCF commodities that appears further below is based on this version of the forecast. Figure G shows the updated positions of the relative forecast errors. The TCF commodity AE for USAGE falls to 55.4% from 66.2% in the original pure forecast. This is reflected in an enhanced *M* coefficient of 0.62, which implies that the improved USAGE forecast outperformed the trend forecast by 38%.

COMMODITY *i*	Original Forecast	Original USAGE ERROR	*Version 1* Forecast	*Version 1* USAGE ERROR	TREND ERROR	Orig. 45° LINE above/(below)	*V.1*: 45° LINE above/(below)
206 BootCutStock	45	108	25	79	75	**32**	**4**
115 Knitfabric	24	139	7	106	169	**(30)**	**(63)**
210 Luggage	-12	131	-19	112	193	**(63)**	**(81)**
114 Hosierynec	19	122	11	107	153	**(31)**	**(46)**
116 Apparel	16	121	4	98	148	**(26)**	**(49)**
205 LeatherTan	-5	119	-15	94	124	**(5)**	**(30)**
209 Leathrgloves	-17	114	-18	112	166	**(52)**	**(54)**
211 WmnsHandbag	19	107	14	99	121	**(14)**	**(22)**

Table 14a: The worst TCF commodity output errors—original forecast versus *version 1* of the improved forecast

It should be noted that there are competing hypotheses that purport to explain the movement in foreign-currency import prices. For example, one could argue that quotas, while being phased out, were still prevalent enough during 1992 to 1998 for foreigners to try to keep their prices high and maximise profit margins. However, weighed against this argument is that import volumes rose sharply over the same period allowing foreigners to capture, for example, a circa 50% share of the U.S. Apparel market by 1998. Also, as quotas are removed, it is reasonable to expect that higher import volumes might be characterised by lower quality and lower margin imported products. But, if such an effect occurred, it wasn't evident in the data, which showed that there were taste and technology changes in favour of imported Apparel from 1992 to 1998; and that these changes intensified in the period from 1998 to 2005.

The strategy of projecting forward inflation-adjusted duty-paid import prices for all TCF industries generally reduced the size of the forecast error for each TCF commodity, though sometimes only by a small amount. Recall that Table A lists the twenty worst errors on a relative and/or absolute basis under the original forecast versus the extrapolated trend. It is noteworthy that eight of the nine largest errors on an absolute basis were TCF commodities. However, with the exception of *BootCutStock*, USAGE always outperformed the trend forecast, and usually by a significant margin.

This is seen in Figure G and can also be seen in Table 14a, which compares the original forecast to the improved forecast (*version 1*); the respective forecast errors; and the model's performance versus the trend error as measured by vertical displacement around a 45-degree line.

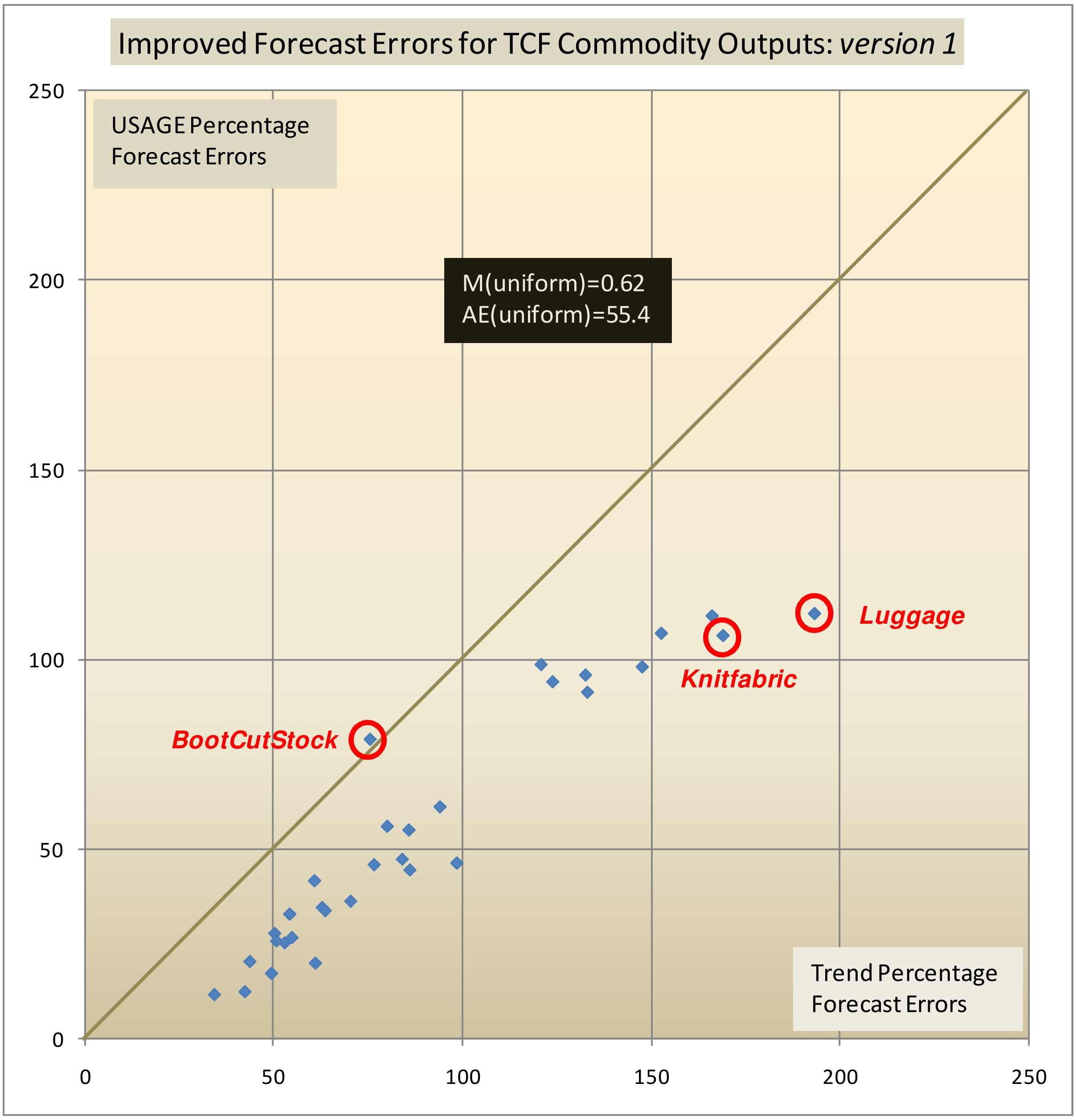

Figure G: Percentage forecast errors for TCF commodity outputs in *version 1* of the improved USAGE pure forecast for 1998-2005 relative to the extrapolated 1992-1998 trend forecast

After running the improved simulation some more thought was given to the large reductions (from 1992 to 1998) seen in total primary-factor input costs. In USAGE this term is referred to as "all-factor-augmenting technical change" and can be interpreted as follows: the industry could *potentially* produce the same output in 1998 as it did in 1992 with less primary-factor inputs and the same other inputs. It is potential because actual output will also depend on other factors such as relative-price changes. The large falls, sector wide, in all-factor-augmenting technical change were having a significant impact on output (by stifling domestic basic prices thereby improving competitiveness). In forecast, these costs effects (via productivity enhancements) are projected forward. It became clear that productivity gains in the TCF sector ought to not be automatically baked in to the forecast. Why? Because the share of total primary-factor input costs to total costs was declining significantly throughout these industries. In this relatively labour-intensive sector, output-boosting cost savings from shedding workers (in particular) were likely to be getting smaller; and this effect could be reinforced by possibly higher unit labour costs that might arise from increased labour scarcity (especially as companies were shifting operations abroad). To see how this would pan out the improved forecast simulation was rerun with the single change of no additional potentially output-boosting primary-factor cost savings for the TCF commodities (*version 2* of the improved forecast).

The results were very promising, e.g., for *Knitfabric* output contracted 35.4% on the back of rising costs, and its USAGE error fell significantly, to 24%. This can be seen in Table 14b with the results of the new simulation listed in the 2nd- and 3rd-last columns. Figure H shows the updated positions of the relative forecast errors under *version 2* of the improved USAGE pure forecast. In this instance, the TCF commodity AE for USAGE falls to 25.2% from 66.2% in the original pure forecast. This is reflected in a vastly enhanced *M* coefficient of 0.28, which implies that the improved USAGE forecast outperformed the trend forecast by 72%. The bulk of the remaining error for this sector was due to the significant underestimation of the import-favouring movement in *impftwist*, which in all likelihood could not have been predicted by the modeller.

COMMODITY *i*	Original Forecast	Original USAGE ERROR	*Version 1* Forecast	*Version 1* USAGE ERROR	*Version 2* Forecast	*Version 2* USAGE ERROR	1998-2005 Actual Output
206 BootCutStock	45	108	25	79	-27	5	-31
115 Knitfabric	24	139	7	106	-35	24	-48
210 Luggage	-12	131	-19	112	-38	62	-62
114 Hosierynec	19	122	11	107	-21	47	-46
116 Apparel	16	121	4	98	-25	44	-48
205 LeatherTan	-5	119	-15	94	-32	56	-56
209 Leathrgloves	-17	114	-18	112	-27	88	-61
211 WmnsHandbag	19	107	14	99	-9	59	-42

Table 14b: The worst TCF commodity output percentage forecast errors—original forecast, and versions 1 & 2 of the improved USAGE pure forecast

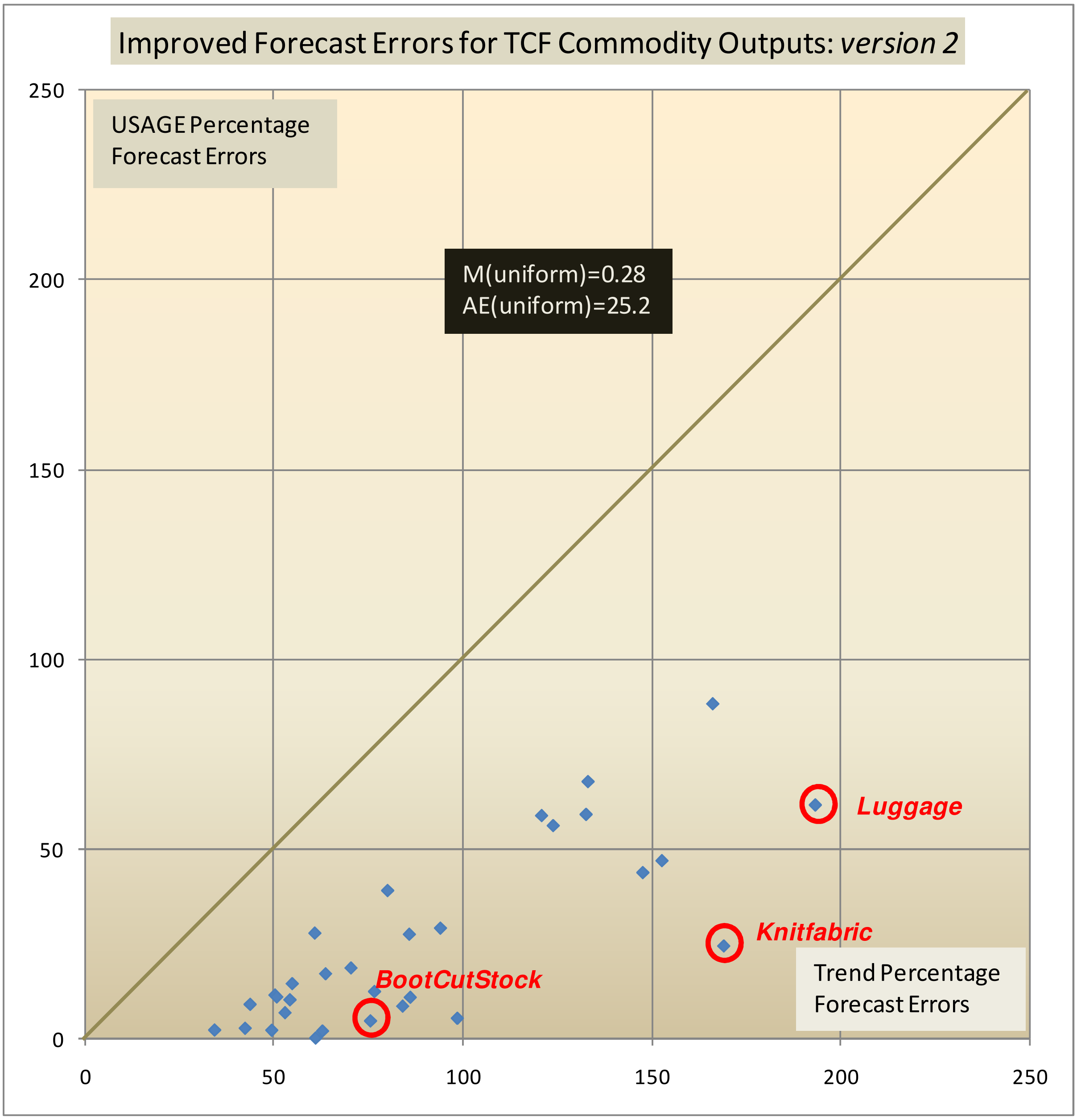

Figure H: Percentage forecast errors for TCF commodity outputs in *version 2* of the improved USAGE pure forecast for 1998-2005 relative to the extrapolated 1992-1998 trend forecast

As mentioned previously, the analysis of the 'large-error' TCF commodities that appears below is based on *version 1* of the improved USAGE pure forecast, in which productivity gains in the TCF sector are projected forward. Output forecasts and USAGE errors are also reported for *version 2* of the improved USAGE pure forecast in sections titled "Strategy to improve the forecast".

Knitfabric → Knit Fabric Mills (Part of Industry Group 225: Knitting Mills)

- ***2257: Weft Knit Fabric Mills*** – *Establishments primarily engaged in knitting weft (circular) fabrics or in dyeing, or finishing weft (circular) knit fabrics.*
- ***2258: Lace and Warp Knit Fabric Mills*** – *Establishments primarily engaged in knitting, dyeing, or finishing warp (flat) knit fabrics, or in manufacturing, dyeing, or finishing lace goods.*

Knitfabric - Knit Fabric Mills	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-8.7	-17.3	-6.7	-6.8
All-factor-augmenting technical change	*a1prim*	-55.0	-6.4	-69.3	-69.3
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-18.8	-1.4	-21.6	-21.6
Combined change in household tastes	*a3com*	9.2	-18.9	10.8	10.8
Commodity-using technical and taste change	*ac*	-10.8	-21.8	-12.7	-12.7
Contribution to output of commodity-using technical & taste change	*cont_ac*	-9.8	-19.6	-11.4	-11.4
Vertical shift of the export demand curve	*cont_fepc*	1.4	11.0	1.7	1.7
Import/domestic twist by commodity	*ftwist_src*	195.4	429.2	85.7	82.7
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-6.9	-30.7	-7.9	-7.9
Twist caused by strong growth	*twist_eff*	1.7	-19.1	1.8	-1.9
Basic price of domestic goods	*p0dom*	-6.5	-16.4	2.4	1.3
Basic price of imported goods	*p0imp*	-1.4	-27.7	12.8	2.9
Ratio of basic prices: domestic to import	*fpdm*	-5.2	15.2	-9.3	-1.6
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	38.1	-51.8	29.5	16.8
Total supplies of domestic goods	***x0dom***	**33.0**	**-48.4**	**23.8**	**7.1**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	29.7	-70.5	20.3	5.3
Total supplies of imported goods	*x0imp*	233.3	85.3	113.4	116.7
Household demands undifferentiated by source	*x3*	50.3	27.8	32.0	33.1
Export volumes	*x4*	88.9	183.9	67.4	31.5
Change in net import share to domestic output	*dtradeshare*	3.7	-17.2	5.9	8.6

Table 15: Key results for *Knitfabric*

1. Why did the model erroneously give good prospects to Knit Fabric Mills?

Knitfabric had a USAGE error of 139% versus the larger trend forecast error of 169%. The key results for this commodity are shown in Table 15. The actual outcome for *Knitfabric* output (*x0dom*) was a 48.4% contraction over the 1998-2005 period. This followed 33.0% growth from 1992-1998. The extrapolated trend was therefore 40% growth versus the USAGE forecast of 23.8% growth. Table 16 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- Import penetration was just 10% of the domestic market (Section 5 of Table 16).
- Producers purchased 88% of domestic output; foreigners 9%; and households 3% (Section 3 of Table 16).
- Labour makes up 85% of factor input costs (Section 6b of Table 16).

Knit Fabric Mills (*Knitfabric*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	119 Knitfabric: 8668	116 Knitoutwear: 277	Rest: 320	**Total: 9266**
Proportion	119 Knitfabric: 0.936	116 Knitoutwear: 0.030	Rest: 0.035	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	115 Knitfabric: 8668	103 Broadfabric: 261	Rest: 89	**Total: 9018**
Proportion	115 Knitfabric: 0.961	103 Broadfabric: 0.029	Rest: 0.010	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	8142	898	9040	**0.88**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	284	23	307	**0.03**
Exports	BAS4	796	0	796	**0.09**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	45	0	45	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**9266**	**921**	**10188**	
Source/Total		**0.91**	**0.09**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	120 Apparel: 4883	119 Knitfabric: 2020	Rest: 1238	Total: 8142	**Total: 0.901**
Imported	120 Apparel: 622	119 Knitfabric: 163	Rest: 113	Total: 898	**Total: 0.099**
Total	**120 Apparel: 5506**	**119 Knitfabric: 2183**	**Rest: 1351**	**Total: 9040**	
Proportion	**120 Apparel: 0.609**	**119 Knitfabric: 0.241**	**Rest: 0.149**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	8651	962	9613	**0.92**	**0.83**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	721	57	777	**0.08**	**0.07**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	45	0	45	**0.00**	**0.00**
Total	**9416**	**1019**	**10435**		
Source/Total	**0.90**	**0.10**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	7222	**0.80**	LABOUR	1622	**0.85**
Factor	1912	**0.21**	CAPITAL	290	**0.15**
Other	-178	**-0.02**	LAND	0	**0.00**
Production Taxes	61	**0.01**	**Total**	**1912**	
Total	**9018**				

Source	c. Intermediate Inputs				Proportion
Domestic	115 Knitfabric: 2174	105 YarnFinish: 1971	Rest: 2641	Total: 6786	**Total: 0.940**
Imported	115 Knitfabric: 177	105 YarnFinish: 105	Rest: 154	Total: 436	**Total: 0.060**
Total	**115 Knitfabric: 2351**	**105 YarnFinish: 2077**	**Rest: 2795**	**Total: 7222**	
Proportion	**115 Knitfabric: 0.325**	**105 YarnFinish: 0.288**	**Rest: 0.387**		

Table 16: Key attributes of the *Knitfabric* database in 1998

From Table 16 Section 4a, it can be determined that the majority of sales were to the *Apparel* industry. As shall be seen below, the model did a poor job (in terms of the absolute error size) of forecasting *Apparel* where the USAGE error was 121%. It is this error that drove the poor result in *Knitfabric*. In particular, USAGE vastly overestimated the growth of the U.S. *Apparel* industry. Hence, if the modeller could have done better at forecasting *Apparel*, it is likely that a better projection for *Knitfabric* would have eventuated.

2. What happened in the forecast?

Column 4 of Table 15 shows that from 1998 to 2005 total sales (*x0* or absorption) of *Knitfabric* in the U.S. slumped 51.8% on the back of lower sales into the U.S. of domestically-produced *Knitfabric* (*x0dom_dom* fell 70.5%). The market was dominated by local producers, and at the same time, imports (*x0imp*) rose 85.3% off a low base. The main drivers of the actual results were:

- The 15.2% change in relative prices favouring the purchase of more imports (note that the Armington elasticities were set to one)—versus a 9.3% move *against* imports in forecast.
- The sharp move in *impftwist* favouring the sale of imports of -30.7%, versus a more subdued -7.9% in forecast.
- The sharp factor-input cost reductions that occurred from 1992 to 1998 were also projected forward; but instead of maintaining their growth rate they largely failed to materialise.

Hence, the forecast underestimated the impact of domestic-import preference twists (the nature of this effect has been described previously). Also, relative prices were expected to strongly favour domestic producers, when in fact they moved in favour of importers. To elaborate, there are different types of prices in the model but output changes are partly driven by changes in relative basic prices such as the landed-duty-paid import price for a commodity. This is a function of the foreign-currency price, the exchange rate, and any tariffs on the commodity. From 1992 to 1998 the foreign-currency price of *Knitfabric* increased, and the main driver of this was projected forward. This strongly contributed to a higher basic price of imported *Knitfabric* than turned out to be the case (in fact, the basic import price fell). Finally, the projected output-boosting productivity increases never eventuated, further weighing on output.

3. Macro perspective

In sync with earlier commentary, it was very difficult to source evidence that was publicly available prior to the end of 1998 that could provide a convincing argument that output of this commodity would slump during the forecast period. In terms of general information, we garnered that major domestic players in the industry had embarked on an aggressive expansion and acquisition program during the mid to late 1990s.[76] However, this ended badly with many key manufacturers filing for Chapter 11 bankruptcy protection under heavy debt burdens in the early part of the next decade; and only very few re-emerged.[77] Furthermore, in the lace & warp knit fabric space:

> "During the 1980s a slump in clothing sales and a growing flood of inexpensive imports slowed growth in this industry considerably. Throughout the mid-1990s domestic manufacturers remained competitive by introducing new specialty fabrics, such as microdeniers and spandex blends ... During the mid-1990s the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) opened new markets for the textile industry, but also increased foreign competition ... In general, however, despite efforts to expand operations overseas, U.S. textile mills in the early 2000 continued to struggle with increased foreign competition."[78]

The relaxation of trade barriers saw to a surge in imports in the period from 1992 to 1998 for *Knitfabric* (see Figure 6). This may have pointed to a slowdown in the overall production of this trade exposed sector but without hard evidence in terms of falling product shipments one might have been loathed to adopt this as the default position.[79]

4. Conclusion

Most of *Knitfabric's* sales were to the *Apparel* industry. As shall be seen below, *Apparel* registered 25.0% growth during the historical simulation and exports of the commodity grew by 124.6% whilst imports grew by 59.6%. Following strong increases in 1996 and 1997 growth in *Knitfabric* imports paused in 1998. It would have been difficult for the modeller to confidently assert that imports would continue to surge and decimate *Knitfabric*. It is also unlikely the modeller would have seen cause to adjust domestic-import twist factors, or even to sensibly estimate the magnitude of any such adjustment. However, it is clear that improvements could have been made to the import-price forecasts. Basic import prices for commodities in this sector were heavily tied to policy. From 1992

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[76] http://www.referenceforbusiness.com/industries/Textile-Mill/Lace-Warp-Knit-Fabric-Mills.html, visited 17 August 2009.

[77] http://www.referenceforbusiness.com/industries/Textile-Mill/Weft-Knit-Fabric-Mills.html, visited 17 August 2009.

[78] http://www.encyclopedia.com/doc/1G2-3434500073.html, visited 17 August 2009.

[79] The modeller would have had data for the value of shipments and for capex up until only 1997 available to them. This data showed the value of shipments rebounding strongly in 1997 after a contraction in 1996. In addition, the capex data showed a surge in 1997, probably reflecting the rise in merger and acquisition activity.

to 1998 the (nominal) landed-duty-paid import price for *Knitfabric* fell slightly; but fell considerably in real terms. It is sensible to assume that policy-makers would allow real basic import prices to continue to fall at the same annual rate. (Compare this to a highly unlikely rise in nominal basic import prices; being driven by also unlikely rising foreign-currency import prices.)

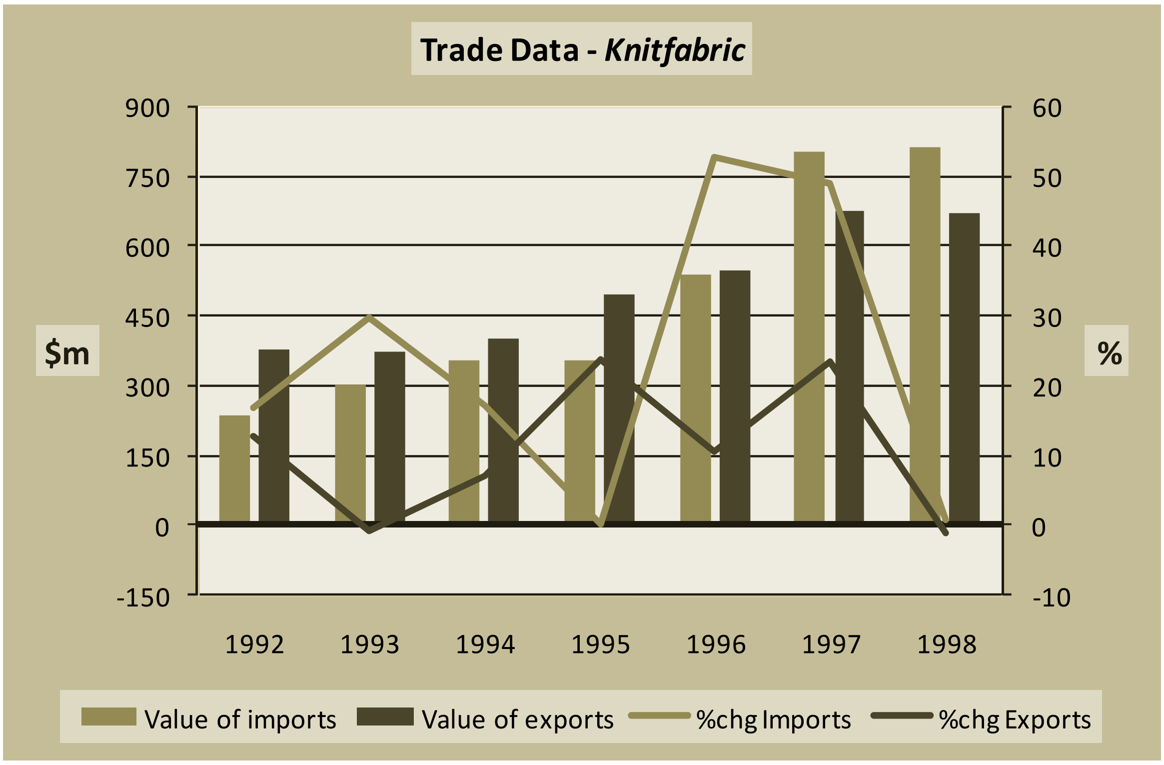

Figure 6: 1992-1998—U.S. trade by the *Knitfabric* industry in nominal dollars

5. Strategy to improve the forecast

In re-running the simulation, import-price forecasts were generated by extrapolating the *real* price change from 1992 to 1998. This was done for all textile, clothing and footwear (TCF) industries. For *Knitfabric* this resulted in more realistic import-price projections and less erroneous domestic-import relative (basic) price movements, and hence an improved estimate for *x0dom_dom*. These effects culminated in an improved forecast for output growth of 7.1% and reduced the USAGE error from 139% to 106%. The absolute size of the error remained quite large due to the ongoing underestimation of *impftwist*, the error in forecasting the main buyer, *Apparel*, and the projection of the impact on output for even higher factor-input cost reductions. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings (i.e., no further all-factor-augmenting technical change) gave better results. In this case, higher costs meant that output contracted 35.4% and the USAGE error improved to 24%.

***Apparel* → Apparel Made From Purchased Materials (SICs 231-238)**

Known as the cutting-up and needle trades, includes establishments producing clothing and fabricating products by cutting and sewing purchased woven or knit textile fabrics and related materials, such as leather, rubberized fabrics, plastics, and furs. Also included are establishments that manufacture clothing by cutting and joining (for example, by adhesives) materials such as paper and non-woven textiles. Included in the apparel industries are three types of establishments: (1) the regular or inside factories; (2) contract factories; and (3) apparel jobbers. The regular factories perform all of the usual manufacturing functions within their own plant; the contract factories manufacture apparel from materials owned by others; and apparel jobbers perform the entrepreneurial functions of a manufacturing company, such as buying raw materials, designing and preparing samples, arranging for the manufacture of clothing from their materials, and selling of the finished apparel.

- **Industry Group 231:** Men's And Boys' Suits, Coats, And Overcoats
- **Industry Group 232:** Men's And Boys' Furnishings, Work Clothing, And Allied Garments
- **Industry Group 233:** Women's, Misses', And Juniors' Outerwear
- **Industry Group 234:** Women's, Misses', Children's, And Infants'
- **Industry Group 235:** Hats, Caps, And Millinery
- **Industry Group 236:** Girls', Children's, And Infants' Outerwear
- **Industry Group 237:** Fur Goods
- **Industry Group 238:** Miscellaneous Apparel And Accessories

Apparel - Apparel Made From Purchased Materials	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-12.3	-16.4	-9.9	-10.0
All-factor-augmenting technical change	*a1prim*	-55.9	-0.9	-70.5	-70.5
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-24.3	-0.3	-27.7	-27.7
Combined change in household tastes	*a3com*	8.0	-15.2	9.4	9.4
Commodity-using technical and taste change	*ac*	-5.5	-6.5	-6.6	-6.6
Contribution to output of commodity-using technical & taste change	*cont_ac*	-0.7	-0.8	-0.8	-0.8
Vertical shift of the export demand curve	*cont_fepc*	2.2	-5.3	2.5	2.5
Import/domestic twist by commodity	*ftwist_src*	29.2	291.8	29.9	29.4
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-10.7	-57.8	-12.3	-12.3
Twist caused by strong growth	*twist_eff*	0.1	-18.8	0.1	-2.6
Basic price of domestic goods	*p0dom*	-9.1	-17.6	-0.3	-2.1
Basic price of imported goods	*p0imp*	-7.9	-27.3	12.8	-4.8
Ratio of basic prices: domestic to import	*fpdm*	-1.3	13.0	-11.7	2.8
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	38.5	25.1	26.5	30.1
Total supplies of domestic goods	***x0dom***	**25.0**	**-47.6**	**15.8**	**3.8**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	26.5	-47.4	7.9	2.7
Total supplies of imported goods	*x0imp*	59.6	95.6	45.8	57.9
Household demands undifferentiated by source	*x3*	41.6	28.7	26.4	30.9
Export volumes	*x4*	124.6	-47.8	85.1	17.4
Change in net import share to domestic output	*dtradeshare*	14.7	190.9	29.6	39.7

Table 17: Key results for *Apparel*

1. Why did the model erroneously give good prospects to *Apparel*?

Apparel had a USAGE error of 121% versus the larger trend forecast error of 148%. The key results for this commodity are shown in Table 17. The actual outcome for *Apparel* output (*x0dom*) was a 47.6% contraction over the 1998-2005 period. This followed 25.0% growth from 1992-1998. The extrapolated trend was therefore 30% growth versus the USAGE forecast of 15.8% growth. Table 19 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- About 49% of total domestic sales came from imports (Section 5 of Table 19).
- 11% of domestic production was exported (Section 3 of Table 19).
- 87% of domestic output was sold to consumers (Section 5 of Table 19).

A priori, given the strong share of sales to consumers, an inaccurate projection for the household taste variable (*a3com*) could create a material divergence between forecast and reality. The model extrapolated household preferences from the historical run resulting in tastes moving in favour of *Apparel*. This did not turn out to be true, with a difference of 24.6 percentage points. However, no clear evidence could be found to suggest that by 1998 consumer tastes were souring towards this commodity.

More important was the model's underestimation of *impftwist*. As mentioned previously, this purports to measure the contribution to output from the impact of the shifter on the twist (*ftwist_src*). This can be seen in Table 18. The impact on the domestic sales share of *Apparel* was a 12.3% contraction in forecast, c*eteris paribus*, when in reality the damage to the market share of domestic producers was 57.8%.

In addition, reduced protection coincided with the increasing emergence of China and India as super-cheap producers and exporters of *Apparel.* This is reflected in the trade data, which is illustrated in Figure 7. As was the case for all TCF commodities, the foreign-currency price increase of imported *Apparel* that occurred between 1992 and 1998 was projected forward. This strongly contributed to a higher basic price of imported *Apparel* than turned out to be the case (in fact, the basic import price fell sharply). This impacted relative basic prices in a way that was incorrectly favourable to domestic producers. The model estimated an 11.7% change in favour of domestic output, when in reality there was an *unfavourable* 13.0% change.

Finally, the impact on output of the sharp cost reductions relating to primary-factor inputs that occurred from 1992 to 1998 were also projected forward; but instead of these cost effects intensifying, they failed to materialise.

ftwist_src	29.87%	*Apparel* (original forecast)		
		start	end	
Import	3211	21.44	26.17	
Domestic	11764	78.56	73.83	-6.02
Total	**14975**	**=BAS1**		
		start	end	
Import	0	0	0	
Domestic	0	0	0	0.00
Total	**0**	**=BAS2**		
		start	end	
Import	51931	53.38	59.79	
Domestic	45350	46.62	40.21	-13.75
Total	**97281**	**=BAS3**		
		Weighted Average =		-12.72
Sales	112256	*impftwist (%)*		-12.33
The difference is due to b.o.t.e. estimation error				

ftwist_src	291.82%	*Apparel* (actual outcome)		
		start	end	
Import	3211	21.44	51.68	
Domestic	11764	78.56	48.32	-38.49
Total	**14975**	**= BAS1**		
		start	end	
Import	0	0	0	
Domestic	0	0	0	0.00
Total	**0**	**= BAS2**		
		start	end	
Import	51931	53.38	81.77	
Domestic	45350	46.62	18.23	-60.90
Total	**97281**	**= BAS3**		
		Weighted Average =		-57.91
Sales	112256	*impftwist (%)*		-57.83
The difference is due to b.o.t.e. estimation error				

Table 18: The predicted and actual impacts of import twist factors on *Apparel* in the period from 1998 to 2005

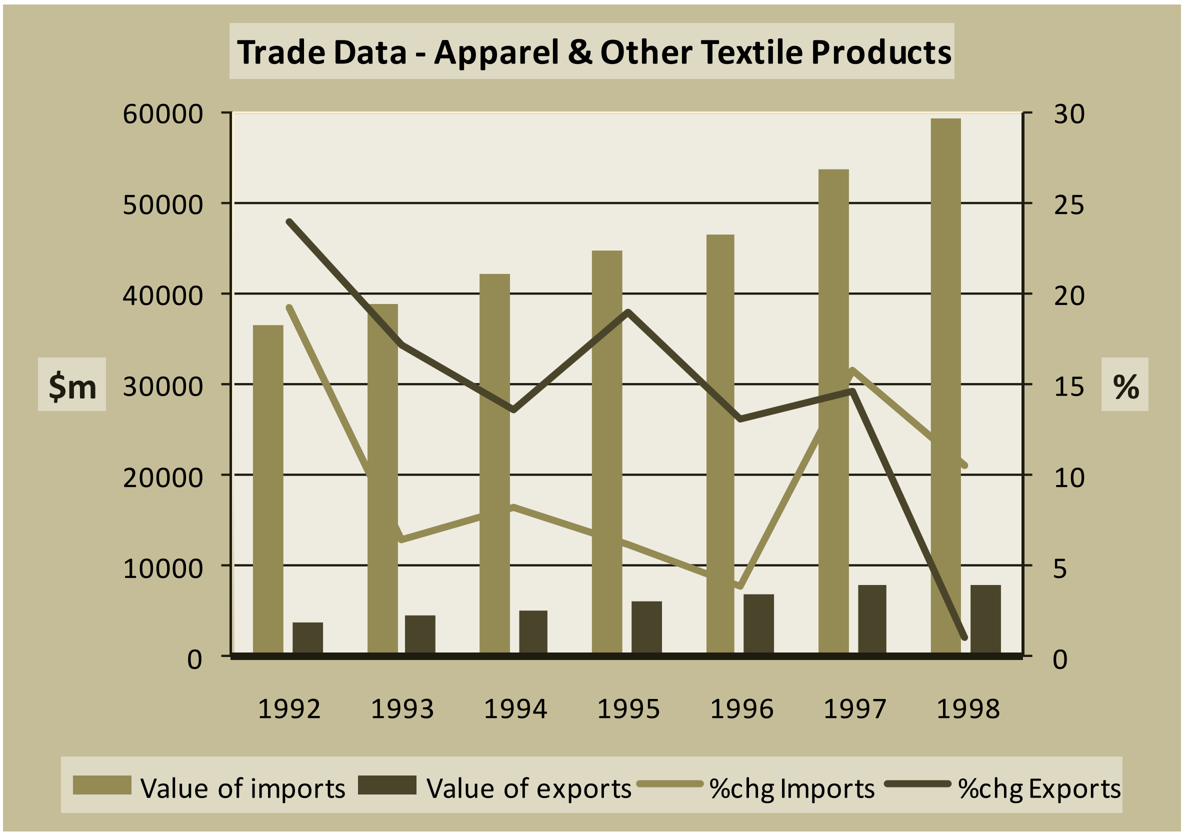

Figure 7: 1992-1998—U.S. trade by the Apparel & Other Textile Products industries in nominal dollars

2. Macro perspective

The impact of the Uruguay Round of multilateral trade negotiations (MTN) that was implemented over the period 1995-2000 for developed countries has already been discussed. As part of this the U.S. lowered tariffs and commenced the phase-out of quotas but reserved the right to impose safeguards once the phase-out was complete. However, the U.S. refused to agree to accelerated quota growth and tariff reductions. Furthermore under the terms of the Uruguay Round agreement, developing countries were afforded much higher tariff rates than developed countries. The modeller could not have been sure that reductions in protection would subsequently be reversed.

In forming a view about the prospects for *Apparel* the modeller could have noted the advice in the following quote:

> "Key factors that affect the demand for many textiles and apparel subsectors include health of end-use markets, growth in the overall economy and consumer spending, and trends in foreign trade. A broad range of textile products are used in the production of apparel, home furnishings, and industrial products ... Most apparel markets are affected by trends in consumer spending, overall growth in the national economy, demographics, and foreign trade."[80]

By late 1998 it was not clear that consumer tastes would begin to sour overall, whilst taking an increased liking to imports—well beyond that which could be explained by changes in relative prices.

3. Conclusion

In summary, import twist factors, relative prices and household preferences all worked against domestic output of *Apparel*, resulting in a large forecast error. Whilst the modeller could have been wary of strong domestic growth numbers given that TCF industries were becoming increasingly exposed to foreign entry, it seems that it would have been too difficult to predict the magnitude of the preference twist in favour of imports. By late 1998 it was not clear that consumer tastes would begin to sour overall, whilst taking an increased liking to imports—well beyond that which could be explained by changes in relative prices. Furthermore, the modeller could not have been sure that reductions in protection would not subsequently be reversed. However, as was the case for all TCF commodities, improvements could have been made to the import-price forecasts because basic import prices were heavily tied to policy.

[80] http://www.wa.gov/esd/lmea/sprepts/indprof/textiles.htm, visited 1 September 2009.

2.2.2 Broad Brush Approach: Textiles, Clothing & Footwear (TCF)

Apparel Made From Purchased Materials (*Apparel*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	120 Apparel: 57932	116 Knitoutwear: 4689	Rest: 1891	**Total: 64512**
Proportion	120 Apparel: 0.898	116 Knitoutwear: 0.073	Rest: 0.029	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	116 Apparel: 57932	Rest: 805	**Total: 58737**
Proportion	116 Apparel: 0.986	Rest: 0.014	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	11764	3211	14975	**0.18**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	45350	51931	97281	**0.70**
Exports	BAS4	7082	0	7082	**0.11**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	315	0	315	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**64512**	**55142**	**119653**	
Source/Total		**0.54**	**0.46**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	120 Apparel: 6796	504 SLCEcorrect: 959	Rest: 4009	Total: 11764	**Total: 0.786**
Imported	120 Apparel: 1252	508 Holiday: 476	Rest: 1483	Total: 3211	**Total: 0.214**
Total	**120 Apparel: 8048**	**504 SLCEcorrect: 1012**	**Rest: 5915**	**Total: 14975**	
Proportion	**120 Apparel: 0.537**	**504 SLCEcorrect: 0.068**	**Rest: 0.395**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	14198	4587	18786	**0.12**	**0.06**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	99753	114874	214627	**0.87**	**0.43**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	315	0	315	**0.00**	**0.00**
Total	**114266**	**119462**	**233728**		
Source/Total	**0.49**	**0.51**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	44102	**0.75**	LABOUR	14106	**0.88**
Factor	16030	**0.27**	CAPITAL	1924	**0.12**
Other	-1576	**-0.03**	LAND	0	**0.00**
Production Taxes	181	**0.00**	**Total**	**16030**	
Total	**58737**				

Source	c. Intermediate Inputs				Proportion
Domestic	103 Broadfabric: 10025	116 Apparel: 7693	Rest: 21552	Total: 39270	**Total: 0.890**
Imported	103 Broadfabric: 1678	116 Apparel: 1435	Rest: 1720	Total: 4832	**Total: 0.110**
Total	**103 Broadfabric: 11703**	**116 Apparel: 9128**	**Rest: 23272**	**Total: 44102**	
Proportion	**103 Broadfabric: 0.265**	**116 Apparel: 0.207**	**Rest: 0.528**		

Table 19: The key attributes of *Apparel* in 1998

4. Strategy to improve the forecast

In re-running the simulation, real basic import prices were projected forward, generating more realistic relative basic price changes. For *Apparel* this produced an improved forecast for output growth of 3.8% and reduced the USAGE error from 121% to 98%. This was done for all TCF industries, which resulted in more realistic import-price projections and hence, less erroneous domestic-import relative-price movements. This improved the estimate for *x0dom_dom* and, in turn, for *x0dom.* However, the absolute size of the error remained quite large due to the ongoing underestimation of *impftwist*, the error in forecasting household preferences, and the overestimation of factor input cost reductions. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings (i.e., no further all-factor-augmenting technical change) gave better results. In this case, higher costs meant that output contracted 24.7% and the USAGE error improved to 44%.

Luggage → Luggage (SIC 3161)

Establishments primarily engaged in manufacturing luggage of leather or other materials. The luggage industry produces a wide variety of products, including suitcases, briefcases, attaché cases, hand luggage, tote bags, trunks, and occupational cases. Materials used in addition to leather include plastics, nylon, cotton, linen, and metals. Many products use a combination of these materials. Construction methods include sewing, molding, and laminating.

Luggage - Luggage	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-4.6	1.1	-2.7	-2.9
All-factor-augmenting technical change	*a1prim*	-22.5	60.7	-25.9	-25.9
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-10.9	24.0	-12.5	-12.5
Combined change in household tastes	*a3com*	8.3	-19.9	9.7	9.7
Commodity-using technical and taste change	*ac*	11.0	6.2	13.9	13.9
Contribution to output of commodity-using technical & taste change	*cont_ac*	1.5	0.8	1.8	1.8
Vertical shift of the export demand curve	*cont_fepc*	4.2	-10.7	4.9	4.9
Import/domestic twist by commodity	*ftwist_src*	120.9	682.3	127.7	127.5
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-42.9	-83.3	-48.0	-48.0
Twist caused by strong growth	*twist_eff*	-3.1	-24.8	-6.6	-8.5
Basic price of domestic goods	*p0dom*	2.8	5.9	7.2	5.4
Basic price of imported goods	*p0imp*	2.8	8.6	15.6	7.9
Ratio of basic prices: domestic to import	*fpdm*	0.1	-2.5	-7.3	-2.4
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	50.0	13.2	26.8	30.5
Total supplies of domestic goods	*x0dom*	**10.0**	**-61.9**	**-12.1**	**-19.1**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	-14.7	-74.5	-32.2	-34.6
Total supplies of imported goods	*x0imp*	78.1	37.6	42.7	48.1
Household demands undifferentiated by source	*x3*	45.1	12.1	26.3	30.3
Export volumes	*x4*	65.2	-14.6	64.7	40.3
Change in net import share to domestic output	*dtradeshare*	104.1	697.0	196.3	233.9

Table 20: Key results for *Luggage*

1. **Why did the model erroneously give good prospects to *Luggage*?**

Luggage had a USAGE error of 131% versus the larger trend forecast error of 193%. The key results for this commodity are shown in Table 20. The actual outcome for *Luggage* output (*x0dom*) was a 61.9% contraction over the 1998-2005 period. This followed 10.0% growth from 1992-1998. The extrapolated trend was therefore 12% growth versus the USAGE forecast of a 12.1% contraction. Table 21 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- About 79% of total sales in the U.S. came from imports (Section 5 of Table 21).
- 21% of production was exported (Section 3 of Table 21).
- 88% of U.S.-destined domestic output was sold to consumers (Section 5 of Table 21).

Luggage (*Luggage*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries		215 Luggage: 947	Rest: 43	**Total: 990**
Proportion		215 Luggage: 0.957	Rest: 0.043	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	210 Luggage: 947	416 WholesleTrde: 30	Rest: 62	**Total: 1039**
Proportion	210 Luggage: 0.912	416 WholesleTrde: 0.029	Rest: 0.060	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	137	377	514	**0.14**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	640	2485	3125	**0.65**
Exports	BAS4	209	0	209	**0.21**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	5	0	5	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**990**	**2862**	**3853**	
Source/Total		**0.26**	**0.74**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	479 LaborOrgan: 23	215 Luggage: 12	Rest: 101	Total: 137	**Total: 0.266**
Imported	479 LaborOrgan: 106	508 Holiday: 25	Rest: 247	Total: 377	**Total: 0.734**
Total	**479 LaborOrgan: 129**	**508 Holiday: 31**	**Rest: 353**	**Total: 514**	
Proportion	**479 LaborOrgan: 0.251**	**508 Holiday: 0.061**	**Rest: 0.688**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	152	441	593	**0.12**	**0.03**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	1100	4333	5433	**0.88**	**0.18**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	5	0	5	**0.00**	**0.00**
Total	**1257**	**4774**	**6031**		
Source/Total	**0.21**	**0.79**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	577	**0.56**	LABOUR	293	**0.63**
Factor	467	**0.45**	CAPITAL	174	**0.37**
Other	-8	**-0.01**	LAND	0	**0.00**
Production Taxes	3	**0.00**	**Total**	**467**	
Total	**1039**				

Source	c. Intermediate Inputs				Proportion
Domestic	103 Broadfabric: 126	108 Coatdfabric: 76	Rest: 300	Total: 501	**Total: 0.869**
Imported	103 Broadfabric: 20	108 Coatdfabric: 19	Rest: 37	Total: 76	**Total: 0.131**
Total	**103 Broadfabric: 146**	**108 Coatdfabric: 95**	**Rest: 337**	**Total: 577**	
Proportion	**103 Broadfabric: 0.253**	**108 Coatdfabric: 0.164**	**Rest: 0.583**		

Table 21: The key attributes of *Luggage* in 1998

There were several factors contributing to the erroneous forecast. On the supply side, primary factors comprised 45% of total input costs (Section 6a of Table 21); “all-factor-augmenting technical change” (*a1prim*) indicated a 25.9% improvement in primary-factor efficiency (see Table 20). This meant that the *Luggage* industry was projected to require nearly 26% less primary factors to produce the same level of output whilst holding all other inputs constant. The *contribution* of “all-factor-augmenting technical change” to total input costs in the forecast was estimated to be an overall cost reduction of about 12.5% (*cont_a1prim*). In reality, this efficiency measure (*a1prim*) deteriorated by 60.7%, and its contribution to total input costs rose 24.0%, thereby further weighing on output.

On the demand side, households were responsible for 65% of sales of domestically-produced *Luggage* and 90% of total sales (domestic and imported). This meant that any large change in household preferences would have a significant impact on the forecast. In particular, the combined change in household tastes (*a3com*) was projected forward to be 9.7%. This means that at any given set of prices and per capita income, consumption per household of *Luggage* would be about 9.7% higher in 2005 than in 1998.[81] In reality, household tastes towards *Luggage* soured by 19.9%—a difference of 29.6 percentage points. Even though exports were a much smaller share of output, the prediction for foreign preferences was also off the mark. The export-demand curve was forecast to shift upward when it in fact shifted downward (see *cont_fepc* in Table 20). This was a difference of 15.6 percentage points.

ftwist_src	127.70%	*Luggage* (original forecast)			*ftwist_src*	682.30%	*Luggage* (actual outcome)		
		start	end				start	end	
Import	377	73	86		Import	377	73	96	
Domestic	137	27	14	-48.36	Domestic	137	27	4	-83.35
Total	**514**	**=BAS1**			**Total**	**514**	**= BAS1**		
		start	end				start	end	
Import	0	0	0		Import	0	0	0	
Domestic	0	0	0	0.00	Domestic	0	0	0	0.00
Total	**0**	**=BAS2**			**Total**	**0**	**= BAS2**		
		start	end				start	end	
Import	2485	80	90		Import	2485	80	97	
Domestic	640	20	10	-50.38	Domestic	640	20	3	-84.44
Total	**3125**	**=BAS3**			**Total**	**3125**	**= BAS3**		
		Weighted Average =		-50.10			Weighted Average =		-84.28
Sales	3639	*impftwist (%)*		-48.00	Sales	3639	*impftwist (%)*		-83.35
The difference is due to b.o.t.e. estimation error					The difference is due to b.o.t.e. estimation error				

Table 22: The impact of import twist factors on *Luggage*

[81] More precisely, the consumption per household of *Luggage* in 2005 would be 10*(1 – share of *Luggage* in household expenditure) percent higher than in 1998.

Import twist factors worked overwhelmingly against the domestic commodity. In particular, the impact of the shifter on the twist was (*ceteris paribus*) projected to do 48.0% damage to the market share of domestic producers of *Luggage*. In reality, it did an even more significant 83.3% damage, as illustrated in Table 22. This shows both in forecast and reality, that if not for other factors (e.g., changes in relative prices) the market share of domestic producers would have fallen dramatically.

2. Macro perspective

An external forecast was found, dated February 1995, by SBI, a division of MarketResearch.com, who claim to be the world's largest aggregator of syndicated market research reports. The report provided the following quote:

> "U.S. luggage market growth trends strengthened over the 1990s due to sharper gains in personal income and favorable demographics. Demand was also stimulated by the introduction of wheeled and lightweight luggage products and casual luggage lines, and the growing need for lifestyle products such as backpacks, sports bags, and computer cases. Stronger growth resulted in rising U.S. luggage manufacturer profit margins. Margin gains also benefited from improvements in labour productivity and moderating material costs. U.S. manufacturers were able to boost plant profit margins despite rising competition from foreign-sourced products and relatively weak product price gains. Market growth is forecast to strengthen further over the next five years as the key baby boomer market moves through its prime luggage buying years."[82]

SBI had a very bullish outlook for *Luggage*, however, the commodity increased by just 10.0% over the period 1992-1998. By 1998, SBI's view may well have changed but any further reports could not be located.

Turning to the trade data for *Luggage* that is illustrated in Figure 8, it is quite clear that imports were growing strongly from 1992 to 1998. Exports also grew strongly (up to 1997) as foreign markets became more open, but this growth was off a relatively low base.

[82] http://www.mindbranch.com/Luggage-R460-19, visited 3 September 2009.

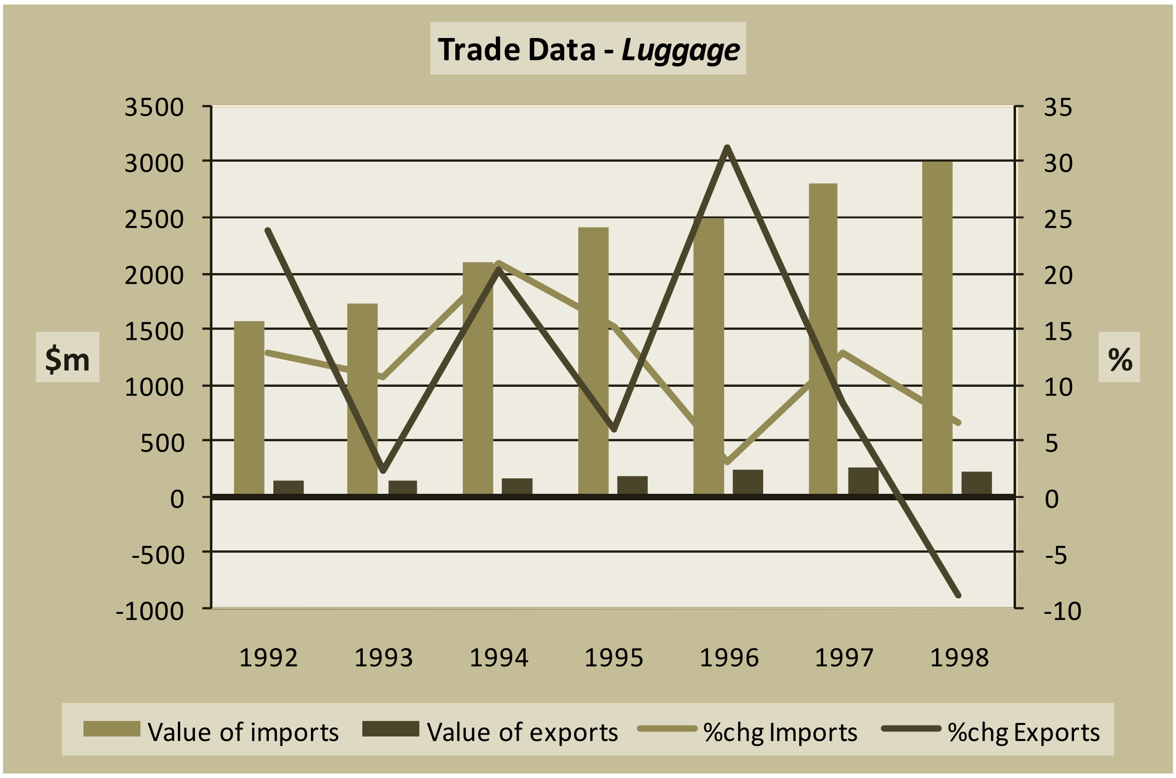

Figure 8: 1992-1998—U.S. trade by the *Luggage* industry in nominal dollars

3. Conclusion

Luggage output increased modestly over the period from 1992 to 1998. As noted earlier, where commodities have large import shares (e.g., there was 79% import penetration in *Luggage* in the 1998 database), it is notoriously difficult to accurately forecast domestic output in the absence of specialised knowledge. This is because total supplies of domestic goods (*x0dom*) will move off a low base. In this instance, the model usually does a better job at predicting the commodity's absorption (*x0*), i.e., all U.S. sales of the commodity both domestic and imported. By late 1998 it was not clear that consumer tastes would begin to sour overall, whilst taking an increased liking to imports—well beyond that which could be explained by changes in relative prices. Overall, it is unlikely the modeller could have confidently made *ad hoc* changes to the forecast parameters regarding *Luggage*. However, as was the case for all TCF commodities, knowing that basic import prices were heavily tied to policy an improved forecast could have been produced by projecting real basic import prices.

4. Strategy to improve the forecast

In re-running the simulation, a more intuitive approach was used to generate import-price forecasts by extrapolating what had happened to *real* basic import prices in the historical period (1992 to 1998). This resulted in more realistic import-price projections and hence, less erroneous domestic-import relative-price movements. This improved the estimate for *x0dom_dom* and, in turn, for *x0dom* resulting in a 19.1% contraction in forecast output. The USAGE error fell from 131% to 112%. However, the absolute size of the error remained quite large due to the ongoing underestimation of *impftwist*; the errors in forecasting household and foreign preferences; as well as technical change parameters. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings saw forecast output contract 38.4% and the USAGE error improved to 62%.

BootCutStock → Boot and Shoe Cut Stock and Findings (SIC 3131)

Part of Major Group 31: Leather And Leather Products, BootCutStock covers establishments primarily engaged in manufacturing leather soles, inner soles, and other boot and shoe cut stock and findings. This industry also includes finished wood heels.

BootCutStock - Boot & Shoe Cut Stock & Findings	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-7.4	-17.7	-6.1	-6.3
All-factor-augmenting technical change	*a1prim*	-35.5	1.6	-42.3	-42.3
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-16.6	0.6	-19.1	-19.1
Combined change in household tastes	*a3com*	-15.5	-46.0	-17.8	-17.8
Commodity-using technical and taste change	*ac*	-26.1	-14.2	-35.9	-35.9
Contribution to output of commodity-using technical & taste change	*cont_ac*	-18.8	-8.0	-21.5	-21.5
Vertical shift of the export demand curve	*cont_fepc*	31.5	-78.5	37.7	37.7
Import/domestic twist by commodity	*ftwist_src*	201.2	-60.7	201.3	201.6
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-61.7	110.0	-67.3	-67.3
Twist caused by strong growth	*twist_eff*	-1.2	-13.0	5.9	2.0
Basic price of domestic goods	*p0dom*	-0.2	-17.2	7.8	4.5
Basic price of imported goods	*p0imp*	-1.9	8.2	10.7	2.3
Ratio of basic prices: domestic to import	*fpdm*	1.8	-23.6	-2.6	2.2
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	-10.9	-24.2	-15.7	-16.9
Total supplies of domestic goods	***x0dom***	**18.8**	**-30.6**	**44.7**	**24.7**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	-64.2	118.0	-78.3	-78.8
Total supplies of imported goods	*x0imp*	16.4	-39.2	-8.2	-9.4
Household demands undifferentiated by source	*x3*	15.8	-22.8	-3.9	-0.8
Export volumes	*x4*	98.4	-49.9	61.6	39.0
Change in net import share to domestic output	*dtradeshare*	-39.4	37.2	-44.9	-38.4

Table 23: Results for *BootCutStock*

1. Why did the model erroneously give good prospects to *BootCutStock*?

As was the case with *AsbestosPrd*, *BootCutStock* produced an error that was large in both absolute and relative terms. *BootCutStock* had a USAGE error of 108% versus the smaller trend forecast error of 75%. The key results for this commodity are shown in Table 23. The actual outcome for *BootCutStock* output (*x0dom*) was a 30.6% contraction over the 1998-2005 period. This followed 18.8% growth from 1992-1998. The extrapolated trend was therefore 22% growth versus the USAGE forecast of a 44.7% expansion.

Table 24 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- 89% of total sales in the U.S. came from imports (Section 5 of Table 24).
- 88% of production was exported (Section 3 of Table 24).
- 68% of factor inputs were labour (Section 6b of Table 24).

Boot & Shoe Cut Stock & Findings (*BootCutStock*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	211 BootCutStock: 330	112 Nonwovenfab: 24	Rest: 22	**Total: 376**
Proportion	211 BootCutStock: 0.877	112 Nonwovenfab: 0.065	Rest: 0.058	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	206 BootCutStock: 330	207 ShoesExrub: 10	Rest: 6	**Total: 346**
Proportion	206 BootCutStock: 0.953	207 ShoesExrub: 0.028	Rest: 0.019	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	43	361	405	**0.12**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	0	1	1	**0.00**
Exports	BAS4	331	0	331	**0.88**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	2	0	2	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**376**	**362**	**739**	
Source/Total		**0.51**	**0.49**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	437 Laundry: 21	212 ShoesExrub: 7	Rest: 14	Total: 43	**Total: 0.107**
Imported	437 Laundry: 183	212 ShoesExrub: 64	Rest: 115	Total: 361	**Total: 0.893**
Total	**437 Laundry: 204**	**212 ShoesExrub: 71**	**Rest: 130**	**Total: 405**	
Proportion	**437 Laundry: 0.504**	**212 ShoesExrub: 0.176**	**Rest: 0.320**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	46	394	440	**0.96**	**0.10**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	0	2	2	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	2	0	2	**0.04**	**0.00**
Total	**48**	**396**	**444**		
Source/Total	**0.11**	**0.89**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	214	**0.62**	LABOUR	92	**0.68**
Factor	135	**0.39**	CAPITAL	42	**0.32**
Other	-6	**-0.02**	LAND	0	**0.00**
Production Taxes	3	**0.01**	**Total**	**135**	
Total	**346**				

Source	c. Intermediate Inputs				Proportion
Domestic	205 LeatherTan: 66	53 MeatpackPlnt: 25	Rest: 37	Total: 128	**Total: 0.600**
Imported	206 BootCutStock: 51	205 LeatherTan: 31	Rest: 3	Total: 85	**Total: 0.400**
Total	**205 LeatherTan: 97**	**206 BootCutStock: 58**	**Rest: 58**	**Total: 214**	
Proportion	**205 LeatherTan: 0.455**	**206 BootCutStock: 0.272**	**Rest: 0.273**		

Table 24: The key attributes of *BootCutStock* in 1998

Exports were by far the largest share of domestic output. Hence, the accuracy of the forecast for output hinged on the foreign demand forecast. In simplified terms, USAGE relates foreign demand for a commodity to overseas activity; foreign-currency prices; and to several autonomous variables that determine the position of the export-demand curve. From 1992 to 1998 the export-demand curve moved considerably higher. This upward shift in foreign demand was projected forward (*cont_fepc* was +37.7%), which had a highly expansionary impact on forecast output. However, this proved to be a vast overestimation because in reality a very sharp downward shift occurred (*cont_fepc* slumped 78.5%). The collapse in foreign preferences dominated any offsetting effects from a reduction in export prices. Hence the expected strong increase in export volumes did not turn out to be true—instead export volumes virtually halved (down 49.9%). On the supply side, the material primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these failed to materialise.

Furthermore, given the overwhelming importance of export markets for *BootCutStock*, the collapse in foreign demand easily outweighed highly favourable twist trend impacts towards the domestically produced commodity (*impftwist* was +110.0%). The impact of the twist was coupled with a favourable 23.6% move in relative prices. This accounted for the 118.0% increase in sales of U.S. output into the domestic market (to producers) but was not enough to prevent a 30.6% decline in total supplies of the commodity.

2. Macro perspective

It was very difficult to source information about this industry that was specifically pre-1999. It was, however, found that by 1996 U.S. manufacturers began to shift operations overseas to take advantage of lower operating costs in countries like China. Many of the footwear plants that did remain in the U.S. were forced to close, and plant openings had slowed to a trickle by the late 1990s. Pricing was also under intense pressure due to competition from imported shoes. In the labour-intensive footwear industry, U.S. makers simply could not compete with manufacturers overseas whose wage rates were far below U.S. levels.[83] The following quote adds further colour to the situation:

> "The drop in domestically produced footwear, of course, had depressed the business of companies that supply shoe manufacturers. Besides the dramatic increase in shoe

[83] http://www.allbusiness.com/leather-leather-products/boot-shoe-cut-stock-findings-boot/3779454-2.html, visited 7 September 2009.

> imports, leather sole makers also had to contend with a shift by consumers to more casual footwear and the rising cost of leather. While there remained a market for the fine leather shoe, many Americans were no longer dressing up for work and did not require several pairs of dress shoes. During the recession of the early 1990s, the repair trade picked up somewhat, as consumers have traditionally mended old shoes when they did not have the money to buy new ones. Some manufacturers thought sales were less robust than in previous recessions, however, because of the loss of white-collar jobs. There was also concern about longer term trends in the repair market."[84]

Figure 9 illustrates the trade data from 1992 t0 1998. Strong export growth peaked in 1996 at around 50% and was still greater than 10% in 1997. In 1998 exports fell by more than 10%. Imports appear to have been quite cyclical.

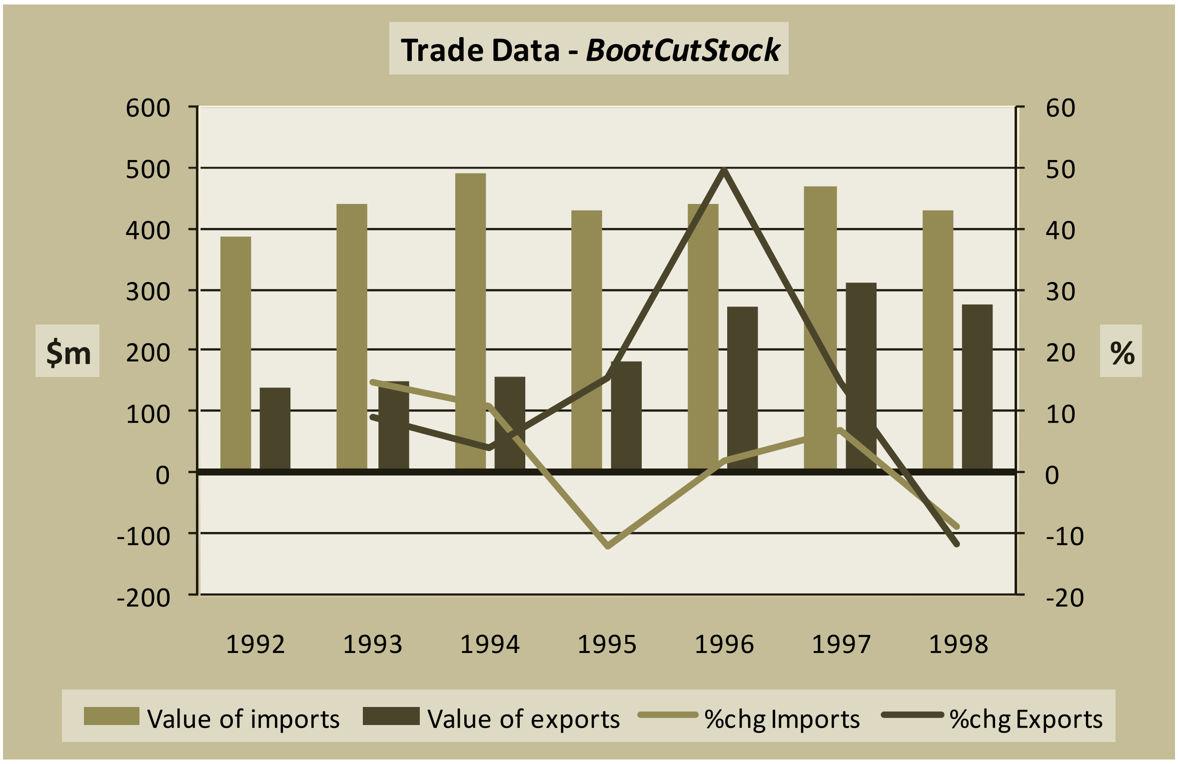

Figure 9: 1992-1998—U.S. trade by the *BootCutStock* industry in nominal dollars

[84] http://www.allbusiness.com/leather-leather-products/boot-shoe-cut-stock-findings-boot/3779454-2.html, visited 7 September 2009.

3. Conclusion

Whilst there was some evidence that exports were beginning to slow, the halving of volumes could not have been anticipated. In any case it is usually difficult to predict foreign demand. Perhaps very large shifts in foreign preferences should be closely investigated, in terms of likely sustainability, rather than be automatically projected forward. Industry conditions were getting tougher as evidenced by a slowdown of plant openings in the late 1990s; the "offshoring" of the industry; and rising competition from low wage nations more generally. This could have indicated that further expansion would be unlikely. This is an instance where the modeller probably would have made *ad hoc* changes to the forecast parameters, such as by nullifying export demand shifts and/or domestic output—but was not pursued here as TCF industries were treated with a broad brush approach.

4. Strategy to improve the forecast

In re-running the simulation, a more intuitive approach was adopted to generate import-price forecasts by extrapolating what had happened to *real* prices in the historical period (1992 to 1998). This resulted in less erroneous domestic-import relative basic price movements. This improved the estimate for *x0dom*, with 24.7% output growth. The USAGE error fell from 108% to 79%. However, the absolute size of the error remained quite large due to the ongoing overestimation of the foreign demand function as well as cost savings. A subsequent simulation differing only by the additional forecast of no further primary-factor cost savings saw forecast output contract 27.0% and the USAGE error improve significantly, to just 5%.

LeatherTan → Leather Tanning and Finishing (SIC 3111)

Establishments primarily engaged in tanning, currying, and finishing hides and skins into leather. This industry also includes leather converters, who buy hides and skins and have them processed into leather on a contract basis by others.

LeatherTan - Leather Tanning & Finishing	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-2.7	-14.8	-1.3	-1.6
All-factor-augmenting technical change	*a1prim*	-23.5	17.4	-27.7	-27.7
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-6.6	4.1	-7.7	-7.7
Combined change in household tastes	*a3com*	5.8	-19.8	6.8	6.8
Commodity-using technical and taste change	*ac*	-4.6	-25.2	-5.3	-5.3
Contribution to output of commodity-using technical & taste change	*cont_ac*	-3.7	-20.8	-4.3	-4.3
Vertical shift of the export demand curve	*cont_fepc*	0.6	-16.3	0.7	0.7
Import/domestic twist by commodity	*ftwist_src*	41.8	303.8	36.1	35.4
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-8.7	-46.3	-10.0	-10.0
Twist caused by strong growth	*twist_eff*	-5.9	-22.4	-4.7	-7.5
Basic price of domestic goods	*p0dom*	8.2	-6.6	12.9	11.9
Basic price of imported goods	*p0imp*	1.9	-0.2	14.4	7.0
Ratio of basic prices: domestic to import	*fpdm*	6.1	-6.5	-1.3	4.6
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	7.7	-50.6	4.1	-0.9
Total supplies of domestic goods	***x0dom***	**-2.1**	**-56.4**	**-4.6**	**-15.3**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	-3.3	-68.3	-9.6	-17.8
Total supplies of imported goods	*x0imp*	51.4	-9.4	38.1	41.4
Household demands undifferentiated by source	*x3*	31.0	2.9	24.7	25.0
Export volumes	*x4*	5.4	-21.1	11.8	-6.4
Change in net import share to domestic output	*dtradeshare*	7.8	16.2	9.9	15.5

Table 25: Results for *LeatherTan*

1. **Why did the model erroneously give relatively good prospects to *LeatherTan*?**

LeatherTan had a USAGE error of 119% versus the bigger trend forecast error of 124%. The key results for this commodity are shown in Table 25. The actual outcome for *LeatherTan* output (*x0dom*) was a 56.4% contraction over the 1998-2005 period. This followed a 2.1% contraction from 1992-1998. The extrapolated trend was therefore a further 2% contraction versus the USAGE forecast of a 4.6% contraction.

Table 26 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- 29% of total sales in the U.S. came from imports (Section 5 of Table 26).
- 25% of production was exported (Section 3 of Table 26).
- 74% of production costs were intermediate inputs (Section 6a of Table 26).

Leather Tanning & Finishing (*LeatherTan*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	210 LeatherTan: 3032	54 Meatpacklnt: 186	Rest: 10	**Total: 3228**
Proportion	210 LeatherTan: 0.939	54 Meatpacklnt: 0.058	Rest: 0.003	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	205 LeatherTan: 3032	Rest: 50	**Total: 3082**
Proportion	205 LeatherTan: 0.984	Rest: 0.016	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	2396	990	3385	**0.74**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	817	0	817	**0.25**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	16	0	16	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**3228**	**990**	**4218**	
Source/Total		**0.77**	**0.23**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	212 ShoesExrub: 498	210 LeatherTan: 497	Rest: 1400	Total: 2396	**Total: 0.708**
Imported	212 ShoesExrub: 229	126 AutoAppTrim: 175	Rest: 585	Total: 990	**Total: 0.292**
Total	**212 ShoesExrub: 728**	**210 LeatherTan: 662**	**Rest: 1996**	**Total: 3385**	
Proportion	**212 ShoesExrub: 0.215**	**210 LeatherTan: 0.196**	**Rest: 0.589**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	2491	1044	3534	**0.99**	**0.70**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	16	0	16	**0.01**	**0.01**
Total	**2507**	**1044**	**3550**		
Source/Total	**0.71**	**0.29**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	2289	**0.74**	LABOUR	645	**0.84**
Factor	766	**0.25**	CAPITAL	121	**0.16**
Other	5	**0.00**	LAND	0	**0.00**
Production Taxes	22	**0.01**	**Total**	**766**	
Total	**3082**				

Source	c. Intermediate Inputs				Proportion
Domestic	53 Meatpacklnt: 872	205 LeatherTan: 514	Rest: 545	Total: 1931	**Total: 0.844**
Imported	205 LeatherTan: 173	53 Meatpacklnt: 114	Rest: 71	Total: 358	**Total: 0.156**
Total	**53 Meatpacklnt: 986**	**205 LeatherTan: 687**	**Rest: 616**	**Total: 2289**	
Proportion	**53 Meatpacklnt: 0.431**	**205 LeatherTan: 0.300**	**Rest: 0.269**		

Table 26: The key attributes of *LeatherTan* in 1998

Several factors contributed to the erroneous forecast. The main buyers of the commodity were other TCF industries. As seen earlier, these industries generally underperformed in the period from 1998 to 2005. Furthermore, there was a large shift away from use of *LeatherTan*, which is reflected in the contribution to output of *LeatherTan*-using technical and taste change (*cont_ac*). This is projected forward in forecast, where USAGE calculated a 4.3% reduction; in reality there was a 20.8% decline. In addition, the USAGE prediction for foreign preferences was also off the mark. The export-demand curve was forecast to shift slightly upward when it in fact shifted strongly downward (see *cont_fepc* in Table 25). As has been the norm in these industries, import twist factors worked overwhelmingly against the domestic commodity. In particular, the impact of the shifter on the twist was (*ceteris paribus*) projected to do 10.0% damage to the domestic market share of *LeatherTan*. In reality, it did an even more significant 46.3% damage. On the supply side, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these were reversed over the seven years from 1998 to 2005.

2. Macro perspective

In the U.S., automotive upholstery and casual footwear make up most of the leather market (see Section 4a of Table 26). The number of companies engaged in leather tanning and finishing had declined since the 1980s as a result of takeover activity and the number of U.S. tanning and finishing establishments decreased from 342 in the early 1980s to 328 in the late 1990s.[85] In line with conditions in the broader TCF sector, competition from overseas leather tanners, especially in developing nations, had adversely affected the industry in the U.S.[86] Leather tanning in the U.S. is primarily the work of privately held companies, where the vast majority of the leather processed is cattle hide. So-called specialty leathers—including deer, calf, pig, goat, sheep, lamb, kangaroo, and various reptiles—comprised only about 5%. With 72 establishments, New York has the most companies engaged in leather tanning and finishing.[87]

Turning to the trade data for *LeatherTan* in Figure 10, it can be seen that the rebound in exports that occurred in the mid 1990s had stalled by 1998. Overall, the growth patterns for both imports and exports seemed cyclical but fairly sharp and out of sync. This created a degree of volatility that made it difficult pinpoint any long term trend.

[85] http://www.answers.com/topic/leather-tanning-and-finishing, visited 16 September 2009.
[86] http://www.answers.com/topic/leather-tanning-and-finishing, visited 16 September 2009.
[87] http://www.answers.com/topic/leather-tanning-and-finishing, visited 16 September 2009.

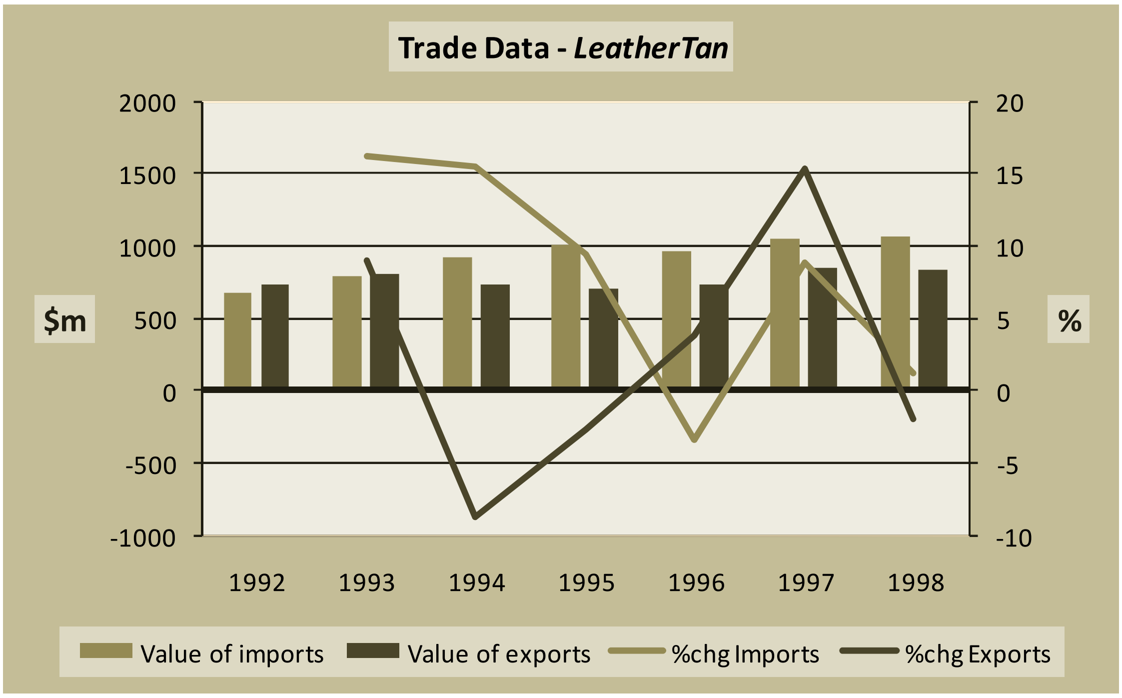

Figure 10: 1992-1998—U.S. trade by the *LeatherTan* industry in nominal dollars

3. Conclusion

Great volatility was evident in the trade data, so there seemed to be no convincing argument that overall trade volumes would fall away. With no *a priori* view that the TCF sector was facing a gloomy period ahead, the modeller is unlikely to have imagined that output would more than halve.

4. Strategy to improve the forecast

In re-running the simulation, a more intuitive approach was used to generate import-price forecasts by extrapolating what had happened to *real* prices in the historical period (1992 to 1998). This was done for all TCF industries, which generally resulted in more realistic import-price projections and hence, less erroneous domestic-import relative-price movements. In the case of *LeatherTan*, this technique resulted in a larger distortion in relative prices. However, the larger divergence in relative prices placed more pressure on sales and choked off exports, thereby muting output. The resultant 15.3% contraction in forecast output saw the USAGE error fall to 94%. The error remained large due to the overestimation of foreign demand and underestimation of domestic-import twist factors. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 31.9% and the USAGE error improve markedly, to 56%.

Hosierynec → Hosiery, Not Elsewhere Classified (SIC 2252)

This industry is defined as establishments primarily engaged in knitting, dyeing, or finishing hosiery, not elsewhere classified. Establishments primarily engaged in manufacturing women's full-length and knee-length hosiery (except socks), and panty hose are classified in Industry 2251. Establishments primarily engaged in manufacturing elastic (orthopedic) hosiery are classified in Industry 3842.

- Anklets, hosiery
- Boys' hosiery
- Children's hosiery
- Dyeing and finishing hosiery, except women's full-length and
- Girls' hosiery
- Hosiery, except women's and misses' full-length and knee-length
- Leg warmers
- Men's hosiery
- Nylons, except women's full-length and knee-length
- Socks
- Socks, slipper-mits
- Stockings, except women's and misses' full-length and knee-length
- Tights, except women's

Hosierynec - Hosiery, Not Elsewhere Classified	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-14.0	-21.3	-12.1	-11.9
All-factor-augmenting technical change	*a1prim*	-54.4	-17.5	-66.7	-66.7
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-26.0	-6.1	-29.6	-29.6
Combined change in household tastes	*a3com*	10.7	-3.3	12.6	12.6
Commodity-using technical and taste change	*ac*	-1.5	8.5	-1.8	-1.8
Contribution to output of commodity-using technical & taste change	*cont_ac*	0.0	0.2	0.0	0.0
Vertical shift of the export demand curve	*cont_fepc*	2.4	1.2	2.8	2.8
Import/domestic twist by commodity	*ftwist_src*	191.0	899.2	89.0	87.5
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-14.8	-68.9	-17.1	-17.1
Twist caused by strong growth	*twist_eff*	1.1	-18.3	0.8	-0.9
Basic price of domestic goods	*p0dom*	-10.4	-16.0	-3.3	-3.4
Basic price of imported goods	*p0imp*	-4.4	-24.4	12.8	-0.7
Ratio of basic prices: domestic to import	*fpdm*	-6.3	10.8	-14.3	-2.8
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	44.1	44.7	32.7	34.7
Total supplies of domestic goods	***x0dom***	**30.1**	**-46.1**	**19.3**	**11.3**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	26.6	-50.6	9.8	7.6
Total supplies of imported goods	*x0imp*	238.6	388.5	112.3	131.0
Household demands undifferentiated by source	*x3*	46.4	45.4	32.9	35.0
Export volumes	*x4*	239.7	1.5	124.9	56.3
Change in net import share to domestic output	*dtradeshare*	9.3	152.6	16.6	22.5

Table 27: Results for *Hosierynec*

1. Why did the model erroneously give good prospects to *Hosierynec*?

Hosierynec had a USAGE error of 122% versus the bigger trend forecast error of 153%. The key results for this commodity are shown in Table 27. The actual outcome for *Hosierynec* output (*x0dom*) was a 46.1% contraction over the 1998-2005 period. This followed 30.1% growth from 1992-1998. The extrapolated trend was therefore a further 36% expansion versus the USAGE forecast of 19.3% growth.

Table 28 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- USAGE industry *Hosierynec* produced more of USAGE commodity *WomenHosiery* (51.4%) compared to USAGE commodity *Hosierynec* (47.7%—Section 2 of Table 28).
- 22% of total sales in the U.S. came from imports (Section 5 of Table 28).
- 89% of production was purchased by households (Section 3 of Table 28).
- 70% of production costs were intermediate inputs (Section 6a of Table 28).

There were several key drivers behind the erroneous forecast. Firstly, the model calculated a 14.3% change in relative prices favouring the domestically produced commodity, when in reality there was a 10.8% unfavourable move in relative prices. The Armington elasticities were set at 2, thereby indicating a good degree of substitutability between domestic and imported *Hosierynec*.

Secondly, the price disadvantage faced by domestic producers was magnified by a strong preference twist towards the imported commodity. The model underestimated the impact of this on production. In the absence of relative-price changes (and other factors) this would have done 68.9% damage to domestic market share. This impact is reflected in the sharp move in *impftwist,* as can be seen in Table 27. Given that imports held just 22% of the U.S. *Hosierynec* market there was plenty of room for these to grow. Households were by far the largest buyer and overall household demand rose by 45.4% over the period; stronger than the 32.9% that USAGE predicted. This came despite a 3.3% swing away in consumer tastes (*a3com*) from *Hosierynec.* For the reasons mentioned above, this strong rise in household demand essentially drove the 388.5% spike in imports (*x0imp*) and the 50.6% collapse in domestic sales of the locally produced product (*x0dom_dom*). Also, exports were much weaker than forecast. However, as they comprised a relatively minor segment of production, these were not as an important determinant of the results. Finally, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these prevailed only in part in the seven years from 1998 to 2005—the savings in overall costs from all-factor-augmenting technical change (*cont_a1prim*) were just 6.1% as opposed to the 29.6% projected by USAGE.

Hosiery, Not Elsewhere Classified (*Hosierynec*) - 1998 Database					
1. Main Producers of the Commodity at Basic Prices					
Industries	115 Hosierynec: 1436	114 Womenhosiery: 28	Rest: 11	**Total: 1476**	
Proportion	115 Hosierynec: 0.973	114 Womenhosiery: 0.019	Rest: 0.008		
2. Output Composition of the Main Producing Industry at Basic Prices					
Commodities	113 Womenhosiery: 1546	114 Hosierynec: 1436	Rest: 29	**Total: 3011**	
Proportion	113 Womenhosiery: 0.514	114 Hosierynec: 0.477	Rest: 0.009		

3. Total Sales of Domestic Output & Imports at Basic Prices					
Demand Type		**Domestic**	**Imported**	**Total**	**Dom/Total Dom**
Current Production	BAS1	33	5	39	**0.02**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	1306	332	1638	**0.89**
Exports	BAS4	129	0	129	**0.09**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	7	0	7	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**1476**	**337**	**1813**	
Source/Total		**0.81**	**0.19**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix					
Source	**a. Current Production**			**BAS1**	**Proportion**
Domestic	115 Hosierynec: 13	508 Holiday: 12	Rest: 9	Total: 33	**Total: 0.865**
Imported	508 Holiday: 3	510 ExpTour: 1	Rest: 1	Total: 5	**Total: 0.135**
Total	**508 Holiday: 15**	**115 Hosierynec: 13**	**Rest: 11**	**Total: 39**	
Proportion	**508 Holiday: 0.389**	**115 Hosierynec: 0.331**	**Rest: 0.280**		
Source	**b. Industry Investment**			**BAS2**	**Proportion**
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.					
Demand Type	**Domestic**	**Imported**	**Total**	**Dom/Total Dom**	**Dom/Total**
Current Production	49	10	60	**0.02**	**0.02**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	2315	661	2977	**0.98**	**0.76**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	7	0	7	**0.00**	**0.00**
Total	**2372**	**672**	**3044**		
Source/Total	**0.78**	**0.22**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices					
a. All Inputs		**Proportion**	**b. Factor Inputs**		**Proportion**
Intermediate	2093	**0.70**	LABOUR	786	**0.80**
Factor	986	**0.33**	CAPITAL	200	**0.20**
Other	-88	**-0.03**	LAND	0	**0.00**
Production Taxes	20	**0.01**	**Total**	**986**	
Total	**3011**				
Source	**c. Intermediate Inputs**				**Proportion**
Domestic	105 YarnFinish: 642	113 Womenhosiery: 322	Rest: 1011	Total: 1975	**Total: 0.944**
Imported	105 YarnFinish: 31	301 TextMach: 29	Rest: 58	Total: 118	**Total: 0.056**
Total	**105 YarnFinish: 673**	**113 Womenhosiery: 322**	**Rest: 1098**	**Total: 2093**	
Proportion	**105 YarnFinish: 0.321**	**113 Womenhosiery: 0.154**	**Rest: 0.524**		

Table 28: The key attributes of *Hosierynec* in 1998

2. Macro perspective

The biggest impact on the commodity's lamentable performance over the 1998-2005 period was the replacement of domestic production with surging imports. It seems the entry of China into the WTO in 2001 and phasing out of the MFA quotas by 2005 amplified cost pressures that existed throughout the 1990s. The Multifibre Agreement, or Agreement on Textiles and Clothing, covered the period 1974-2004, replacing earlier agreements. The phase-out of import quotas took place over ten years (1995-2005) in four phases. At each stage, the percentage of goods not limited by quotas increased, while the quotas for goods still protected also increased. However, as mentioned previously, the U.S. had recourse to special safeguard provisions in the case that imports from China caused or threatened to cause market disruptions to local industry. The trade data in Figure 11 shows strong growth in both imports and exports. The industry commentary for *Hosierynec* had a similar tone to the broader TCF sector:

> "During the late 1990s and early 2000s, hosiery manufacturers tried to operate more efficiently—and some companies merged—to compete more effectively in the global marketplace. Kayser-Roth Corp. was acquired by an Italian hosiery firm named Golden Lady. ... Renfro Corp. and Ridgeview Inc. were two leading hosiery makers that closed factories to reduce their expenses."[88]

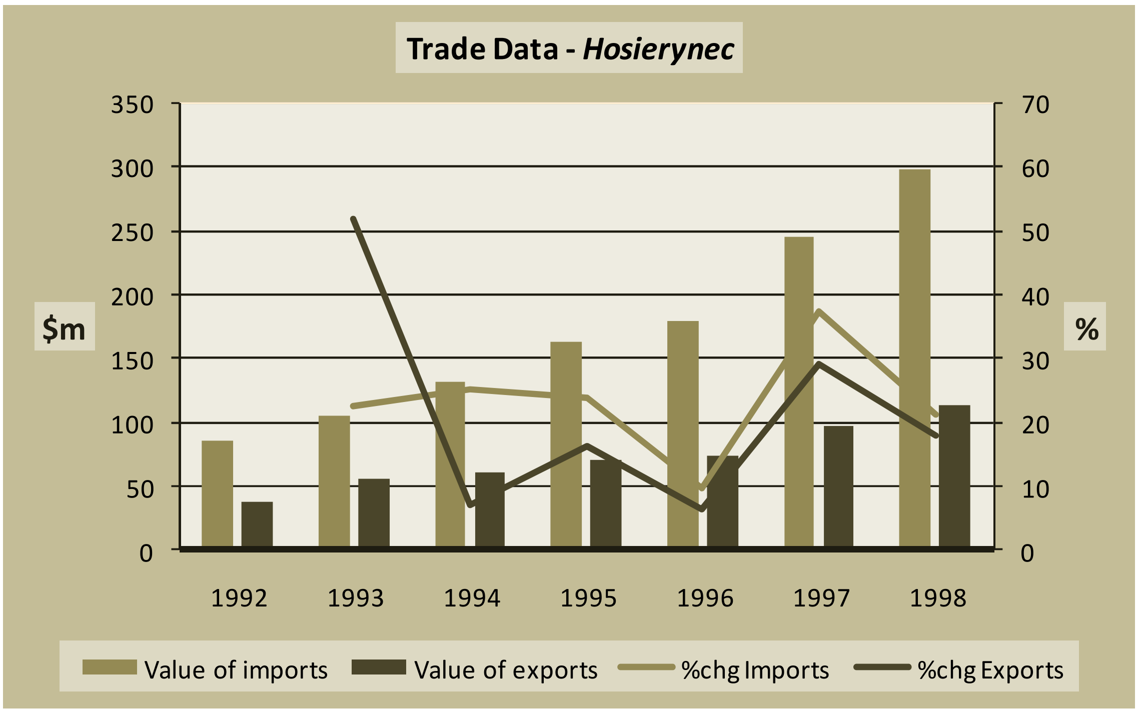

Figure 11: 1992-1998—U.S. trade by the *Hosierynec* industry in nominal dollars

[88] http://www.referenceforbusiness.com/industries/Textile-Mill/Hosiery-Elsewhere-Classified.html, visited 1 September 2009.

3. Conclusion

Even with the strong growth in imports and the impact of trade reform, it is unlikely that the modeller could have imagined that output would almost halve over the forecast period. The strength of the import-favouring twists and the household preference shift away from *Hosierynec* are unlikely to have been predicted. More predictable, however, was that the output-boosting productivity savings seen in the 1992-1998 period were unlikely to intensify, as much of the low hanging fruit had already been obtained.

4. Strategy to improve the forecast

In re-running the simulation, a more intuitive approach was used to generate import-price forecasts by extrapolating what had happened to *real* prices in the historical period (1992 to 1998). This was done for all TCF industries, which generally resulted in more realistic import-price projections and hence, less erroneous domestic-import relative-price movements. The resultant 11.3% output growth in forecast *Hosierynec* output saw the USAGE error fall to 107% from 122%. The error remained large due to the ongoing underestimation of domestic-import twist factors and overestimation of cost savings from primary-factor inputs. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 21.0% and the USAGE error improve markedly, to 47%.

Leathrgloves → Leather Gloves & Mittens (SIC 3151)

This sector is comprised of establishments primarily engaged in manufacturing dress, semidress, and work gloves exclusively of leather or leather with lining of other material. Establishments primarily engaged in manufacturing sporting and athletic gloves are classified in Industry 3949; those manufacturing dress, semidress, and work gloves and mittens of cloth or cloth and leather combined are classified in Industry 2381; and those manufacturing safety gloves are classified in Industry 3842.

- Dress and semidress gloves, leather
- Gloves, leather
- Mittens, leather
- Welders' gloves
- Work gloves, leather

Leathrgloves - Leather Gloves & Mittens	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-6.6	-7.7	-6.4	-6.0
All-factor-augmenting technical change	*a1prim*	-23.4	31.1	-26.4	-26.4
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-10.6	12.3	-12.2	-12.2
Combined change in household tastes	*a3com*	6.3	-23.2	7.4	7.4
Commodity-using technical and taste change	*ac*	-0.7	-14.4	-0.9	-0.9
Contribution to output of commodity-using technical & taste change	*cont_ac*	0.0	-0.7	0.0	0.0
Vertical shift of the export demand curve	*cont_fepc*	-6.4	-2.6	-7.4	-7.4
Import/domestic twist by commodity	*ftwist_src*	37.4	374.3	40.5	40.5
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-20.7	-76.5	-23.7	-23.7
Twist caused by strong growth	*twist_eff*	-4.6	-24.4	-7.8	-8.1
Basic price of domestic goods	*p0dom*	6.4	-1.0	10.7	9.8
Basic price of imported goods	*p0imp*	1.2	9.5	12.8	6.1
Ratio of basic prices: domestic to import	*fpdm*	5.1	-9.6	-1.8	3.5
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	40.9	7.9	24.1	27.1
Total supplies of domestic goods	***x0dom***	**3.2**	**-61.0**	**-16.7**	**-17.5**
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	12.5	-65.2	-12.9	-13.5
Total supplies of imported goods	*x0imp*	53.4	30.4	35.7	39.9
Household demands undifferentiated by source	*x3*	42.6	8.4	24.4	27.5
Export volumes	*x4*	-43.8	9.3	-71.9	-76.5
Change in net import share to domestic output	*dtradeshare*	88.2	696.0	187.9	182.8

Table 29: Results for *Leathrgloves*

1. **Why did the model erroneously give relatively good prospects to *Leathrgloves*?**

Leathrgloves had a USAGE error of 114% versus the bigger trend forecast error of 166%. The key results for this commodity are shown in Table 29. The actual outcome for *Leathrgloves* output (*x0dom*) was a 61.0% contraction over the 1998-2005 period. This followed 3.2% growth from 1992-1998. The extrapolated trend was therefore a further 4% expansion versus the USAGE forecast of a 16.7% decline. Table 30 shows the main users, cost structure and other information of interest of the 1998 database that was used in the forecast. The following observations can be made:

- 75% of total sales in the U.S. came from imports (Section 5 of Table 30).
- 89% of production was purchased by households (Section 3 of Table 30).

There were three main drivers behind the erroneous forecast. Firstly, there was a strong preference twist towards the imported commodity with the model underestimating the impact of this on domestic market share. In the absence of relative-price changes (and other factors) this would have done 76.5% damage to domestic market share. This impact is reflected in the sharp move in *impftwist,* as can be seen in Table 29. As it turns out, in forecast, USAGE underestimated the extent that the change in relative prices favoured the domestic commodity; largely offsetting the *impftwist* error. Secondly, households were by far the largest buyer and overall household demand rose by 8.4% over the period from 1998 to 2005; considerably weaker than the 24.4% that USAGE predicted. This arose because USAGE failed to account for a 23.2% swing in consumer tastes (*a3com*) away from *Leathrgloves.* USAGE projected forward the 6.3% favourable preference/taste shift (+7.4% in forecast). As a result, the sharp decline in household demand drove the 65.2% collapse domestic sales of the locally produced product (*x0dom_dom*). Finally, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these actually reversed in the seven years from 1998 to 2005, further weighing on output.

2. Macro perspective

This is a very small industry which has been squeezed by cheaper imports since WWII.[89] Historical data shows that the domestic industry was relatively stagnant between 1992 and 1998. Figure 12 indicates that any growth in demand was met by rising imports. This strength in imports is also consistent with the solid growth in absorption in the historical period (*x0* rose 40.9%). Other than commentary around rising import penetration and a chronological history of industry consolidation, it was difficult to source external projections around 1998 that were specifically for the U.S.

3. Conclusion

This is a small industry and as such it was always going to be difficult to accurately forecast output growth. Even with the strong growth in imports and the impact of trade reform, it is unlikely that the modeller could have imagined that output (*x0dom*) would more than halve over the forecast period. In particular, there was nothing to suggest that consumers would experience a significant preference shift away from the commodity.

[89] http://www.referenceforbusiness.com/industries/Leather/Leather-Gloves-Mittens.html, visited 1 Sept 2009.

Leather Gloves & Mittens (*Leathrgloves*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	214 Leathrgloves: 114	206 FabRubPrdnec: 6	Rest: 6	**Total: 126**
Proportion	214 Leathrgloves: 0.902	206 FabRubPrdnec: 0.051	Rest: 0.047	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	209 Leathrgloves: 114	116 Apparel: 10	Rest: 8	**Total: 132**
Proportion	209 Leathrgloves: 0.865	116 Apparel: 0.073	Rest: 0.062	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	7	14	21	**0.05**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	112	344	456	**0.89**
Exports	BAS4	7	0	7	**0.06**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	1	0	1	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**126**	**358**	**485**	
Source/Total		**0.26**	**0.74**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	443 MiscRepair: 3	214 Leathrgloves: 2	Rest: 2	Total: 7	**Total: 0.316**
Imported	443 MiscRepair: 8	508 Holiday: 3	Rest: 3	Total: 14	**Total: 0.684**
Total	**443 MiscRepair: 11**	**508 Holiday: 4**	**Rest: 6**	**Total: 21**	
Proportion	**443 MiscRepair: 0.502**	**508 Holiday: 0.201**	**Rest: 0.297**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	8	20	28	**0.04**	**0.01**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	207	659	867	**0.96**	**0.23**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	1	0	1	**0.00**	**0.00**
Total	**216**	**679**	**895**		
Source/Total	**0.24**	**0.76**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion
Intermediate	77	**0.59**
Factor	56	**0.43**
Other	-2	**0.00**
Production Taxes	0	**-0.01**
Total	**132**	

b. Factor Inputs		Proportion
LABOUR	52	**0.93**
CAPITAL	4	**0.07**
LAND	0	**0.00**
Total	**56**	

Source	c. Intermediate Inputs				Proportion
Domestic	205 LeatherTan: 30	106 Threadmills: 4	Rest: 27	Total: 62	**Total: 0.944**
Imported	205 LeatherTan: 15	103 Broadfabric: 1	Rest: 0	Total: 16	**Total: 0.056**
Total	**205 LeatherTan: 46**	**103 Broadfabric: 5**	**Rest: 27**	**Total: 77**	
Proportion	**105 YarnFinish: 0.321**	**113 Womenhosiery: 0.154**	**Rest: 0.524**		

Table 30: The key attributes of *Leathrgloves* in 1998

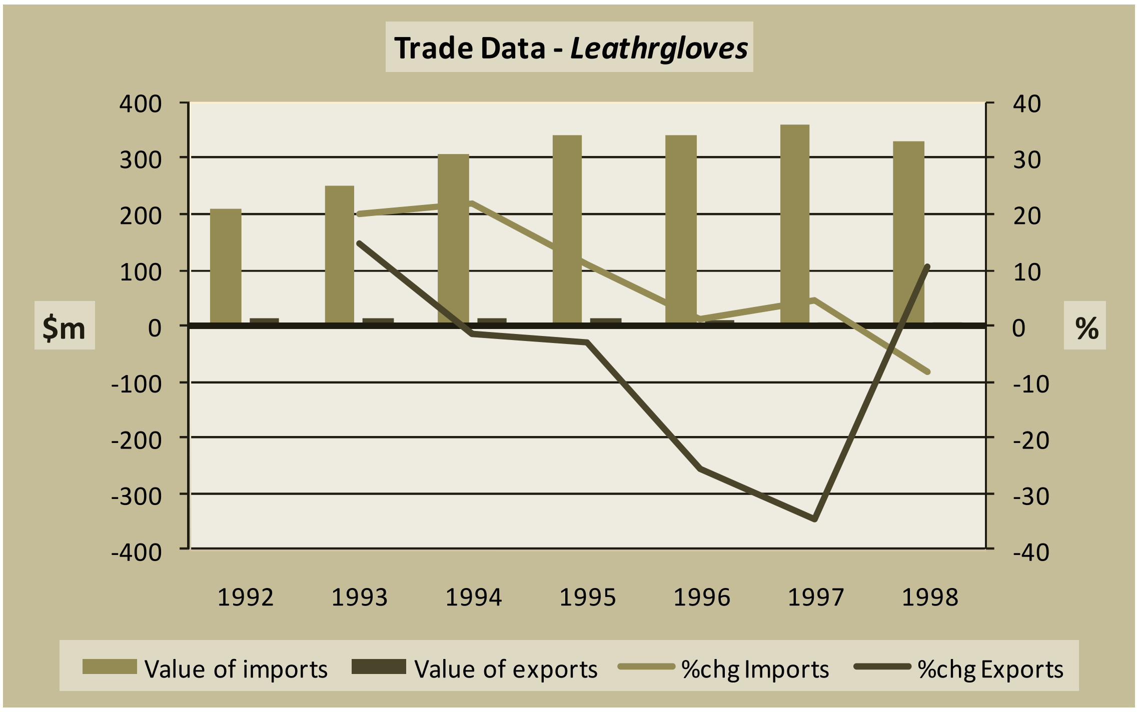

Figure 12: 1992-1998—U.S. trade by the *Leathrgloves* industry in nominal dollars

4. Strategy to improve the forecast

In re-running the simulation, a more intuitive approach was used to generate import-price forecasts by extrapolating what had happened to *real* prices in the historical period (1992 to 1998). This was done for all TCF industries, which generally resulted in more realistic import-price projections and hence, less erroneous domestic-import relative-price movements. This reduced the size of the forecast error through its negating impact on domestic sales and export volumes.

In the case of *Leathrgloves*, this technique resulted in a larger distortion in relative prices, which favoured the imported commodity. The ensuing pressure on domestic and foreign destination sales had the effect of muting *x0dom*, albeit slightly. The resultant 17.5% contraction in forecast output saw the USAGE error fall marginally, to 112%. The error remained large mostly due to the ongoing mis-estimation of the change away from the commodity in household tastes and preferences and the underestimation of domestic-import twist factors. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 26.6% and the USAGE error improve to 88%.

WmnsHandbag → Women's Handbags (SIC 3171)

Establishments in this industry are primarily engaged in manufacturing women's handbags and purses of leather or other materials, except precious metal. Establishments primarily engaged in manufacturing precious metal handbags and purses are classified in Industry 3911.

- Handbags, women's: of all materials, except precious metal
- Pocketbooks, women's: of all materials, except precious metal
- Purses, women's: of all materials, except precious metal

WmnsHandbag - Women's Handbags	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	***a***	-6.4	3.8	-3.3	-3.3
All-factor-augmenting technical change	***a1prim***	-22.5	57.6	-26.5	-26.5
Contribution to costs of all-factor-augmenting technical change	***cont_a1prim***	-12.8	26.9	-14.8	-14.8
Combined change in household tastes	***a3com***	-5.2	8.5	-6.1	-6.1
Commodity-using technical and taste change	***ac***	-43.8	-38.4	-59.4	-59.4
Contribution to output of commodity-using technical & taste change	***cont_ac***	-0.9	-0.6	-1.0	-1.0
Vertical shift of the export demand curve	***cont_fepc***	-0.6	11.1	-0.8	-0.8
Import/domestic twist by commodity	***ftwist_src***	-18.9	554.0	-22.5	-22.4
Twist trends impact on non-marg, non-invent domestic demand	***impftwist***	17.3	-84.8	20.4	20.4
Twist caused by strong growth	***twist_eff***	-0.4	-16.9	0.7	-0.2
Basic price of domestic goods	***p0dom***	2.6	12.5	9.0	7.8
Basic price of imported goods	***p0imp***	3.8	7.3	15.6	9.1
Ratio of basic prices: domestic to import	***fpdm***	-1.1	4.9	-5.8	-1.2
Quantity of sales (domestic and imported) in U.S. - Absorption	***x0***	23.7	51.5	7.8	10.2
Total supplies of domestic goods	***x0dom***	**22.7**	**-42.2**	**18.9**	**14.3**
Quantity of sales of domestically produced in U.S.	***x0dom_dom***	49.8	-73.0	19.8	16.3
Total supplies of imported goods	***x0imp***	20.2	94.5	3.9	8.2
Household demands undifferentiated by source	***x3***	27.1	52.4	8.4	10.8
Export volumes	***x4***	15.6	293.9	15.2	-0.1
Change in net import share to domestic output	***dtradeshare***	-2.3	521.3	-19.5	-10.4

Table 31: Results for *WmnsHandbag*

1. **Why did the model erroneously give good prospects to *WmnsHandbag*?**

WmnsHandbag had a USAGE error of 107% versus the bigger trend forecast error of 121%. The key results for this commodity are shown in Table 31. The actual outcome for *WmnsHandbag* output (*x0dom*) was a 42.2% contraction over the 1998-2005 period. This followed 22.7% growth from 1992-1998. The extrapolated trend was therefore a further 27% expansion versus the USAGE forecast of 18.9% growth. Table 32 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- 75% of total sales in the U.S. came from imports (Section 5 of Table 32).
- 90% of production was purchased by households (Section 3 of Table 32).
- 9% of production was exported (Section 3 of Table 32).
- Factor inputs comprised 52% of total costs (Section 6a of Table 32).
- Labour comprised 54% of factor costs (Section 6b of Table 32).
- *LeatherTan* was the main intermediate input at 46.4% (Section 6c of Table 32).

The key reason for the erroneous forecast was the incorrect projection of the impact on output of domestic-import twist trends (*impftwist*). Based on the composition of absorption of the commodity (*x0dom_dom* and *x0imp*) in the historical period and relative-price changes between domestic and imported *WmnsHandbag*, the model calculated that there must have been a twist against imports (*ftwist_src*); the contribution to output of this twist (namely, a 17.3% boost) was projected forward. This meant that USAGE was predicting an additional 20.4% boost to the market share of domestic producers in the forecast period (*ceteris paribus*). It turned out that, from 1998 to 2005, there was an enormous import-favouring twist that had the impact (*ceteris paribus*) equivalent to 84.8% damage to the market share of domestic producers.

Focusing on the actual result between 1998 and 2005, on the basis of relative-price changes alone (where there was a 4.9% change favouring imports) the ratio of imported to domestic *WmnsHandbag* being sold into the domestic market would have increased by about 15%.[90] [15% = $1.049^3 - 1$]. However, the ratio spiked upward by 620% [= 1.945/0.270 – 1]. As imports surged 94.5% higher to meet rising household demand, domestic sales slumped by 73%. Hence, USAGE inferred that there must have been an enormous twist towards imports. If not for a strong rise in exports (*x4* rose 293.9% off a low base; driven by an 11.1% increase in the export demand function) overall domestic output would have fallen by more than 42.2%. By chance, the model's incorrect projection of household tastes (*a3com*) prevented an even larger forecasting error as this tempered the key demand driver for the commodity. On the supply side, the modest primary-factor-input cost savings that occurred from 1992 to 1998 were projected to continue, but these sharply reversed over the seven years from 1998 to 2005—contributing to the forecast reduction in output of *WmnsHandbag*.

[90] The parameters in the model known as the Armington elasticities were set at 3. *Ceteris paribus,* this indicates a good degree of substitution between the domestically produced commodity and the imported equivalent.

Women's Handbags (*WmnsHandbag*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	216 WmnsHandbag: 534	215 Luggage: 10	Rest: 1	**Total: 545**
Proportion	216 WmnsHandbag: 0.979	215 Luggage: 0.018	Rest: 0.002	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	211 WmnsHandbag: 534	212 PerLeathrGds: 20	Rest: 19	**Total: 574**
Proportion	211 WmnsHandbag: 0.931	212 PerLeathrGds: 0.036	Rest: 0.034	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	7	17	24	**0.01**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	489	1449	1938	**0.90**
Exports	BAS4	46	0	46	**0.09**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	3	0	3	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**545**	**1466**	**2011**	
Source/Total		**0.27**	**0.73**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	508 Holiday: 3	216 WmnsHandbag: 2	Rest: 2	Total: 7	**Total: 0.306**
Imported	508 Holiday: 10	510 ExpTour: 5	Rest: 2	Total: 17	**Total: 0.694**
Total	**508 Holiday: 13**	**510 ExpTour: 6**	**Rest: 5**	**Total: 24**	
Proportion	**508 Holiday: 0.541**	**510 ExpTour: 0.252**	**Rest: 0.207**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	13	33	46	**0.01**	**0.00**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	969	2896	3865	**0.98**	**0.25**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	3	0	3	**0.00**	**0.00**
Total	**985**	**2930**	**3915**		
Source/Total	**0.25**	**0.75**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	279	**0.49**	LABOUR	161	**0.54**
Factor	299	**0.52**	CAPITAL	137	**0.46**
Other	-8	**-0.01**	LAND	0	**0.00**
Production Taxes	3	**0.01**	**Total**	**299**	
Total	**574**				

Source	c. Intermediate Inputs				Proportion
Domestic	205 LeatherTan: 89	273 Hardwarenec: 26	Rest: 113	Total: 228	**Total: 0.817**
Imported	205 LeatherTan: 40	273 Hardwarenec: 5	Rest: 6	Total: 51	**Total: 0.183**
Total	**205 LeatherTan: 130**	**273 Hardwarenec: 31**	**Rest: 119**	**Total: 279**	
Proportion	**205 LeatherTan: 0.464**	**273 Hardwarenec: 0.111**	**Rest: 0.425**		

Table 32: The key attributes of *WmnsHandbag* in 1998

2. Macro perspective

What distinguishes *WmnsHandbag* from the other TCF sectors examined above is that in the period from 1992 to 1998 the quantity of sales of the domestically produced commodity (*x0dom_dom*) grew faster than the imported equivalent (49.8% versus 20.2%, respectively). This growth was rapid enough for domestic producers to increase their market share (valued at purchasers' prices) from 23.1% in 1992 to 25.0% in 1998. However, similar to many of the TCF industries, *WmnsHandbag* experienced significant outsourcing of manufacturing to China. An example of this is the high-end American label "Coach", which outsourced and shifted production to lower cost markets while retaining responsibility for design and marketing:

> "On the manufacturing side, Coach looked to increase operating margins by turning increasingly to outsourcing and shifting from domestic production to production in lower cost markets. Whereas only about 25 percent of Coach products were produced by independent manufacturers in 1998, around 80 percent of the products were made by outsourcers just two years later."[91]

3. Conclusion

Given than domestic producers gained market share over the period from 1992 to 1998, and that imports appeared to have peaked in 1996 (see the trade data in Figure 13), it is unlikely that the modeller could have imagined that output (*x0dom*) would fall by nearly three-quarters over the forecast period—even though outsourcing of the commodity was already taking place.

4. Strategy to improve the forecast

An improved forecast was generated by treating the TCF industries with a broad brush—by projecting *real* basic import prices. This produced more realistic relative-price changes for *WmnsHandbag* that placed additional pressure on sales. The resultant 14.3% output growth in forecast output saw the USAGE error fall from 107% to 99%. The error remained large due to the ongoing mis-estimation of domestic-import twist factors and overestimation of cost savings from primary-factor inputs. A subsequent simulation differing only by the additional forecast of no further primary-factor-input cost savings saw forecast output contract 8.7% and the USAGE error improve markedly, to 59%.

[91] http://www.fundinguniverse.com/company-histories/coach-inc-history/, visited 1 September 2009.

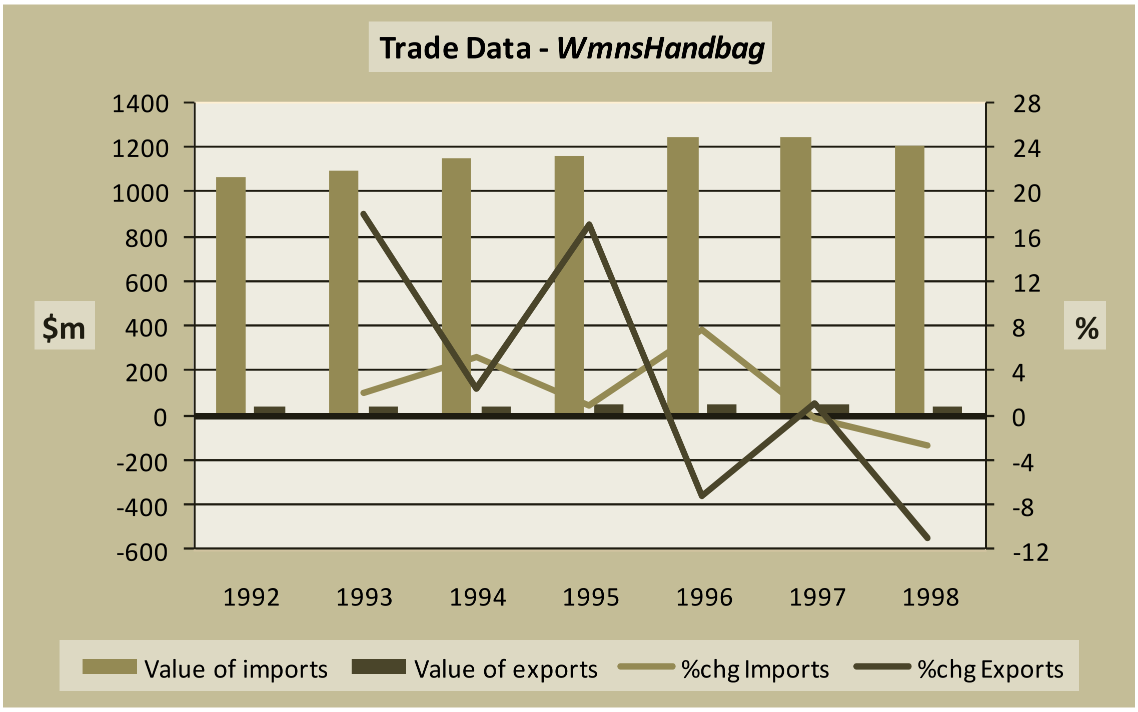

Figure 13: 1992-1998—U.S. trade by the *WmnsHandbag* industry in nominal dollars

2.3 Commodities where the USAGE Forecast Could Not be Improved

Among the twenty worst USAGE errors featured in Table A were five commodities that could be described as resources-related. These are essentially energy and mining related commodities: *AccStrucSMD, PetNgExplor, PetNgDrill, Nonferrores,* and *Copperore*. It was concluded that without great foresight it is probably unlikely that a better forecast could have been generated for these commodities or sectors in general. The same is perhaps true for the construction-related commodity, *CutStone*, where it was not clear cut whether an improved forecast could have been generated.

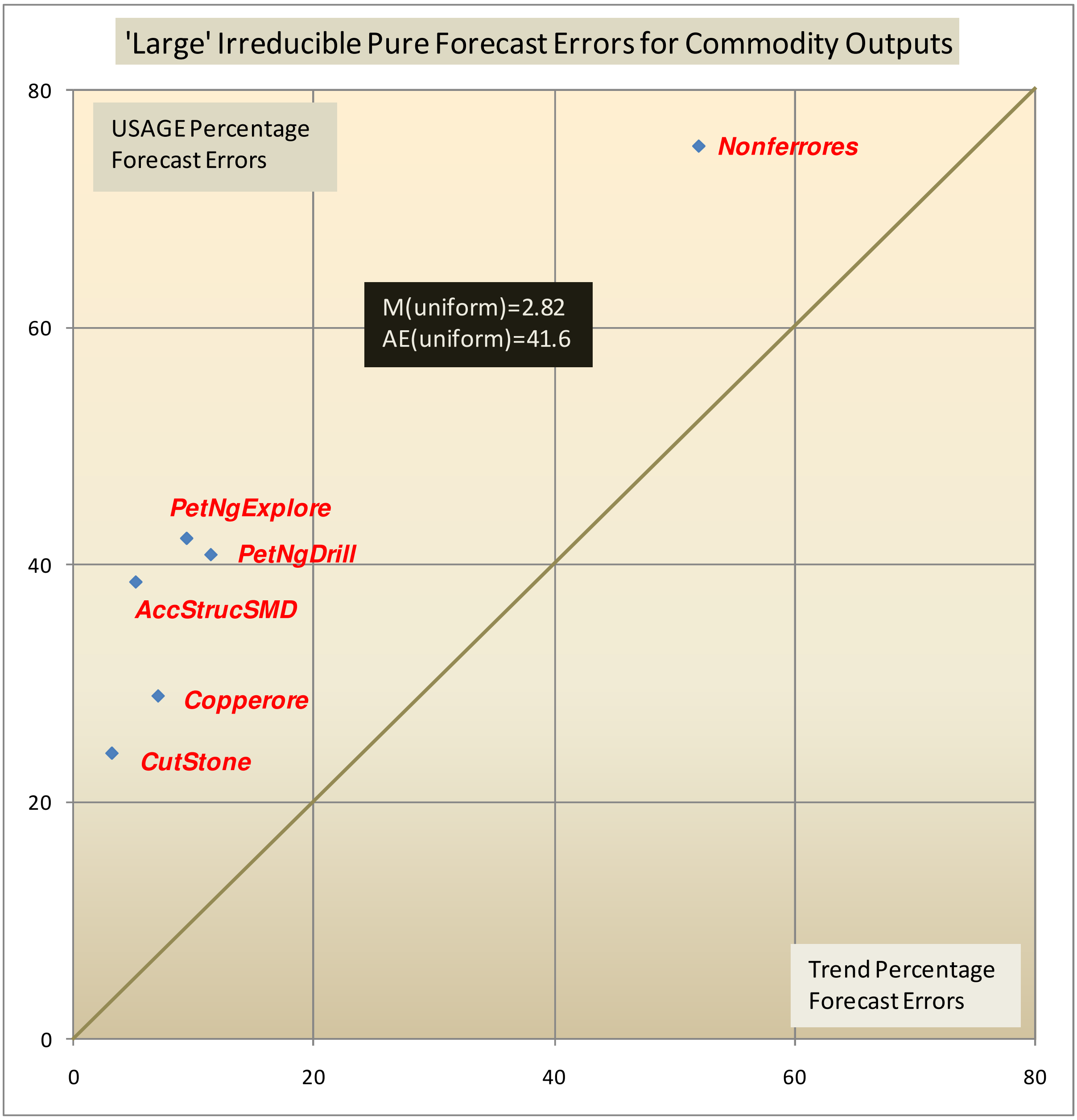

Figure I: Percentage forecast errors that were irreducible for 'large-error' commodity outputs 1998-2005— extrapolated 1992-1998 trend forecast versus the original USAGE pure forecast

Figure I shows that each of these six commodities underperformed the trend extrapolation forecast. In this case, USAGE's unweighted AE was 41.6%. The *M* coefficient was 2.82—which translates to 182% underperformance—reflecting that this small sub-set of commodities all appeared well above the 45-degree line.

Analysis of these commodities generally found that their volatile and cyclical nature would require great faith in even the most well-regarded sector experts for projections extending beyond a couple of years. In 1998 could the modeller have confidently predicted the economic gloom of 2002 and the strength of the rebound from 2004? It seems unlikely. Diversified resources giant, BHP Billiton (formerly BHP), can be considered a bellwether for this sector. Its 10-year price chart using quarterly data from the beginning of 1989 to the end of 1998 is shown in Figure 14. It shows the cyclical and volatile nature of the metals and mining industries.

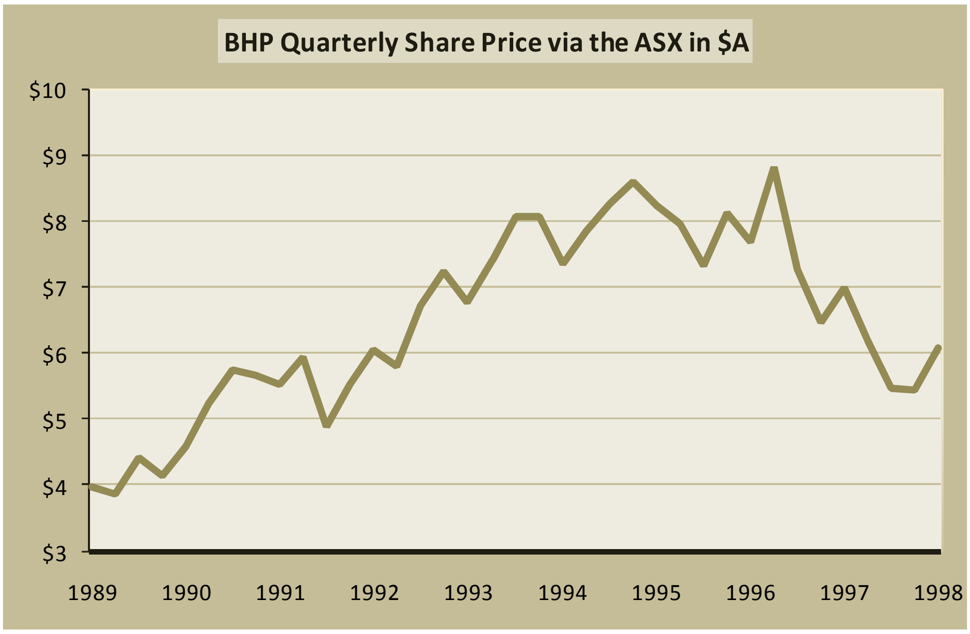

Figure 14: Quarterly share price data for BHP in AUDs as traded on the Australian Stock Exchange *(source: IRESS)*

For the sake of completeness, analysis of these six 'large-error' commodities is provided below.

AccStrucSMD → Access Structures for Solid Mineral Development

This comprises parts of three different SIC industries:

- ***1081 Metal Mining Services***

  Establishments primarily engaged in performing metal mining services for others on a contract or fee basis, such as the removal of overburden, strip mining for metallic ores, prospect and test drilling, and mine exploration and development.

- ***1241 Coal Mining Services***

  Establishments primarily engaged in performing coal mining services for others on a contract or fee basis.

- ***1481 Nonmetallic Minerals Services, Except Fuels***

  Establishments primarily engaged in the removal of overburden, strip mining, and other services for nonmetallic minerals, except fuels, for others on a contract or fee basis.

AccStrucSMD - Access Structures for Solid Mineral Development	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-0.6	1.8	4.4	N/A
All-factor-augmenting technical change	*a1prim*	-4.1	3.5	-4.6	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-2.2	1.9	-2.5	
Commodity-using technical and taste change	*ac*	-29.0	-33.5	-33.0	
Contribution to output of commodity-using technical & taste change	*cont_ac*	-29.0	-33.4	-32.9	
Neutral technical change - capital creation	*a2*	-1.3	10.9	-0.0	
Average i-augmenting tech change in capital formation	*ac2_tot*	-19.4	-14.2	-21.4	
Basic price of domestic goods	*p0dom*	24.3	27.4	29.8	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	28.5	41.5	-13.1	
Total supplies of domestic goods	***x0dom***	**28.5**	**41.5**	**-13.1**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	27.9	41.9	-12.6	

Table 33a: Key results for *AccStrucSMD*

Coal - Coal	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Basic price of domestic goods	*p0dom*	-9.6	41.9	10.5	N/A
Total supplies of domestic goods	*x0dom*	10.7	9.5	6.0	
Level of expected rate of return in period t-1	*lev_eror_l*	-1.4%	10.9%	10.9%	
Level of actual rate of return in period t-1	*lev_ror_act_l*	11.1%	29.4%	10.2%	
Level of expected rate of return in period t	***lev_eror***	**4.1%**	**12.3%**	**7.9%**	
Capital creation by using industry	***y***	**51.5**	**117.5**	**11.4**	

Table 33b: Key results for *Coal*

2.3 Commodities where the USAGE Forecast Could Not be Improved

Access Structures for Solid Mineral Development (*AccStrucSMD*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	41 AccStrucSMD: 1689	**Total: 1689**
Proportion	41 AccStrucSMD: 1.000	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	40 AccStrucSMD: 1689	**Total: 1689**
Proportion	40 AccStrucSMD: 1.000	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	0	0	0	**0.00**
Industry Investment	BAS2	1681	0	1681	**1.00**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	0	0	0	**0.00**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	8	0	8	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**1689**	**0**	**1689**	
Source/Total		**1.00**	**0.00**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	**0**	**0**	**0**	**Total: 0**	
Proportion	**0**	**0**	**0**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	25 Coal: 961	23 Copperore: 183	Rest: 537	Total: 1681	**Total: 1.000**
Imported	0	0	0	Total: 0	**Total: 0**
Total	25 Coal: 961	23 Copperore: 183	Rest: 537	**Total: 1681**	
Proportion	**25 Coal: 0.572**	**23 Copperore: 0.109**	**Rest: 0.320**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	0	0	0	**0.00**	**0.00**
Industry Investment	1681	0	1681	**1.00**	**1.00**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	8	0	8	**0.00**	**0.01**
Total	**1689**	**0**	**1689**		
Source/Total	**1.00**	**0.00**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	743	**0.44**	LABOUR	766	**0.84**
Factor	916	**0.54**	CAPITAL	150	**0.16**
Other	23	**0.01**	LAND	0	**0.00**
Production Taxes	6	**0.00**	**Total**	**916**	
Total	**1689**				

Source	c. Intermediate Inputs				Proportion
Domestic	445 EngineerSer: 574	433 MiscRepair: 26	Rest: 136	Total: 736	**Total: 0.991**
Imported	445 EngineerSer: 5	350 ElecteqICE: 2	Rest: 0	Total: 7	**Total: 0.009**
Total	**445 EngineerSer: 580**	**433 MiscRepair: 26**	**Rest: 138**	**Total: 743**	
Proportion	**445 EngineerSer: 0.780**	**433 MiscRepair: 0.035**	**Rest: 0.185**		

Table 34: The key attributes of *AccStrucSMD* in 1998

2.3 Commodities where the USAGE Forecast Could Not be Improved

1. Why did the model erroneously give poor prospects to *AccStrucSMD*?

AccStrucSMD had a USAGE error of 39% versus the smaller trend forecast error of 5%; hence it was situated well above the 45-degree line. The key results for this commodity and its main user (*Coal*) are shown in Tables 33a and 33b. The actual outcome for *AccStrucSMD* output (*x0dom*) was a 41.5% expansion over the 1998-2005 period. This followed 28.5% growth from 1992-1998. The extrapolated trend was therefore a further 34% expansion versus the USAGE forecast of a 13.1% contraction. Table 34 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- This commodity was used solely for investment purposes (Section 3 of Table 34).
- There were no imports or exports (Section 3 of Table 34).
- The Coal industry was the main buyer of the commodity, accounting for 57.2% of sales (Section 4b of Table 34).
- Labour and Engineering Services were the two main production inputs (Sections 6b and 6c of Table 34).

To understand the key drivers behind the erroneous forecast there must be an examination of the Coal industry's expected rate of return (*lev_eror*) and its subsequent investment (*y*). Over the period 1992-1998 investment in *Coal* increased by 51.5% (see bottom of Table 33). This drove the 28.5% rise in *AccStrucSMD* output during that period. In 1998, the capital-weighted average expected rate of return for all industries was 8.9%—for *Coal* it was just 4.1%. With only modest growth of 6.0% predicted for the coal industry, USAGE translated the low rate of return into what turned out to be relatively weak investment (up 11.4%) for the 1998-2005 period. This led the model to incorrectly forecast a 13.1% contraction in output for *AccStrucSMD*. In reality, there was a strong increase in coal prices (*p0dom* increased 41.9%), which led to surging investment in *Coal* (*y* rose 117.5%).

Table 35 shows predicted and actual demand for inputs to capital creation (*x2csi*) in the industries that use *AccStrucSMD*. As this commodity is used only for investment, and there are no imports, the total demanded from domestic sources (*x2csi_dom*) closely reconciles with overall commodity output (*x0dom*). The first row is for the Coal industry. The last two columns effectively show the impact on the growth of *AccStrucSMD* as a result of the investment demand projections. In the case of *Coal*, the weak investment projection was expected to contribute -5 percentage points to the circa 13% reduction in output of *AccStrucSMD*. However, as seen earlier, investment in the coal industry turned out to be quite strong, and made a 53 percentage points contribution to the circa 42% output growth in *AccStrucSMD*. Almost all other *AccStrucSMD*-using industries reduced their demand for the commodity.

Investing Industry (*j*)	Sales (*BAS2*) 1998		Growth in industry demand for *AccStrucSMD* as input to capital creation (*x2csi*)			Weighted contribution to growth of *AccStrucSMD* 1998-2005	
	$M	Share	1992-1998	1998-2005 Actual	1998-2005 Forecast	Actual	Forecast
25 Coal	**961**	**57%**	**26%**	**93%**	**-8%**	**53%**	**-5%**
23 Copperore	183	11%	-41%	-48%	10%	-5%	1%
28 crushedstone	152	9%	178%	-4%	-34%	0%	-3%
32 Chemfertiliz	122	7%	160%	-29%	-45%	-2%	-3%
29 SandGravel	93	6%	196%	-11%	-36%	-1%	-2%
24 Nonferrores	86	5%	9%	-46%	14%	-2%	1%
30 ClayCeramic	43	3%	166%	-38%	-35%	-1%	-1%
22 Ironmetlores	22	1%	83%	-49%	-1%	-1%	0%
31 Nonmetminsrv	20	1%	157%	102%	-42%	1%	0%
Total Demand for Inputs of *AccStrucSMD* into Capital Creation (sum of contributions)						**+42%**	**-13%**

Table 35: Demand for *AccStrucSMD* inputs for capital creation by all *AccStrucSMD*-using industries (*x2csi*)

2. Macro perspective

The general commentary emerging from this sector in the late 1990s was that there was an increase of mining services as an industry in its own right largely due to cost-cutting measures on the part of the mining industry. With specific services contracted out, firms could avoid a large commitment of capital investment. Thus, faced with erratic demand conditions, the sector experienced an increase in flexible conditions of production, including just-in-time methods, which created smoother production, reduced turnover times, and reduced down-time. Flexible work rules involving eradication of union work rules—or at the very least, union cooperation—contributed to mine efficiency.[92] [93] [94] [95]

The outlook for the coal industry (the main purchaser of mining services) adds further colour. According to the EIA's Annual Energy Outlook for 1998 (published January 1997), the forecast for *Coal* was follows:

[92] http://www.answers.com/topic/metal-mining-services, visited 8 September 2009.
[93] http://www.answers.com/topic/coal-mining-services, visited 8 September 2009.
[94] http://www.answers.com/topic/nonmetallic-minerals-services-except-fuels, visited 8 September 2009.
[95] The unusual arrangement of citations in the industry conditions commentary in the opening passage for 'Macro perspective' was prompted by virtually identical discussions at each of the above web pages. Hence, citations appear as a group at the end of the paragraph, rather than repeatedly throughout the passage.

> "Average minemouth prices fall steadily to $13.27 per ton in 2020. Consumption increases about 22 percent, to 26 quadrillion Btu per year, from 1996 levels. Driven by increasing exports and domestic demand, coal production grows 1.1 percent per year to 1,376 million tons in 2020."[96]

The quote above referred to long term price pressures. Discussion about renewable energy was also taking place. The EIA's view was:

> "Renewable fuel use increases by an average of 0.5 percent per year. Total production, including hydropower, rises from 6.9 quadrillion Btu in 1996 to 7.7 quadrillion Btu in 2020, mainly because of increases in industrial biomass consumption."[97]

In the 1999 Annual Energy Outlook (published December 1998) the modeller would have gauged a downward revision to the outlook for coal:

> "Coal prices...drop significantly; increases in productivity, greater reliance on cheaper western coal, and flat labour costs combine to drive down the average minemouth price of coal 30 percent to $12.74 per ton ... In this environment of declining or modestly increasing energy prices, U.S. total consumption rises about 28 percent in 2020 from the 1997 level. Coal consumption rises 0.9 percent annually, reflecting (like natural gas) increased electricity generation." [98]

Figure 15 shows the trade data for *Coal*. Exports were the main component and they were clearly falling from the mid-1990s; overall output (*x0dom*) rose modestly during the period.

3. Conclusion

While the resources sector is cyclical by nature, it probably would have been too tough for the modeller to form a reliable long term view without taking in external projections. Furthermore, as seen in the EIA outlook statements from that time, alternative energy sources to coal were being touted, so the forecast is unlikely to have appeared unreasonable. In reality there was overall strong demand for the coal industry, due mostly to the resources boom that occurred during the latter part of the forecast period. Overall, it would be unlikely that the modeller could have produced a better forecast.

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[96] http://www.eia.doe.gov/emeu/plugs/plaeo98.html, visited 9 September 2009.
[97] http://www.eia.doe.gov/emeu/plugs/plaeo98.html, visited 9 September 2009.
[98] http://www.eia.doe.gov/emeu/plugs/plaeo99.html, visited 9 September 2009.

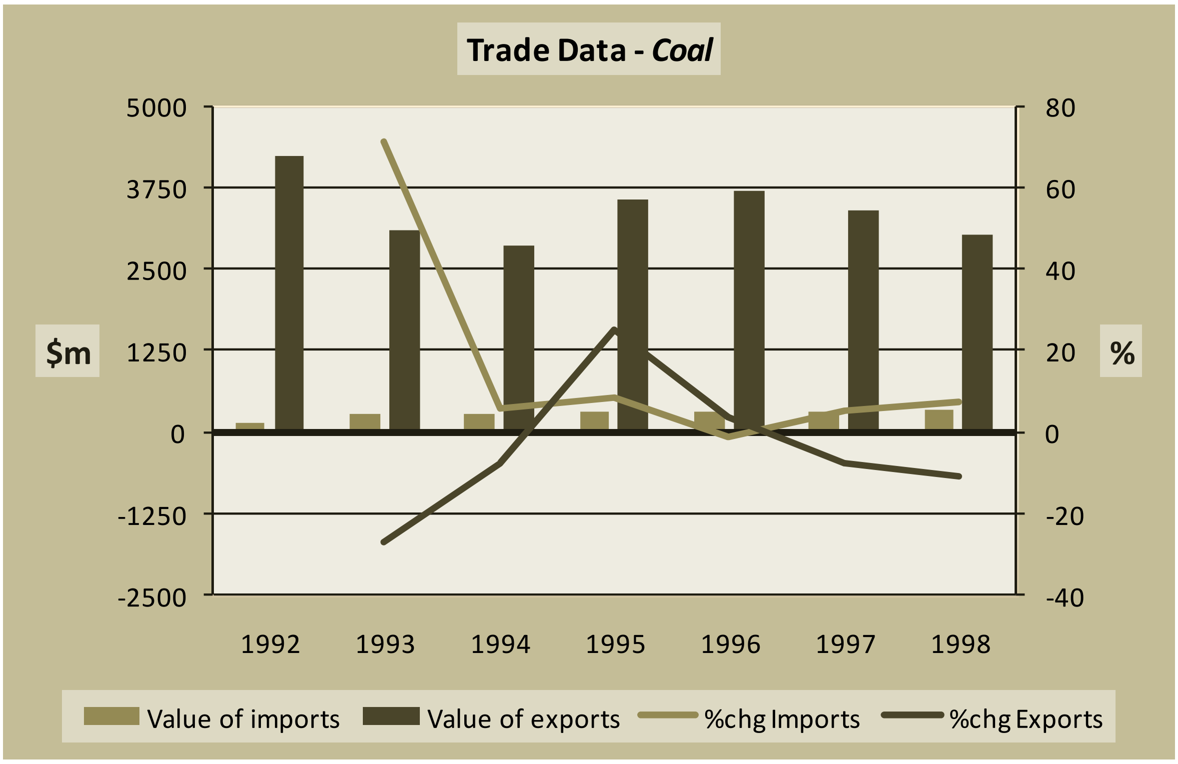


Figure 15: 1992-1998—U.S. trade by the *Coal* industry in nominal dollars

PetNgExplor → Petroleum, Natural Gas, and Solid Mineral Exploration

This comprises parts of four different SIC industries:

- ***1081 Metal Mining Services***

  Establishments primarily engaged in performing metal mining services for others on a contract or fee basis, such as the removal of overburden, strip mining for metallic ores, prospect and test drilling, and mine exploration and development.

- ***1241 Coal Mining Services***

  Establishments primarily engaged in performing coal mining services for others on a contract or fee basis.

- **138: Oil And Gas Field Services**
  - *1381 Drilling Oil and Gas Wells* – Establishments primarily engaged in drilling wells for oil or gas field operations for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.
  - *1382 Oil and Gas Field Exploration Services* – Establishments primarily engaged in performing geophysical, geological, and other exploration services for oil and gas on a contract or fee basis.
  - *1389 Oil and Gas Field Services, Not Elsewhere Classified* – Establishments primarily engaged in performing oil and gas field services, not elsewhere classified, for others on a contract or fee basis.

- ***1481 Nonmetallic Minerals Services, Except Fuels***

  Establishments primarily engaged in the removal of overburden, strip mining, and other services for nonmetallic minerals, except fuels, for others on a contract or fee basis.

PetNgExplor - Petroleum, Natural Gas, and Solid Mineral Exploration	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-7.7	-14.8	-1.4	
All-factor-augmenting technical change	*a1prim*	-9.3	-21.3	-10.3	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-7.5	-18.2	-8.7	
Commodity-using technical and taste change	*ac*	-53.1	-49.7	-58.8	
Contribution to output of commodity-using technical & taste change	*cont_ac*	-53.1	-49.5	-58.6	
Neutral technical change - capital creation	*a2*	-1.3	10.9	-0.0	N/A
Average i-augmenting tech change in capital formation	*ac2_tot*	-24.2	-21.3	-30.6	
Basic price of domestic goods	*p0dom*	10.2	6.1	18.7	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	45.8	43.4	-18.0	
Total supplies of domestic goods	***x0dom***	**45.8**	**43.4**	**-18.0**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	45.1	43.8	-17.6	

Table 36a: Key results for *PetNgExplor*

NatGas - Natural Gas	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Basic price of domestic goods	*p0dom*	12.6	317.4	22.3	N/A
Total supplies of domestic goods	*x0dom*	6.7	-5.8	16.0	
Level of expected rate of return in period t-1	*lev_eror_l*	-3.5%	5.8%	5.8%	
Level of actual rate of return in period t-1	*lev_ror_act_l*	5.9%	29.2%	3.5%	
Level of expected rate of return in period t	*lev_eror*	**1.8%**	**8.3%**	**6.3%**	
Capital creation by using industry	*y*	**139.5**	**75.4**	**29.8**	
***Crude* - Crude Petroleum**	**Model Notation**	**1992-1998 % chg**	**1998-2005 % chg**	**Original Forecast 1998-2005**	**Improved Forecast 1998-2005**
Basic price of domestic goods	*p0dom*	-32.0	371.2	33.9	N/A
Total supplies of domestic goods	*x0dom*	-13.1	-15.9	-9.5	
Level of expected rate of return in period t-1	*lev_eror_l*	-1.8%	4.8%	4.8%	
Level of actual rate of return in period t-1	*lev_ror_act_l*	4.9%	26.3%	0.4%	
Level of expected rate of return in period t	*lev_eror*	**1.1%**	**6.8%**	**3.4%**	
Capital creation by using industry	*y*	**47.6**	**65.1**	**-7.1**	

Table 36b: Key results for *NatGas* and *Crude*

1. Why did the model erroneously give poor prospects to *PetNgExplor*?

PetNgExplor had a USAGE error of 42% versus the smaller trend forecast error of 9%; hence it was situated well above the 45-degree line. The key results for this commodity and its main users (*NatGas* and *Crude*) are shown in Tables 36a and 36b. These industries use *PetNgExplor* to create capital for future production. The actual outcome for *PetNgExplor* output (*x0dom*) was a 43.4% expansion over the 1998-2005 period. This followed 45.8% growth from 1992-1998. The extrapolated trend was therefore a further 55% expansion versus the USAGE forecast of an 18.0% contraction. Table 37 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- Virtually all output was sold to investors (97%) (Section 3 of Table 37).
- There were two main buyers; Natural Gas (52.3%) and Crude Petroleum (46.6%) (Section 4b of Table 37).
- There were no imports or exports (Section 3 of Table 37).
- Labour was by far the main input cost (Section 6b of Table 37).

Petroleum, Natural Gas, and Solid Mineral Exploration (*PetNgExplor*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	40 PetNgExplor: 2543	**Total: 2543**
Proportion	40 PetNgExplor: 2543	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	39 PetNgExplor: 2543	**Total: 2543**
Proportion	39 PetNgExplor: 2543	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	58	0	58	**0.02**
Industry Investment	BAS2	2472	0	2472	**0.97**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	0	0	0	**0.00**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	12	0	12	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**2543**	**0**	**2543**	
Source/Total		**1.00**	**0.00**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production	BAS1	Proportion
Domestic	40 PetNgExplor: 58	Total: 58	**Total: 1.000**
Imported	0	Total: 0	**Total: 0**
Total	**40 PetNgExplor: 58**	**Total: 58**	
Proportion	**40 PetNgExplor: 1.000**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	27 NatGas: 1292	26 Crude: 1153	Rest: 28	Total: 2472	**Total: 1.000**
Imported	0	0	0	Total: 0	**Total: 0**
Total	27 NatGas: 1292	26 Crude: 1153	Rest: 28	**Total: 2472**	
Proportion	**27 NatGas: 0.523**	**26 Crude: 0.466**	**Rest: 0.011**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	58	0	58	**0.02**	**0.02**
Industry Investment	2472	0	2472	**0.97**	**0.97**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	12	0	12	**0.00**	**0.01**
Total	**2543**	**0**	**2543**		
Source/Total	**1.00**	**0.00**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	364	**0.14**	LABOUR	1780	**0.84**
Factor	2128	**0.84**	CAPITAL	348	**0.16**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	50	**0.02**	**Total**	**2128**	
Total	**2543**				

Source	c. Intermediate Inputs				Proportion
Domestic	39 PetNgExplor: 58	194 PetrolRefin: 36	Rest: 240	Total: 334	**Total: 0.918**
Imported	285 ConstMachin: 11	238 BlastFurnace: 5	Rest: 14	Total: 30	**Total: 0.082**
Total	**39 PetNgExplor: 58**	**194 PetrolRefin: 39**	**Rest: 267**	**Total: 364**	
Proportion	**39 PetNgExplor: 0.160**	**194 PetrolRefin: 0.106**	**Rest: 0.734**		

Table 37: The key attributes of *PetNgExplor* in 1998

To understand the key drivers behind the erroneous forecast there must be an examination of the Natural Gas and Crude Petroleum industries' expected rates of return (*lev_eror*) and subsequent investment (*y*). Over the period 1992-1998 investment in *NatGas* increased by 139.5%, while investment in *Crude* rose 47.6% (see Table 33b). This drove the 45.8% rise in *PetNgExplor* output during that period. In 1998, the capital-weighted average expected rate of return for all industries was 8.9%—for *NatGas* and *Crude* it was 1.8% and 1.1%, respectively. With growth rates of 16.0% predicted for *NatGas* and -9.5% for *Crude*, USAGE translated the low expected rates of return into a vast slowdown in the pace of investment overall across those two industries for the 1998-2005 period. In fact, investment was predicted to be negative in the Crude Petroleum industry. This led the model to incorrectly forecast an 18.0% contraction in output for *PetNgExplor*.

In reality, there was a huge spike in natural gas prices (*p0dom* increased 317.4%) as the industry was starting to benefit from market deregulation in the early 1990s. This led to stronger than expected investment in *NatGas* (*y* rose 75.4%). Crude petroleum prices rose stronger still—up 371.2%—which led to a 65.1% increase in investment as opposed to the predicted contraction of 7.1%.

2. Macro perspective

Most of the discussion in the section relating to *AccStructSMD* applies here, except the focus is on exploration rather than development. As has been discussed, it is not easy to forecast commodity cycles without the expertise of dedicated outlook providers. Again turning to the EIA's Annual Energy Outlook for 1998 (published December 1997), it is found that total U.S. energy consumption was projected to increase 26 percent by 2020 from its 1996 level.[99] Looking at petroleum and natural gas, the EIA was predicting:

> "**Petroleum:** World average crude oil prices rise in the reference case to $22.32 per barrel (1996 dollars) in 2020. Global demand reaches 117 million barrels per day (up from about 71 million barrels per day in 1996). U.S. crude oil production declines 1.1 percent per year to 4.9 million barrels per day in 2020, while demand for petroleum products grows 1.2 percent per year. The share of petroleum consumption met by net imports rises from 46 percent in 1996 to 66 percent in 2020.
>
> **Natural gas:** The average wellhead price of natural gas rises to $2.54 per thousand cubic feet as demand increases by 1.6 percent per year. Production increases 44 percent to

[99] http://www.eia.doe.gov/emeu/plugs/plaeo98.html, visited 9 September 2009.

> 27 trillion cubic feet and net imports rise more than 80 percent to 4.9 trillion cubic feet in 2020. Consumption by electricity generators more than triples, to over 10 quadrillion Btu in 2020, as does the natural-gas-fired share of electricity generation (excluding cogenerators), which reaches 31 percent in 2020."[100]

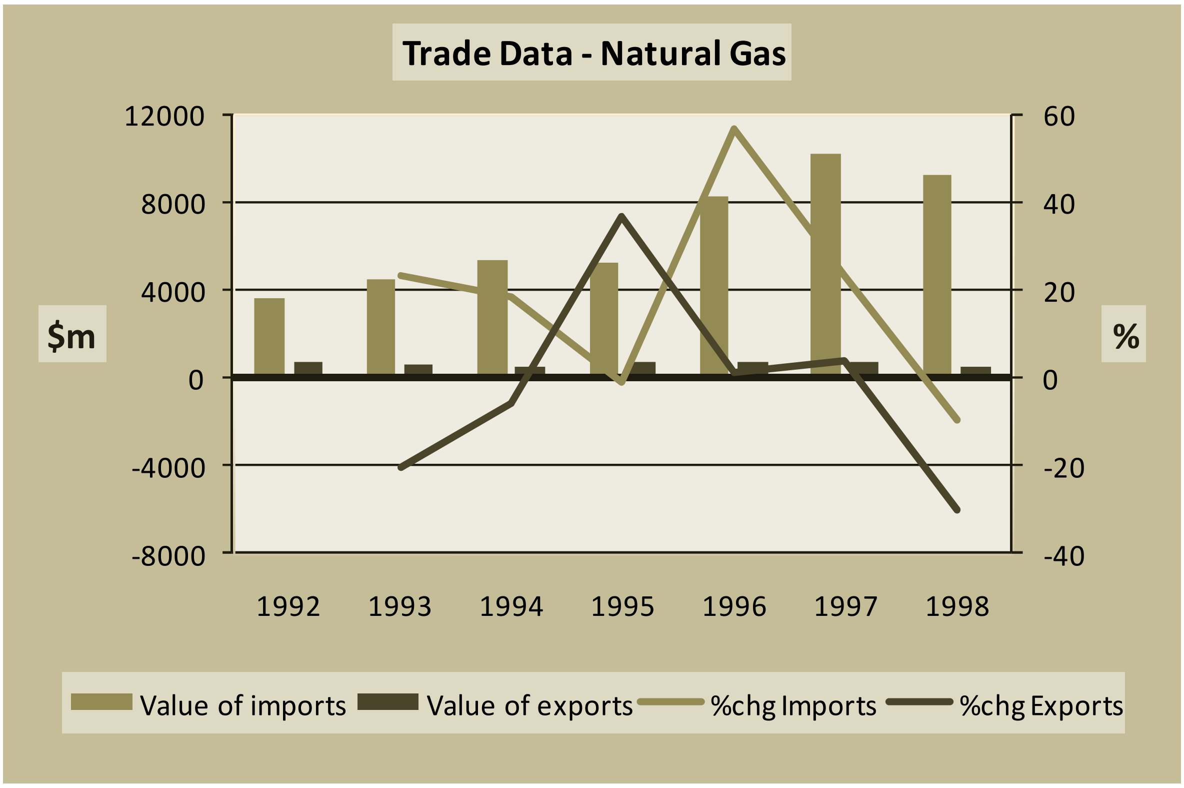
The forecasts were then updated in the Annual Energy Outlook for 1999 (published December 1998):

> "The AEO99 reference case projects U.S. average wellhead prices of natural gas to rise 0.8 percent per year on average through 2020, reaching $2.68 per thousand cubic feet ... In this environment of declining or modestly increasing energy prices ... Natural gas consumption rises 1.7 percent per year...with the greatest gains occurring in the electricity generating sector, where the natural gas share expands from 14 percent to 33 percent by 2020. Petroleum consumption increases 1.2 percent per year, led by continued growth in transportation demand."[101]

3. Conclusion

The EIA forecasts can hardly be interpreted as being bullish. In addition, Figure 16 shows the trade data for the main users of *PetNgExplor*. In particular, falling import demand for Natural Gas and Crude Petroleum can be seen. From a trade balance perspective, exports were relatively insignificant for both industries.[102] Figure 17 shows that crude oil prices were trending downward throughout 1997 and 1998 and prior to this crude oil had traded within a relatively narrow band. Overall, Figures 16 and 17 indicate that the key users of *PetNgExplor* were faced with lower prices and weakening demand. It is likely that the modeller would have been satisfied with a weak forecast for the commodity. Figure 18 shows the sharp reversal in oil prices post-1998. Overall, it would be unlikely that the modeller could have produced a better forecast.

[100] http://www.eia.doe.gov/emeu/plugs/plaeo98.html, visited 9 September 2009.
[101] http://www.eia.doe.gov/emeu/plugs/plaeo99.html, visited 9 September 2009.
[102] In the case of Crude we have not shown export data as exports were small and growth rates were very volatile.



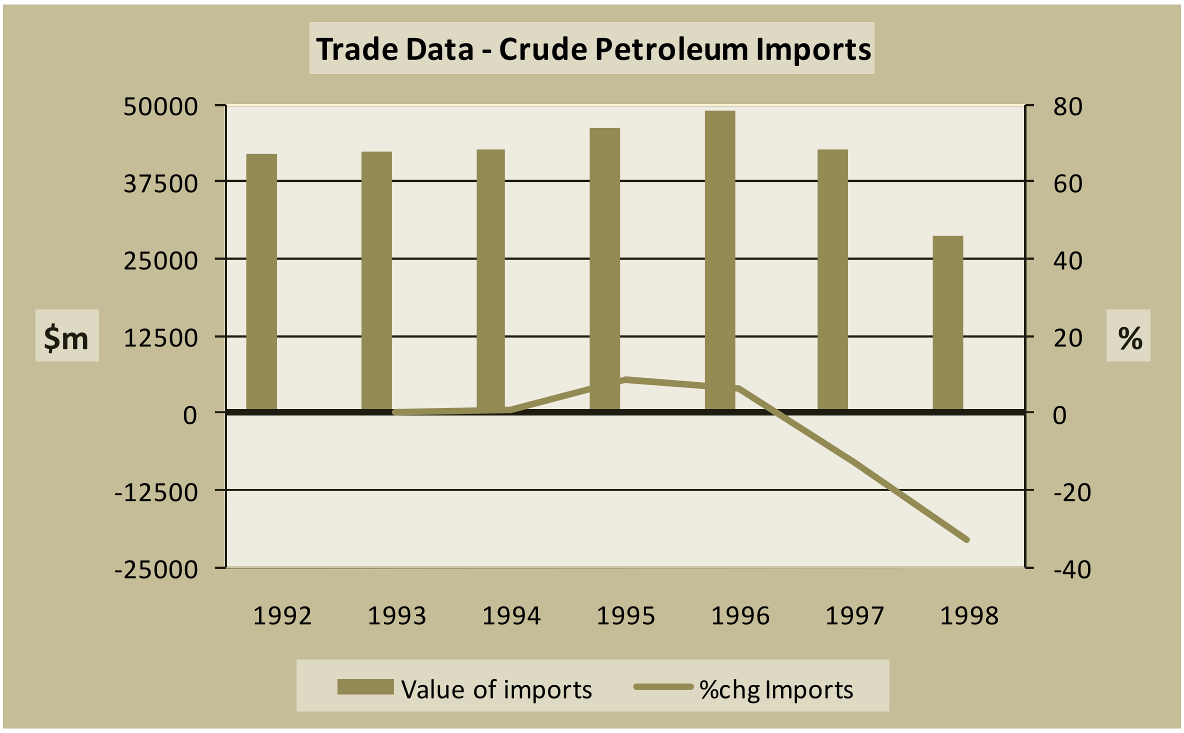


Figure 16: 1992-1998—U.S. trade by the Natural Gas industry and Crude Petroleum imports

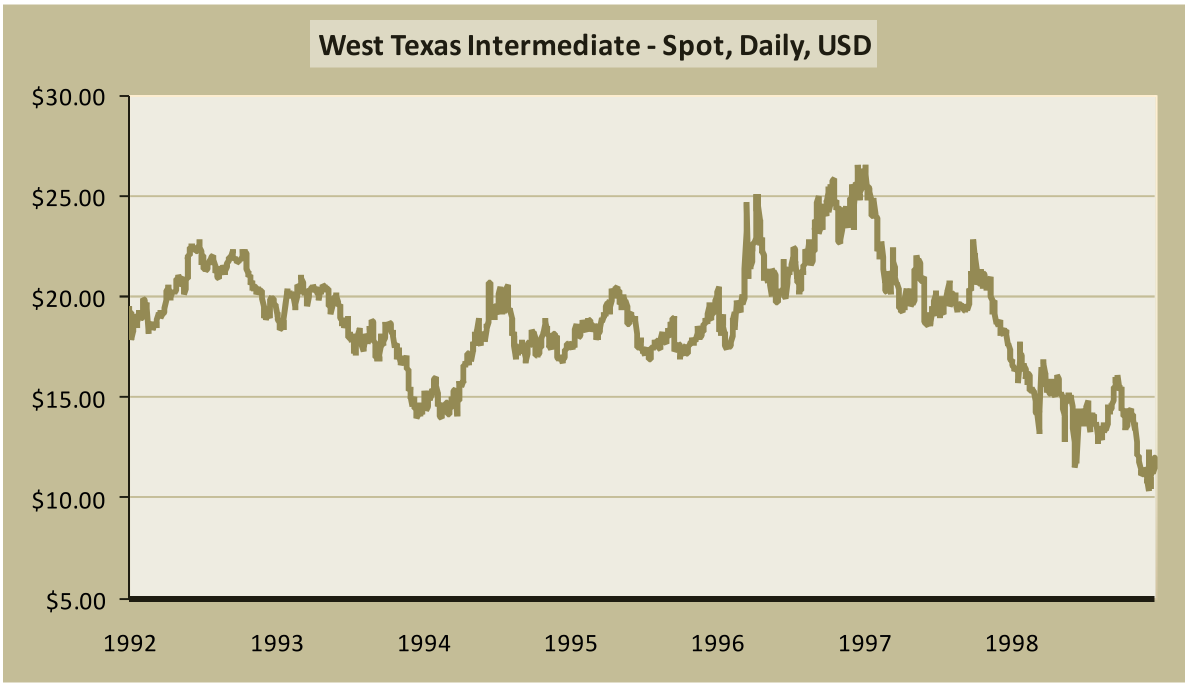


Figure 17: Crude oil prices from 1 January 1992 to 31 December 1998 via NYMEX *(source: IRESS)*

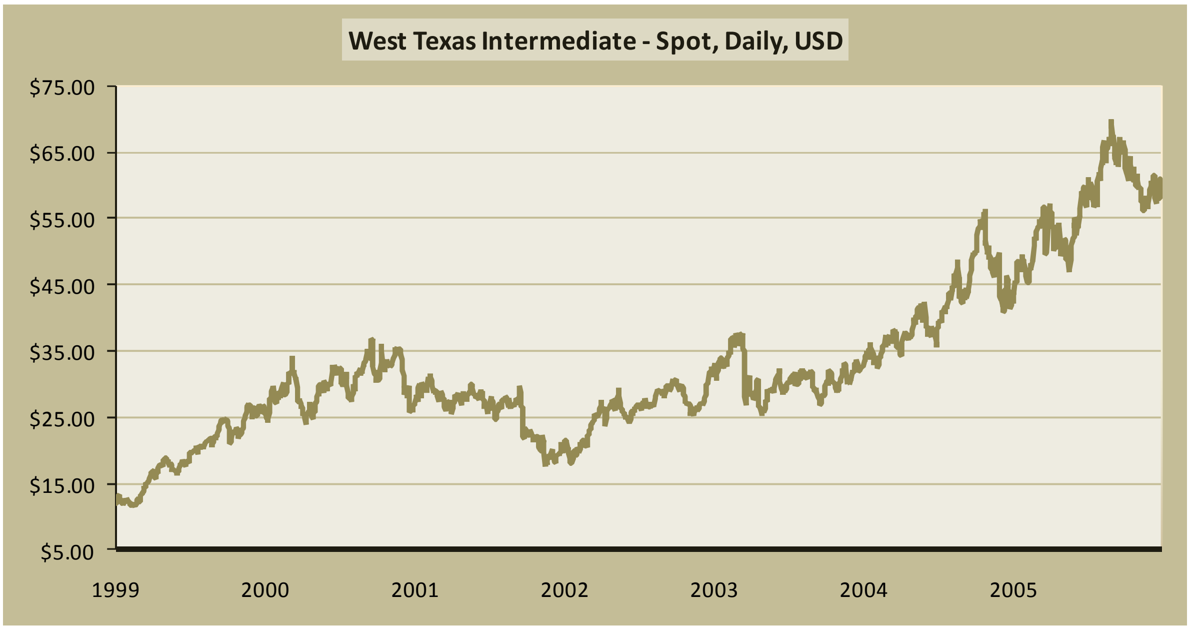


Figure 18: Crude oil prices from 1 January 1999 to 31 December 2005 via NYMEX *(source: IRESS)*

PetNgDrill → Petroleum & Natural Gas Well Drilling (SIC 138)

- 138: Oil And Gas Field Services
  - *1381 Drilling Oil and Gas Wells* – Establishments primarily engaged in drilling wells for oil or gas field operations for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.
  - *1382 Oil and Gas Field Exploration Services* – Establishments primarily engaged in performing geophysical, geological, and other exploration services for oil and gas on a contract or fee basis.
  - *1389 Oil and Gas Field Services, Not Elsewhere Classified* – Establishments primarily engaged in performing oil and gas field services, not elsewhere classified, for others on a contract or fee basis.

***PetNgDrill* - Petroleum & Natural Gas Well Drilling**	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-11.3	-8.5	-6.8	N/A
All-factor-augmenting technical change	*a1prim*	-30.8	-20.3	-34.3	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-22.1	-14.6	-25.3	
Commodity-using technical and taste change	*ac*	-52.5	-47.8	-58.2	
Contribution to output of commodity-using technical & taste change	*cont_ac*	-52.5	-47.6	-58.0	
Neutral technical change - capital creation	*a2*	-1.3	10.9	-0.1	
Average i-augmenting tech change in capital formation	*ac2_tot*	-23.2	-18.4	-29.6	
Basic price of domestic goods	*p0dom*	8.6	18.1	9.7	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	49.8	45.3	-14.9	
Total supplies of domestic goods	***x0dom***	**49.8**	**45.3**	**-14.9**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	49.1	45.8	-14.5	

Table 38a: Key results for *PetNgDrill*

***NatGas* - Natural Gas**	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Basic price of domestic goods	*p0dom*	12.6	317.4	22.3	N/A
Total supplies of domestic goods	*x0dom*	6.7	-5.8	16.0	
Level of expected rate of return in period t-1	*lev_eror_l*	-3.5%	5.8%	5.8%	
Level of actual rate of return in period t-1	*lev_ror_act_l*	5.9%	29.2%	3.5%	
Level of expected rate of return in period t	***lev_eror***	**1.8%**	**8.3%**	**6.3%**	
Capital creation by using industry	***y***	**139.5**	**75.4**	**29.8**	
***Crude* - Crude Petroleum**	**Model Notation**	**1992-1998 % chg**	**1998-2005 % chg**	**Original Forecast 1998-2005**	**Improved Forecast 1998-2005**
Basic price of domestic goods	*p0dom*	-32.0	371.2	33.9	N/A
Total supplies of domestic goods	*x0dom*	-13.1	-15.9	-9.5	
Level of expected rate of return in period t-1	*lev_eror_l*	-1.8%	4.8%	4.8%	
Level of actual rate of return in period t-1	*lev_ror_act_l*	4.9%	26.3%	0.4%	
Level of expected rate of return in period t	***lev_eror***	**1.1%**	**6.8%**	**3.4%**	
Capital creation by using industry	***y***	**47.6**	**65.1**	**-7.1**	

Table 38b: Key results for *NatGas* and *Crude*

1. Why did the model erroneously give poor prospects to *PetNgDrill*?

PetNgDrill had a USAGE error of 41% versus the smaller trend forecast error of 11%; hence it was situated well above the 45-degree line. The key results for this commodity and its main users (*NatGas* and *Crude*) are shown in Tables 38a and 38b. These industries use *PetNgDrill* to create capital for future production. The actual outcome for *PetNgDrill* output (*x0dom*) was a 45.3% expansion over the 1998-2005 period. This followed 49.8% growth from 1992-1998. The extrapolated trend was therefore a further 60% expansion versus the USAGE forecast of a 14.9% contraction. Table 39 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- Virtually all output was sold to investors (99%) (Section 3 of Table 39).
- There were two main buyers; Natural Gas (52.3%) and Crude Petroleum (46.6%) (Section 4b of Table 39).
- There were no imports or exports (Section 3 of Table 39).
- Labour was by far the main input cost (Section 6b of Table 39).

The same analysis used in explaining the nature of the error for *PetNgExplor* applies here. In particular, *PetNgDrill* derives its demand solely from investment demand by industries in the resource sector—mainly Natural Gas (*NatGas*) and Crude Petroleum (*Crude*). Over the period 1992-1998 investment in *NatGas* more than doubled, while in *Crude* it grew solidly. This drove the strong rise in *PetNgDrill* output. In 1998, the capital-weighted average expected rate of return for all industries was considerably higher than for *NatGas* and *Crude*. With only modest growth predicted for *NatGas* and a decline in *Crude*, USAGE translated the low expected rates of return into a vast slowdown in investment overall across those industries. In fact, investment was predicted to be negative in *Crude*. On this basis the model forecast a 14.9% contraction in output for *PetNgDrill*. In reality, there was a huge spike in natural gas prices. This led to stronger than expected investment in *NatGas*. Crude petroleum prices rose stronger still, which led to an acceleration in investment demand growth as opposed to the predicted modest contraction.

Petroleum & Natural Gas Well Drilling (*PetNgDrill*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	39 PetNgDrill: 18878	**Total: 18878**
Proportion	39 PetNgDrill: 1.000	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	38 PetNgDrill: 18878	**Total: 18878**
Proportion	38 PetNgDrill: 1.000	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	113	0	113	**0.01**
Industry Investment	BAS2	18678	0	18678	**0.99**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	0	0	0	**0.00**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	87	0	87	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**18878**	**0**	**18878**	
Source/Total		**1.00**	**0.00**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production	BAS1	Proportion
Domestic	39 PetNgDrill: 113	Total: 113	**Total: 1.000**
Imported	0	Total: 0	**Total: 0**
Total	**39 PetNgDrill: 113**	**Total: 113**	
Proportion	**39 PetNgDrill: 1.000**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	27 NatGas: 9763	26 Crude: 8706	Rest: 208	Total: 18678	**Total: 1.000**
Imported	0	0	0	Total: 0	**Total: 0**
Total	27 NatGas: 9763	26 Crude: 8706	Rest: 208	**Total: 18678**	
Proportion	**27 NatGas: 0.523**	**26 Crude: 0.466**	**Rest: 0.011**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	113	0	113	**0.01**	**0.01**
Industry Investment	18678	0	18678	**0.99**	**0.99**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	87	0	87	**0.00**	**0.01**
Total	**18878**	**0**	**18878**		
Source/Total	**1.00**	**0.00**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	5366	**0.28**	LABOUR	10184	**0.78**
Factor	13139	**0.70**	CAPITAL	2954	**0.23**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	373	**0.02**	**Total**	**13139**	
Total	**18878**				

Source	c. Intermediate Inputs				Proportion
Domestic	175 IndustChem: 569	194 PetrolRefin: 455	Rest: 3512	Total: 4535	**Total: 0.845**
Imported	175 IndustChem: 215	285 ConstMachin: 180	Rest: 437	Total: 831	**Total: 0.155**
Total	**175 IndustChem: 784**	**194 PetrolRefin: 492**	**Rest: 4090**	**Total: 5366**	
Proportion	**175 IndustChem: 0.146**	**194 PetrolRefin: 0.092**	**Rest: 0.762**		

Table 39: The key attributes of *PetNgDrill* in 1998

2. Macro perspective

The discussion in the analogous section relating to *PetNgExplor* applies here, except the focus is on oil and gas well drilling rather than exploration. Again turning to the EIA's Annual Energy Outlook for 1998 (published December 1997), it is found that total U.S. energy consumption was projected to increase just 26 percent by 2020 from its 1996 level, with world average crude oil prices rising (in the reference case) to $22.32 per barrel (1996 dollars) in 2020. As expected, growing demand and falling production would be met by rising net imports. The forecasts were then updated in the Annual Energy Outlook for 1999 (published December 1998) and again did not predict an impending surge in energy prices. The trade data for the main users of *PetNgExplor* showed falling import demand for Natural Gas and Crude Petroleum. Separately, it is noted that crude oil prices were trending downward throughout 1997 and 1998 and prior to this had traded within a relatively narrow band.

3. Conclusion

The difficulty in forecasting commodity cycles without the expertise of dedicated outlook providers is reiterated. However, even with expert input it seems that extra caution should be placed on such forecasts. On balance, it is likely that the modeller would have been satisfied with a weak forecast for the commodity as there was nothing to suggest good prospects. A cursory glance at oil prices post-1998 shows the sudden, sharp reversal that occurred (see Figure 18). In the case of natural gas prices, there was a huge spike post-1998, perhaps as the industry began to benefit from market deregulation in the early 1990s. Again, this would have been difficult to predict. Overall, it would be unlikely that the modeller could have produced a better forecast.

Nonferrores → Nonferrous Metal Ores, except Copper

This comprises 4 different SIC industries:

- *1031 Lead and Zinc Ores*

  Establishments primarily engaged in mining, milling, or otherwise preparing lead ores, zinc ores, or lead-zinc ores.

- 104: Gold And Silver Ores
  - *1041 Gold Ores*
  - *1044 Silver Ores*

- *1081 Metal Mining Services*

  Establishments primarily engaged in performing metal mining services for others on a contract or fee basis, such as the removal of overburden, strip mining for metallic ores, prospect and test drilling, and mine exploration and development.

- *1094 Uranium-Radium-Vanadium Ores*

  Establishments primarily engaged in mining, milling, or otherwise preparing uranium-radium-vanadium ores.

Nonferrores - Nonferrous Metal Ores, except Copper	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-0.5	7.2	2.7	N/A
All-factor-augmenting technical change	*a1prim*	8.6	14.9	8.8	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	2.6	5.0	3.0	
Combined change in household tastes	*a3com*	4.2	-2.7	5.0	
Commodity-using technical and taste change	*ac*	14.6	3.9	15.6	
Contribution to output of commodity-using technical & taste change	*cont_ac*	5.8	1.8	6.8	
Vertical shift of the export demand curve	*cont_fepc*	9.1	20.0	10.7	
Import/domestic twist by commodity	*ftwist_src*	-2.4	-46.5	-1.6	
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	0.1	3.8	0.2	
Twist caused by strong growth	*twist_eff*	-6.5	-15.4	-1.4	
Basic price of domestic goods	*p0dom*	25.5	59.4	27.7	
Basic price of imported goods	*p0imp*	7.3	7.3	20.5	
Ratio of basic prices: domestic to import	*fpdm*	17.0	48.8	6.0	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	9.8	-25.3	15.2	
Total supplies of domestic goods	***x0dom***	**-4.5**	**-38.0**	**9.2**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	4.7	-28.2	13.4	
Total supplies of imported goods	*x0imp*	61.1	17.1	56.4	
Household demands undifferentiated by source	*x3*	28.1	21.5	21.7	
Export volumes	*x4*	-12.0	-45.3	6.9	
Change in net import share to domestic output	*dtradeshare*	5.6	7.1	2.3	

Table 40: Key results for *Nonferrores* results

Nonferrous Metal Ores, except Copper (*Nonferrores*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	24 Nonferrores: 6238	Rest: 40	**Total: 6278**
Proportion	24 Nonferrores: 0.994	Rest: 0.006	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	23 Nonferrores: 6238	Rest: 31	**Total: 6269**
Proportion	23 Nonferrores: 0.995	Rest: 0.005	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	2680	183	2864	**0.43**
Industry Investment	BAS2	75	7	82	**0.01**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	3492	0	3492	**0.56**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	30	0	30	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**6278**	**190**	**6468**	
Source/Total		**0.97**	**0.03**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	24 Nonferrores: 1856	23 Copperore: 264	Rest: 560	Total: 2680	**Total: 0.936**
Imported	24 Nonferrores: 61	243 BlastFurnace: 59	Rest: 64	Total: 183	**Total: 0.064**
Total	**24 Nonferrores: 1918**	**23 Copperore: 270**	**Rest: 676**	**Total: 2864**	
Proportion	**24 Nonferrores: 0.670**	**23 Copperore: 0.094**	**Rest: 0.236**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	421 Electricserv: 61	470 Hospitals: 8	Rest: 7	Total: 75	**Total: 0.914**
Imported	421 Electricserv: 6	470 Hospitals: 1	Rest: 1	Total: 7	**Total: 0.086**
Total	421 Electricserv: 66	470 Hospitals: 9	Rest: 7	**Total: 82**	
Proportion	**421 Electricserv: 0.806**	**470 Hospitals: 0.105**	**Rest: 0.089**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	2743	194	2937	**0.95**	**0.89**
Industry Investment	107	11	118	**0.04**	**0.04**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	30	0	30	**0.01**	**0.01**
Total	**2880**	**204**	**3085**		
Source/Total	**0.93**	**0.07**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	3651	**0.58**	LABOUR	1473	**0.66**
Factor	2218	**0.35**	CAPITAL	745	**0.34**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	400	**0.06**	**Total**	**2218**	
Total	**6269**				

Source	c. Intermediate Inputs				Proportion
Domestic	23 Nonferrores: 1881	175 IndustChem: 187	Rest: 1271	Total: 3339	**Total: 0.915**
Imported	285 ConstMachin: 82	175 IndustChem: 63	Rest: 166	Total: 311	**Total: 0.085**
Total	**23 Nonferrores: 1944**	**175 IndustChem: 250**	**Rest: 1457**	**Total: 3651**	
Proportion	**23 Nonferrores: 0.532**	**175 IndustChem: 0.069**	**Rest: 0.399**		

Table 41: The key attributes of *Nonferrores* in 1998

1. Why did the model erroneously give good prospects to *Nonferrores*?

Nonferrores had a USAGE error of 75% versus the smaller trend forecast error of 52%; hence it was situated well above the 45-degree line. The key results for this commodity are shown in Table 40. The actual outcome for *Nonferrores* output (*x0dom*) was a 38.0% decline over the 1998-2005 period. This followed a 4.5% contraction from 1992-1998. The extrapolated trend was therefore a further 5% output reduction versus the USAGE forecast of a 9.2% expansion. Table 41 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- Producers purchased 43% of domestic output, and investors 1% (Section 3 of Table 41).
- Intermediate demand was driven by *Nonferrores* at 67.0% of total purchases, followed by *Copperore* at 9.4% (Section 4a of Table 41).
- 56% of production was exported (Section 3 of Table 41).
- Imports made up just 7% of the domestic market (Section 5 of Table 41).

There were two main factors contributing to the erroneous forecast. Firstly, despite a larger than projected outward shift (20.0% versus 10.7%) of the export-demand curve (*cont_fepc*), the strong rise in export prices had an overwhelmingly negative impact on volumes—the basic price of domestic goods (*p0dom*) rose by more than double the projected amount (57.4% versus 27.7%). Secondly, Table 42 shows that intermediate use of *Nonferrores* was much lower than expected. The *Nonferrores* industry purchased a significant portion of its own output. The 30% fall in intermediate demand versus the predicted 13% increase explains why *x0dom_dom* fell by as much as it did.

Purchasing Industry (*j*)	Sales (*BAS1*) 1998		Growth in industry demand for *Nonferrores* as input to production (*x1csi*)			Weighted contribution to growth of *Nonferrores* 1998-2005	
	$M	Share	1992-1998	1998-2005 Actual	1998-2005 Forecast	Actual	Forecast
24 Nonferrores	**1856**	**69%**	**2%**	**-36%**	**15%**	**-24.9%**	**10.4%**
23 Copperore	264	10%	-3%	-19%	9%	-1.9%	0.9%
254 PrimNfMetnec	190	7%	2%	-26%	7%	-1.8%	0.5%
243 BlastFurnace	187	7%	33%	-7%	11%	-0.5%	0.8%
179 IndustChem	53	2%	3%	-11%	-6%	-0.2%	-0.1%
22 Ironmetlores	32	1%	25%	-24%	16%	-0.3%	0.2%
Rest	99	4%	1%	-14%	13%	-0.5%	0.5%
Total Demand for Inputs of *Nonferrores* into Production (sum of contributions)						**-30%**	**+13%**

Table 42: Intermediate Demand composition for *Nonferrores* inputs by *Nonferrores*-using industries

2. Macro perspective

At noted in previous discussions, metals and mining-related commodities exhibit volatile cyclical demand patterns. This was certainly the case from 1992 to 1998 for *Nonferrores*. Figure 19 maps gold and silver prices. It shows that gold had been trending downwards from about 1996, whereas silver, exhibited a sharp price spike in early 1998. Gold prices moved sharply higher in the forecast period. Figure 20 highlights the volatility of the trade data, with very large movements in the growth rate of the dollar value of exports.

3. Conclusion

This is another example of where the modeller is unlikely to have been able to do much better in forecast. As mentioned previously, the modeller would have been hard pressed to predict the resources boom that had a very big impact on the tail end of the forecast. Furthermore, exports were the largest share of domestic output. The value of exports for the commodity often moved quite dramatically during the period from 1992 to 1998.

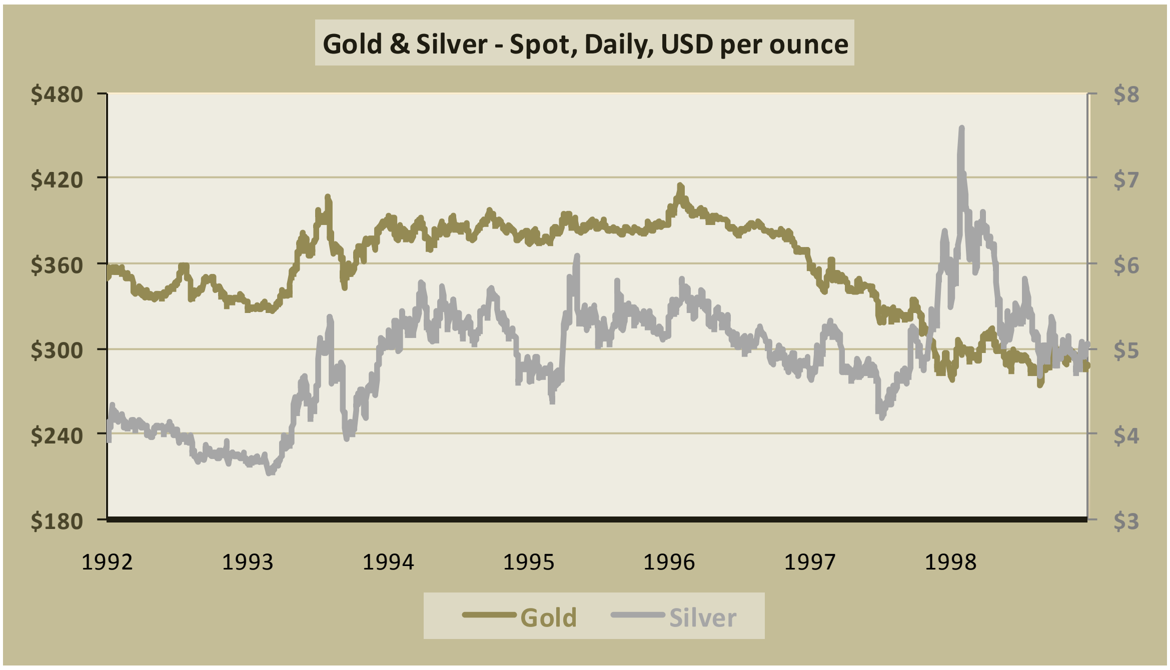


Figure 19: Spot gold and spot silver prices from 1 January 1992 to 31 December 1998 *(source: IRESS)*

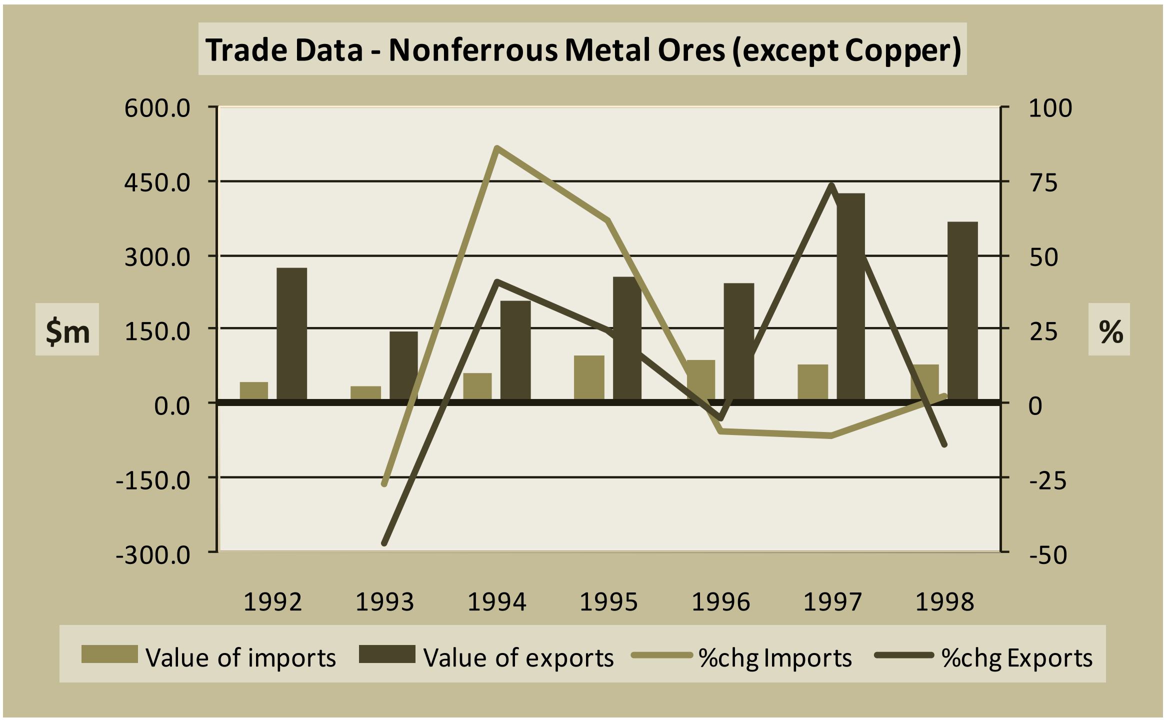


Figure 20: 1992-1998—U.S. trade by the *Nonferrores* industry

Copperore → Copper Ores (SIC 1021)

Part of Major Group 10: Metal Mining, this covers establishments primarily engaged in mining, milling, or otherwise preparing copper ores. This industry also includes establishments primarily engaged in the recovery of copper concentrates by precipitation and leaching of copper ore.

Copperore - Copper Ores	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-4.4	-6.1	0.9	N/A
All-factor-augmenting technical change	*a1prim*	6.4	-17.1	5.9	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	2.9	-10.4	3.4	
Combined change in household tastes	*a3com*	6.7	-12.8	7.8	
Commodity-using technical and taste change	*ac*	26.2	-2.7	26.6	
Contribution to output of commodity-using technical & taste change	*cont_ac*	21.9	-2.6	26.0	
Vertical shift of the export demand curve	*cont_fepc*	-20.6	0.9	0.0	
Import/domestic twist by commodity	*ftwist_src*	-7.0	-81.8	-3.8	
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	0.3	4.1	0.4	
Twist caused by strong growth	*twist_eff*	-8.1	-9.6	-2.3	
Basic price of domestic goods	*p0dom*	37.4	5.6	22.8	
Basic price of imported goods	*p0imp*	7.3	7.3	20.5	
Ratio of basic prices: domestic to import	*fpdm*	28.2	-1.5	1.9	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	5.3	-24.6	6.4	
Total supplies of domestic goods	***x0dom***	**-10.9**	**-18.7**	**5.2**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	3.3	-21.0	5.8	
Total supplies of imported goods	*x0imp*	82.3	-88.3	29.1	
Household demands undifferentiated by source	*x3*	30.6	11.0	25.1	
Export volumes	*x4*	-90.1	127.2	0.8	
Change in net import share to domestic output	*dtradeshare*	14.9	-7.3	1.1	

Table 43: *Copperore* results

1. Why did the model erroneously give good prospects to *Copperore*?

Copperore had a USAGE error of 29% versus the smaller trend forecast error of 7%; hence it was situated well above the 45-degree line. The key results for this commodity are shown in Table 43. The actual outcome for *Copperore* output (*x0dom*) was an 18.7% decline over the 1998-2005 period. This followed a 10.9% contraction from 1992-1998. The extrapolated trend was therefore a further 13% output reduction versus the USAGE forecast of a 5.2% expansion. Table 44 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- Producers purchased 98% of domestic output (Section 3 of Table 44).
- Intermediate demand was driven by Primary smelting and refining of copper (*PrimSmelting*) at 69.0% of total purchases, followed by Industrial inorganic and organic chemicals (*IndustChem*) at 25.2% (Section 4a of Table 44).
- There was just 5% import penetration (Section 5 of Table 44).

2.3 Commodities where the USAGE Forecast Could Not be Improved

Copper Ores (*Copperore*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	23 Copperore: 4110	Rest: 18	**Total: 4129**
Proportion	23 Copperore: 0.996	Rest: 0.004	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	22 Copperore: 4110	21 Ironmetlores: 128	Rest: 20	**Total: 4258**
Proportion	22 Copperore: 0.965	21 Ironmetlores: 0.030	Rest: 0.005	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	4039	212	4251	**0.98**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	0	0	0	**0.00**
Exports	BAS4	70	0	70	**0.02**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	20	0	20	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**4129**	**212**	**4341**	
Source/Total		**0.95**	**0.05**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	252 PrimSmelting: 2784	179 IndustChem: 1020	Rest: 235	Total: 4039	**Total: 0.950**
Imported	252 PrimSmelting: 147	179 IndustChem: 53	Rest: 12	Total: 212	**Total: 0.050**
Total	**252 PrimSmelting: 2931**	**179 IndustChem: 1073**	**Rest: 247**	**Total: 4251**	
Proportion	**252 PrimSmelting: 0.690**	**179 IndustChem: 0.252**	**Rest: 0.058**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	4142	221	4363	**1.00**	**0.95**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	0	0	0	**0.00**	**0.00**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	20	0	20	**0.00**	**0.01**
Total	**4162**	**221**	**4383**		
Source/Total	**0.95**	**0.05**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	1596	**0.38**	LABOUR	564	**0.23**
Factor	2485	**0.58**	CAPITAL	1920	**0.77**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	178	**0.04**	**Total**	**2485**	
Total	**4258**				

Source	c. Intermediate Inputs				Proportion
Domestic	23 Nonferrores: 266	411 Electricserv: 242	Rest: 902	Total: 1409	**Total: 0.883**
Imported	285 ConstMachin: 56	479 NoncompImps: 29	Rest: 102	Total: 186	**Total: 0.117**
Total	**23 Nonferrores: 272**	**411 Electricserv: 243**	**Rest: 1081**	**Total: 1596**	
Proportion	**23 Nonferrores: 0.171**	**411 Electricserv: 0.152**	**Rest: 0.677**		

Table 44: The key attributes of *Copperore* in 1998

The explanation of this error is similar to that of Asbestos Products in Dixon and Rimmer (2012). Most of the sales of this commodity were to copper manufacturers and chemical producers. In 1992, exports comprised 15% of sales. Between 1992 and 1998 exports slumped by 90%. In the USAGE simulation for 1992-1998, there was a significant inward movement of the foreign demand curve, and this was accompanied by rising export prices. At the same time there was strong growth in imports, albeit off a low base. Output of the commodity between 1992 and 1998 fell by 11%. However, with strong import growth and apparent diversion of exports back to the domestic market, the USAGE simulation for 1992-1998 showed weak growth in supplies on the domestic market (*x0dom_dom*) relative to demands by the using industries. In these circumstances, the model implied that during the period 1992 to 1998 there was *Copperore*-using technical change in the using industries (positive *ac(i)* for *i* = 22). In the forecast for 1998 to 2005, the contribution to output of *Copperore*-using technical change (*cont_ac*) was projected forward. With exports in 1998 at very low levels, the inward movement in the export-demand curve was not projected forward (the position of the export-demand curve was assumed constant), and did not affect the forecast output for *Copperore*. The *Copperore*-using industries in the 1998-2005 forecast showed moderate contractions. This provided some offset to the projected *Copperore*-using technical change, but not enough to predict a contraction in the USAGE forecasts.

2. Macro perspective

In 2000, the U.S. was the world's second largest copper producer and a net importer of copper, obtaining 37 percent of refined copper from abroad—and furthermore:

> "World demand for copper has grown steadily since the late 1970s, but in the late 1990s ambitious copper producers, including many located in Chile, the world's largest copper-producing country, ramped up new mining capacity faster than the market could absorb their production. In addition, economic weakness in Asia and Latin America in the late 1990s left global demand growth at a slower pace than some producers anticipated. As a result, copper supplies ran heavy, and copper prices slumped by as much as 50 percent in the latter half of the 1990s, especially during 1998 and 1999, reaching Great Depression-era levels when adjusted for inflation. Soft prices decimated copper

companies' profits and triggered a frantic round of consolidation among major producers."[103]

Figure 21 shows the downward trend in copper prices from the mid-1990s. By the late 1990s this started to translate into rising stockpiles. Also significant is that in 1998 the U.S. went from being a net exporter to a net importer. (This can be seen in Figure 22.) Furthermore, by 1998 exports became a relatively insignificant component of total sales of domestic output.

3. Conclusion

The longevity of falling prices and the higher stockpiles might have indicated to the modeller that *Copperore* faced a bleak outlook. Hence, one might have mounted the argument that the USAGE forecast of 5.2% growth was somewhat bullish. But given the way copper prices were trending in the late 1990s it is not clear why demand would shift so strongly away from copper—particularly given that price reductions were being driven by boosted mining capacity. The most obvious copper substitutes are aluminium, plastics and fibre. The Primary aluminium industry (*Primaluminum*) was also facing a bleak outlook with USAGE predicting a steady decline in output of that commodity. The various plastics and fibre commodities in USAGE all exhibited relatively modest outlooks. On this basis, it is perhaps arguable that the modeller could have done better. However, counter-arguments would point to the cyclical and volatile nature of this commodity, meaning that the forecast 5.2% expansion over seven years may well not have appeared to be unreasonable (this is the rationale accepted in this thesis for not re-projecting *Copperore*). In all likelihood, any strategy to re-implement forecasts for *Copperore* would have revolved around setting domestic output growth to zero. Hence, the gains from such an exercise would have been minimal.

[103] http://www.answers.com/topic/copper-ores, visited 13 September 2009.

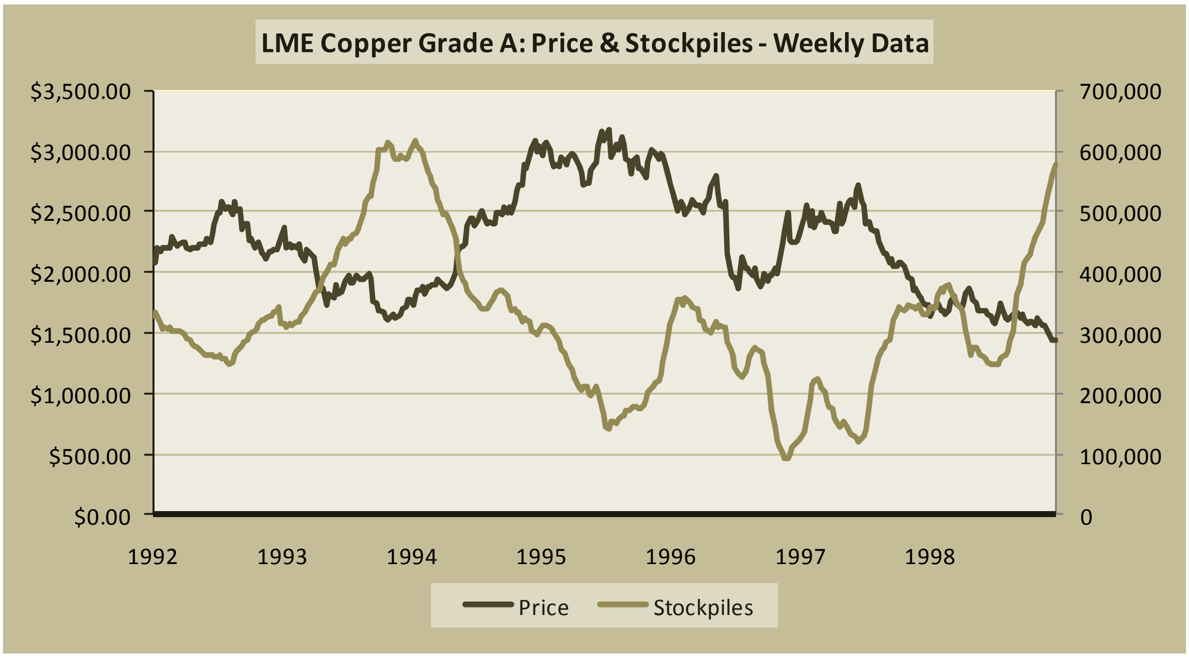


Figure 21: 1992-1998—LME Copper Grade A: Price ($US/tonne) and Stockpiles (tonnes) ***(source: IRESS)***

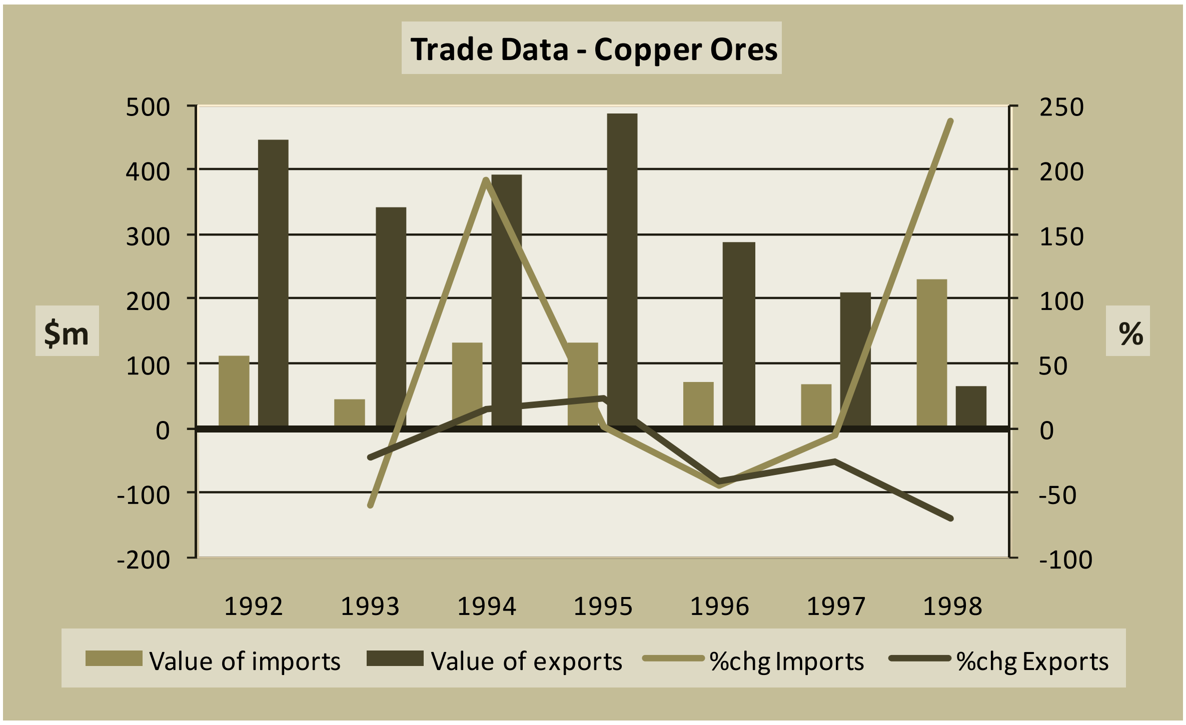


Figure 22: 1992-1998—U.S. trade by the ***Copperore*** **industry in nominal dollars**

CutStone → Cut Stone and Stone Products (SIC 3281)

Part of Major Group 32: Stone, Clay, Glass, And Concrete Products, CutStone covers establishments primarily engaged in cutting, shaping, and finishing granite, marble, limestone, slate, and other stone for building and miscellaneous uses.

CutStone - Cut Stone and Stone Products	Model Notation	1992-1998 % chg	1998-2005 % chg	Original Forecast 1998-2005	Improved Forecast 1998-2005
Average of technical change terms, production	*a*	-5.4	4.1	-2.6	N/A
All-factor-augmenting technical change	*a1prim*	-23.7	33.4	-27.7	
Contribution to costs of all-factor-augmenting technical change	*cont_a1prim*	-12.9	15.5	-14.9	
Combined change in household tastes	*a3com*	5.1	48.9	6.0	
Commodity-using technical and taste change	*ac*	3.6	30.6	4.2	
Contribution to output of commodity-using technical & taste change	*cont_ac*	2.7	22.5	3.2	
Vertical shift of the export demand curve	*cont_fepc*	-0.4	2.4	-0.4	
Import/domestic twist by commodity	*ftwist_src*	105.2	167.4	100.2	
Twist trends impact on non-marg, non-invent domestic demand	*impftwist*	-20.0	-29.9	-22.9	
Twist caused by strong growth	*twist_eff*	-2.2	-2.0	-7.2	
Basic price of domestic goods	*p0dom*	6.3	30.1	15.7	
Basic price of imported goods	*p0imp*	3.1	5.2	16.2	
Ratio of basic prices: domestic to import	*fpdm*	3.1	23.8	-0.4	
Quantity of sales (domestic and imported) in U.S. - Absorption	*x0*	45.3	82.6	18.1	
Total supplies of domestic goods	***x0dom***	**13.9**	**12.2**	**-14.3**	
Quantity of sales of domestically produced in U.S.	*x0dom_dom*	14.0	10.9	-14.2	
Total supplies of imported goods	*x0imp*	103.4	142.6	49.6	
Household demands undifferentiated by source	*x3*	50.6	114.7	25.1	
Export volumes	*x4*	3.6	64.3	-4.6	
Change in net import share to domestic output	*dtradeshare*	34.0	58.8	58.3	

Table 45: *CutStone* results

1. **Why did the model erroneously give poor prospects to *CutStone*?**

CutStone had a USAGE error of 24% versus the smaller trend forecast error of 3%; hence it was situated well above the 45-degree line. The key results for this commodity are shown in Table 45. The actual outcome for *CutStone* output (*x0dom*) was a 12.2% rise over the 1998-2005 period. This followed 13.9% growth from 1992-1998. The extrapolated trend was therefore a further 16% output expansion versus the USAGE forecast of a 14.3% contraction. Table 46 shows the main users, cost structure and other information of interest of the 1998 database used in the forecast. The following observations can be made:

- Producers purchased 60% of domestic output (Section 3 of Table 46).
- Households purchased 37% of domestic output (Section 3 of Table 46).

- Intermediate demand was driven by building and construction industries (Section 4a of Table 46).
- There was 33% import penetration (Section 5 of Table 46).
- Labour was the main factor input cost (Section 6b of Table 46).

From 1992 to 1998 growth in domestic demand for *CutStone* was driven by households. The total rise in household demand for the commodity was 50.6% (see Table 45). Household demand for domestically-produced *CutStone* (*x3cs*) increased 44.8% (this is not shown the results table). Intermediate input demand for the domestically produced commodity (*x1csi*) on the whole was relatively flat during this period. USAGE calculated modest rises in the taste and preference indicators for households and producers (*a3com and cont_ac*), which were projected forward. In the case of households, USAGE predicted total demand (undifferentiated by source) to grow by 25.1% over the seven year forecast horizon. However, household demand for domestically-produced *CutStone* was expected to increase by a slower 14.5%. Where producer demand is concerned, Table 47 shows that USAGE underestimated the growth of the four largest intermediate purchasers of *CutStone*. (The USAGE error was far greater than the trend error for the two largest of these.) Given that production demand was the larger share of output, the model forecast an overall 14.3% reduction in *x0dom* for *CutStone*.

SIC Name	USAGE Commodity	*BAS1* Proportion	x0dom 1998-2005		Above/(Below)
			Actual	Forecast	45° Line
Other new construction	43 OthrConstruc	42%	10%	-1%	**16**
New office, industrial and commercial buildings construction	42 IndComBuild	28%	2%	-17%	**15**
New residential 1 unit structures, nonfarm	33 Nresident1	11%	40%	13%	**(21)**
New residential garden and high-rise apartments construction	36 GardHighrise	5%	39%	13%	**(2)**

Table 46: Key results for the main purchasing industries of *CutStone*

The actual result was 12.2% output growth, which was largely driven by a strong increase in tastes and preferences for *CutStone* by producers and households. Recall that the combined change in household tastes (*a3com*) was projected forward to be 6.0%. This essentially means that at any given set of prices and per capita income, consumption per household of *CutStone* would be 6.0% higher in 2005 than in 1998.[104] In reality, household tastes towards *CutStone* soared by 48.9%; driving an 88.5% increase in consumption demand for the domestically produced commodity. A similar story emerges for the contribution to output of *CutStone*-using technical and taste change (*cont_ac*). This was projected to be 3.2% higher in the forecast, when in fact the increase was 22.5%. These factors were clearly the key drivers behind the error.

[104] More precisely, the consumption per household of *CutStone* in 2005 would be 6*(1 – share of *CutStone* in household expenditure) percent higher than in 1998.

Cut Stone and Stone Products (*CutStone*) - 1998 Database

1. Main Producers of the Commodity at Basic Prices

Industries	236 CutStone: 1181	Rest: 30	**Total: 1212**
Proportion	236 CutStone: 0.975	Rest: 0.025	

2. Output Composition of the Main Producing Industry at Basic Prices

Commodities	231 CutStone: 1181	416 WholesleTrde: 18	Rest: 25	**Total: 1224**
Proportion	231 CutStone: 0.965	416 WholesleTrde: 0.015	Rest: 0.020	

3. Total Sales of Domestic Output & Imports at Basic Prices

Demand Type		Domestic	Imported	Total	Dom/Total Dom
Current Production	BAS1	725	919	1644	**0.60**
Industry Investment	BAS2	0	0	0	**0.00**
Private Consumption	BAS3	444	35	479	**0.37**
Exports	BAS4	36	0	36	**0.03**
Government Demand	BAS5	0	0	0	**0.00**
Inventory Changes	BAS6	6	0	6	**0.01**
Total Margins	TOTMARGINS	0	0	0	**0.00**
Total		**1212**	**954**	**2165**	
Source/Total		**0.56**	**0.44**		

4. Sales of Commodity to Domestic Industrial Users via the Absorption Matrix

Source	a. Current Production			BAS1	Proportion
Domestic	43 OthrConstruc: 302	42 IndComBuild: 201	Rest: 222	Total: 725	**Total: 0.441**
Imported	43 OthrConstruc: 309	33 Nresident1: 283	Rest: 327	Total: 919	**Total: 0.559**
Total	**43 OthrConstruc: 611**	**42 IndComBuild: 415**	**Rest: 618**	**Total: 1644**	
Proportion	**43 OthrConstruc: 0.371**	**42 IndComBuild: 0.253**	**Rest: 0.376**		

Source	b. Industry Investment			BAS2	Proportion
Domestic	0	0	0	Total: 0	**Total: 0**
Imported	0	0	0	Total: 0	**Total: 0**
Total	0	0	0	**Total: 0**	
Proportion	**0**	**0**	**0**		

5. Market Share - Purchasers' Values of All Sales in the U.S.

Demand Type	Domestic	Imported	Total	Dom/Total Dom	Dom/Total
Current Production	924	1194	2118	**0.34**	**0.23**
Industry Investment	0	0	0	**0.00**	**0.00**
Private Consumption	1750	143	1893	**0.65**	**0.44**
Government Demand	0	0	0	**0.00**	**0.00**
Inventory Changes	6	0	6	**0.00**	**0.00**
Total	**2680**	**1337**	**4017**		
Source/Total	**0.67**	**0.33**			

6. Total Costs of the Main Producing Industry - Intermediate & Factor Input Breakdown at Basic Prices

a. All Inputs		Proportion	b. Factor Inputs		Proportion
Intermediate	618	**0.51**	LABOUR	529	**0.87**
Factor	610	**0.50**	CAPITAL	81	**0.13**
Other	0	**0.00**	LAND	0	**0.00**
Production Taxes	-4	**0.00**	**Total**	**610**	
Total	**1224**				

Source	c. Intermediate Inputs				Proportion
Domestic	27 crushedstone: 86	271 Handtools: 40	Rest: 387	Total: 513	**Total: 0.830**
Imported	27 crushedstone: 51	271 Handtools: 17	Rest: 37	Total: 105	**Total: 0.170**
Total	**27 crushedstone: 137**	**271 Handtools: 58**	**Rest: 423**	**Total: 618**	
Proportion	**27 crushedstone: 0.222**	**271 Handtools: 0.093**	**Rest: 0.685**		

Table 47: The key attributes of *CutStone* in 1998

It is also worth noting the significant difference in technological change parameters. On the supply side, primary factors comprised 50% of total input costs (Section 6a of Table 46). In the forecast, all-factor-augmenting technical change (*a1prim*) indicated a 27.7% improvement in primary-factor efficiency. This meant that the *CutStone* industry was projected to require 27.7% less primary factors to produce the same level of output whilst holding all other inputs constant. The contribution of all-factor-augmenting technical change to total input costs (*cont_a1prim*) was estimated to be an overall cost reduction of 14.9%. In reality, this efficiency measure deteriorated by 33.4%, and its contribution to total input costs rose 15.5%. The model's erroneous forecast for further productivity savings prevented an even larger underestimation of total output (*x0dom*).

2. Macro perspective

Although stone remains an important building material, new construction materials and methods developed during the twentieth century have limited its use almost entirely to a finishing element of mostly decorative value.[105] In addition, any forward looking comments made around the 1990s were reasonably cautious:

> "The long-term industry outlook was generally lackluster for the early 2000s. Limited opportunities for further productivity gains, coupled with greater foreign competition, were expected to hurt many industry sectors. Although traditional domestic markets, such as construction, experienced expansive growth in the booming economy of the late 1990s, superior synthetic substitutes continued to make gains. Due to the strength of the construction industry in the late 1990s, the cut stone industry did experience steady growth between 1997 and 2000, when the value of shipments increased from $1.24 billion to $1.63 billion.
>
> Because of stone's weight-to-value ratio, moreover, opportunities for U.S. export growth are slim with the exception of niche specialty stones. U.S. producers exported about 2 percent of production in the late 1990s. A bright spot on the horizon for the industry is the expected continued surge in historical restoration projects that require considerable amounts of stone to replace damaged pieces from the original construction."[106]

[105] http://www.answers.com/topic/cut-stone-and-stone-products, visited 11 September 2009.
[106] http://www.answers.com/topic/cut-stone-and-stone-products, visited 11 September 2009.

3. Conclusion

The modeller may have viewed this overall cautious outlook as being consistent with the downbeat USAGE forecast for the commodity. Moreover, the building and construction boom that occurred mostly during the second half of the forecast period played a key role in the forecast error. Excessive borrowing across many sectors was fuelled by exceptionally low interest rates post the events of “September 11”; lax lending standards; piecemeal regulation; and financial product innovation. The extent and longevity of this boom did not seem to have been expected by industry experts. However, a track record of overly accommodative monetary policy from the mid-1990s and steady industry growth in 1997 and 1998 may have provided some clues that the general outlook was overly guarded. On balance, it is difficult to say, conclusively, that the modeller could have produced a better forecast for *CutStone*. Perhaps, if negative growth was seen to be too pessimistic, a zero growth forecast—at best—might have been worked into the model.

3.0 Concluding Remarks

Economic forecasting is a challenging pursuit. The likelihood of inaccurate predictions is magnified where underlying structural change is occurring. Therefore, it is important to consider the likely future structure of the economy when analysing the impact of potential policy changes. Where structural change is predicted in a baseline forecast, the effects of policy changes can widely differ from a *status quo* assumption about the future structure of the economy. This thesis examines methods for improving baseline economic forecasts using a dynamic CGE model. Assessing forecasting-performance can be used to test the validity of such models, as well as to highlight possible improvements, by investigating the discrepancies between the forecast and actual outcomes.

The model that is employed in this thesis is USAGE—a recursive-dynamic, 500-industry CGE model of the U.S. economy. USAGE generates baseline forecasts by incorporating expert projections for certain macro variables and extrapolating historical trends in technology, consumer preferences, positions of foreign demand curves for U.S. products, and numerous other naturally exogenous variables. In instances where important trends either dissipate or reverse, large forecast errors can arise. This thesis shows how certain CGE forecasting techniques can be improved. However, despite vast improvements in forecast accuracy for some industries and sectors, the average forecast error across industries did not greatly improve due to the sheer volume of commodities. While it is disappointing that the average error is not very reducible, it is also reassuring because it implies that the default implementation of the model is quite powerful.

For some commodities, had all publicly available information at the end of the base year of the forecast been appropriately utilised, certain important trends should not have been expected to continue and hence a better forecast could have been generated. Furthermore, the nature of some forecast errors suggests that projecting forward large values for preference and technology variables relating to import penetration might best be avoided. In other words, where import-domestic preference changes have historically caused significant damage (or alternatively, boosted) the market share of domestic producers, this ought not to be projected forward unless there is overwhelming evidence to suggest otherwise.

In some instances, changes to regulatory regimes that were put in place by 1998 suggested that affected industries had highly constrained growth prospects. No attempt is made to reflect this change in the default implementation of the model—to the detriment of the forecast. In the absence of evidence to the contrary, these regulatory changes should be taken into account in forecasting exercises. In particular, *ad hoc* changes to the forecast strategy are called for in this situation, such as enforcing a zero-growth forecast for affected commodities.

It is shown that for commodities in the trade-exposed textile, clothing and footwear industries moderately better results could have been produced by implementing import-price forecasts in a way that is more aligned with outcomes that are consistent with the historical operation of U.S. trade policy. A practical way to attain this result through the model's implementation is to project forward real basic import prices. There are 31 commodities in this space and eight of these featured among the twenty largest USAGE forecast errors. Moreover, the key drivers behind these errors were usually the significant underestimation of the impact of import-domestic preference twist factors, as well as the overestimation of factor-input cost savings. By 1998 it seemed clear that for the TCF sector, further cost savings ought not to be baked in to the forecast as the bulk of the productivity gains, or low hanging fruit, had already been obtained.

It is concluded that forecasts for commodities in the oil and mining sectors as well as companies that service these cyclical industries typically could not have been improved in the absence of strong convictions (in 1998) about an impending mining "super-cycle" or extended boom. These USAGE commodities are: *AccStrucSMD, PetNgExplor, PetNgDrill, Nonferrores,* and *Copperore.* For the construction-related commodities, such as *CutStone*, demand was fuelled by virtually unprecedented low borrowing costs during a period that featured a strong appetite for taking on debt. In these instances, it is difficult to conclusively argue that the modeller could have produced a better forecast.

Furthermore, it is noted that where commodities have large import shares (e.g., *Dolls*, and *Luggage*), it is always going to be difficult to accurately forecast domestic output in the absence of specialised knowledge given that total supplies of domestic goods will move off a low base. In this instance, the model does a better job at predicting the commodity's absorption, i.e., all U.S. sales of the commodity irrespective of source.

In all, the twenty worst USAGE errors on a relative and/or absolute basis (about 4% of all commodities) were specifically examined to assess the potential for error reduction. After extending the improved method of the model's implementation to all TCF commodities, about 7.4% of commodities were in some way directly re-projected. To generate a large reduction in the forecast error—and hence improvement in model performance—would require an extensive amount of work and probably necessitate the input of numerous industry specialists.

References

Anspacher, Jeffrey, Stefan Osborne and Julian Richards (2011), "The Effect of CO2 Emissions Reduction on the U.S.Electricity Sector", USITC Research paper, available at: http://www.usitc.gov/research_and_analysis/documents/Effect_CO2_Emissions_Reduction_Electricity_Sector.pdf .

Dixon, P.B., B.R. Parmenter, G.J. Ryland and J. Sutton (1977), *ORANI, A General Equilibrium Model of the Australian Economy: Current Specification and Illustrations of Use for Policy Analysis,* Vol. 2 of the First Progress Report of the IMPACT Project, Australian Government Publishing Service, Canberra, pp. xii + 297.

Dixon, P.B., B.R. Parmenter, John Sutton and D.P. Vincent (1982), *ORANI: A Multisectoral Model of the Australian Economy*, Contributions to Economic Analysis 142, North-Holland Publishing Company, pp. xviii + 372.

Dixon, P.B., B. R. Parmenter, A.A. Powell and P.J. Wilcoxen (1992), *Notes and Problems in Applied General Equilibrium Economics*, North-Holland Publishing Company, pp. xvi + 392.

Dixon, P.B. and M.T. Rimmer (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy: a Practical Guide and Documentation of MONASH,* Contributions to Economic Analysis 256, North-Holland Publishing Company, pp. xiv+338.

Dixon, P.B. and M.T. Rimmer (2010a), "Johansen's contribution to CGE modelling: originator and guiding light for 50 years", *CoPS/IMPACT Working Paper G-203*, pp. 48, available at: http://www.monash.edu.au/policy/ftp/workpapr/g-203.pdf .

Dixon, P.B. and M.T. Rimmer (2010b), "Validating a Detailed, Dynamic CGE Model of the USA", *Economic Record, 86 (Special Issue)*, September, 2010.

Dixon, P.B., Bumsoo Lee, Todd Muehlenbeck, M.T. Rimmer, Adam Rose and George Verikios (2010), "Effects on the U.S. of an H1N1 Epidemic: Analysis with a Quarterly CGE Model," *Journal of Homeland Security and Emergency Management*: Vol. 7: Iss. 1, Article 75, 2010 DOI: 10.2202/1547-7355.1769, available at: http://www.bepress.com/jhsem/vol7/iss1/75 .

Dixon, P.B. and M.T. Rimmer (2012) "*Validation in CGE modelling*", chapter 19 in P.B. Dixon and D.W. Jorgenson (editors) Handbook of Computable General Equilibrium Modeling, Elsevier, forthcoming.

Dixon P.B., R.B. Koopman and M.T. Rimmer (2012), "*The MONASH style of CGE modelling: a framework for practical policy analysis*", in Dixon P.B. and D.W. Jorgenson (editors) Handbook of Computable General Equilibrium Modeling, Elsevier, forthcoming.

Fox, A., W. Powers and A. Winston (2008), "Textile and apparel barriers and rules of origin: what's left to gain after the agreement on textiles and clothing?", *Journal of Economic Integration*, September, 29(3), pp. 656-684.

Gehlhar, M., A. Somwaru, P.B. Dixon, M.T. Rimmer and A.R. Winston (2010), "Economywide Implications from US Bioenergy Expansion", *American Economic Review: Papers & Proceedings*, Vol. 100(3), May, pp. 172-77.

Giesecke, J.A. (2011) "Development of a large-scale single U.S. region CGE model using IMPLAN data: A Los Angeles County example with a productivity shock application" *Spatial Economic Analysis*, vol. 6(3).

Giesecke, J.A., W. Burns, A. Barret, E. Bayrak, A. Rose, P. Slovic and M. Suher (2012) "Assessment of the regional economic impacts of catastrophic events: CGE analysis of resource loss and behavioral effects of an RDD attack scenario". *Risk Analysis*, forthcoming.

Hui, Kai-Lung and Png, Ivan (2003) "Piracy and the Legitimate Demand for Recorded Music," Contributions to Economic Analysis & Policy: Vol. 2: Iss. 1, Article 11, available at: http://www.bepress.com/bejeap/contributions/vol2/iss1/art11 .

Johansen, L. (1960), *A Multisectoral Study of Economic Growth*, Contributions to Economic Analysis 21, North-Holland Publishing Company, pp. x+177.

Johansen, L. (1974), *A Multisectoral Study of Economic Growth, second enlarged edition*, Contributions to Economic Analysis 21', North-Holland Publishing Company, pp. X + 274.

Osborne, Stefan (2009), “Energy in 2020: Assessing the Economic Effects of Commercialization of Cellulosic Ethanol” paper issued by the International Trade Administration in the Department of Commerce, available at: http://www.trade.gov/mas/ian/build/groups/public/@tg_ian/documents/webcontent/tg_ian_002699.pdf .

United States International Trade Commission (2004, 2007, 2009 and 2011), *The Economic Effects of Significant U.S. Import Restraints: Fourth, Fifth, Sixth and Seventh Updates*, Investigation No. 332-325, Publications 3701, 3906, 4094 and 4255.

Zahniser, S., T. Hertz, P.B. Dixon and M. Rimmer (2012a), “Immigration policy and its possible effects on U.S. agriculture and the market for hired farm labor: a simulation analysis”, *American Journal of Agricultural Economics*, forthcoming.

Zahniser, S., T. Hertz, P.B. Dixon and M. Rimmer (2012b), “The Potential Impact of Changes in Immigration Policy on U.S. Agriculture and the Market for Hired Farm Labor: A Simulation Analysis”, Economic Research Report no. 135, Economic Research Services in the Department of Agriculture, available at: http://www.ers.usda.gov/media/619408/err135_1_.pdf .

Websites Visited

http://www.osha.gov/pls/imis/sic_manual.html

http://www.noaa.gov/fisheries.html

http://www.nmfs.noaa.gov/sfa/magact/

http://www.nmfs.noaa.gov/sfa/

http://www.nmfs.noaa.gov/sfa/update.html

http://www.nmfs.noaa.gov/sfa/statusoffisheries/Archives/StatusofFisheriesReportCongress1998.pdf

http://www.nmfs.noaa.gov/sfa/SFA-Report-FINAL7_1.pdf

http://www.referenceforbusiness.com/industries/Electronic-Equipment-Components/Electron-Tubes.html

http://en.wikipedia.org/wiki/Plasma_display

http://www.wtec.org/loyola/displays/c3_s1.htm

http://www.wtec.org/loyola/displays/af_world.htm

http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01002519

http://en.wikipedia.org/wiki/Plasma_Display

http://www.tech-notes.tv/Archive/tech_notes_004.htm

http://www.theregister.co.uk/1998/10/21/crts_beat_back_flat_panel/

http://en.wikipedia.org/wiki/Consumer_Electronics_Show

http://www.mindbranch.com/listing/product/R395-0009.html

http://www.answers.com/topic/dolls-and-stuffed-toys

http://www.thefreelibrary.com/FEATURE%2FExclusive+Toy+Products+Targets+Lucrative+Collectible-Dolls...-a019753614

Websites Visited

http://www.wa.gov/esd/lmea/sprepts/indprof/motionp.htm

http://en.wikipedia.org/wiki/Warez

http://www.ehow.com/about_5107851_history-movie-piracy.html

http://www.azoz.com/music/features/0008.html

http://www.bepress.com/bejeap/contributions/vol2/iss1/art11

http://www.answers.com/topic/magnetic-and-optical-recording-media

http://www.apparelandfootwear.org/letters/AAFAComments-ITCTariffStudy020520.pdf

http://www.cbo.gov/ftpdocs/100xx/doc10075/1991_12_traderestraints.pdf

http://www.tx.ncsu.edu/jtatm/volume2issue1/articles/antoshak/antoshakcomplete.pdf

http://docs.google.com/gview?a=v&q=cache:IuD6L3nlSgsJ:opencrs.com/rpts/RS20889_20050610.pdf+1995+quotas+apparel&hl=en&gl=au

http://www.wa.gov/esd/lmea/sprepts/indprof/textiles.htm

http://www.encyclopedia.com/doc/1G2-3434500073.html

http://www.wa.gov/esd/lmea/sprepts/indprof/textiles.htm

http://www.referenceforbusiness.com/industries/Textile-Mill/Lace-Warp-Knit-Fabric-Mills.html

http://www.referenceforbusiness.com/industries/Textile-Mill/Weft-Knit-Fabric-Mills.html

http://www.mindbranch.com/Luggage-R460-19

http://www.allbusiness.com/leather-leather-products/boot-shoe-cut-stock-findings-boot/3779454-2.html

http://www.answers.com/topic/leather-tanning-and-finishing

http://www.referenceforbusiness.com/industries/Leather/Leather-Gloves-Mittens.html

http://www.referenceforbusiness.com/industries/Textile-Mill/Hosiery-Elsewhere-Classified.html,

http://www.fundinguniverse.com/company-histories/coach-inc-history/

Websites Visited

http://www.answers.com/topic/metal-mining-services

http://www.answers.com/topic/coal-mining-services

http://www.answers.com/topic/nonmetallic-minerals-services-except-fuels

http://www.eia.doe.gov/emeu/plugs/plaeo98.html

http://www.eia.doe.gov/emeu/plugs/plaeo99.html

http://www.answers.com/topic/copper-ores

http://www.answers.com/topic/cut-stone-and-stone-products

Appendix 1: List of Equations

$$GDP_{EXP} = C + I + G + X - M \tag{1.3.1}$$

$$GDP_{INC} = A * F(L,K) \tag{1.3.2}$$

$$\ell_{SEC}(q) = \sum_{j=1}^{3} S(j,q) * \ell_{IND}(j) \quad , q = 1,2 \tag{1.3.3}$$

$$alab_{IND}(j) = \sum_{q=1}^{2} M(j,q) * f_{SEC}(q) \quad , j = 1,2,3 \tag{1.3.4}$$

$$\tilde{\gamma} = cr - gr \tag{1.3.5}$$

$$x5(i) = \tilde{x}5\_obs(i) + f5\_gen \quad , i=1,2, \ldots, N_{COM} \tag{1.3.6}$$

$$cr = c - \tilde{c}pi \tag{1.3.7}$$

$$C + G = \tilde{A}PC * GNP \tag{1.3.8}$$

$$x3(i) - \tilde{h} = EPS(i) * (c - \tilde{h}) + \sum_{i=1}^{N_{COM}} ETA(i,k) * p3(k) + \tilde{a}3(i) - a3\_ave \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.9}$$

$$a3\_ave = \sum_{i=1}^{N_{COM}} S_3(i) * \tilde{a}3(i) \tag{1.3.10}$$

$$x3(i) = x3\_obs(i) + \tilde{f}3\_adj \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.11}$$

$$AGGINV * ir = \sum_{j=1}^{N_{IND}} \left(VINVEST(j) * y(j) \right) \tag{1.3.12}$$

$$y(j) = k(j) + \tilde{i}k\_ratio(j) + \sum_{r=1}^{N_{SEC}^{(r)}} MINV(j,r) * \tilde{f}y\_s(r) + \tilde{i}k\_ratio\_u \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.13}$$

$$y\_s(r) = y\_s\_obs(r) + \tilde{y}\_adj \quad , r = 1,2,\ldots,N_{SEC}^{(r)} \tag{1.3.14}$$

$$y\_s(r) = \sum_{j \in SEC(r)} \left[\frac{VINVEST(j)}{SECINVEST(r)} \right] * y(j) \quad , r = 1,2,\ldots,N_{SEC}^{(r)} \tag{1.3.15}$$

$$\begin{aligned} x0imp(i) = & \sum_{j=1}^{N_{IND}} \left[S_1(i,imp,j) * x1(i,imp,j) + S_2(i,imp,j) * x2(i,imp,j) \right] \\ & + S_3(i,imp) * x3(i,imp) + S_5(i,imp) * x5(i,imp) \quad , i = 1,2,\ldots,N_{COM} \end{aligned} \tag{1.3.16}$$

$$x(i,s,a) = xyz(a) - \sigma_{ARM} * \left(p(i,s,a) - p(i,a)\right) + DUMMY(i,s,a) * twist\_src(i) \quad , \\ i = 1,2,\ldots,N_{COM} \\ s = dom, imp \\ a = \text{all agents (industries, capital creators, households and governments)} \tag{1.3.17}$$

$$twist\_src(i) = \omega * (x0dom(i) - gdpreal) + \tilde{f}twist\_src(i) + twist\_src\_gen \quad , \\ i = 1,2,\ldots,N_{COM} \tag{1.3.18}$$

$$x0imp(i) = x0imp\_obs(i) + \tilde{f}0imp\_adj \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.19}$$

$$M = \psi_M\left[X0IMP(1),\ldots,X0IMP(N_c)\right] \tag{1.3.20}$$

$$K = \zeta\left(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT\right) \tag{1.3.21}$$

$$X = GDP\left(\tilde{R}OR, \tilde{A}, \tilde{L}, TOFT\right) - \left(\tilde{C} + \tilde{I} + \tilde{G} - \tilde{M}\right) \tag{1.3.22}$$

$$x4(i) = \tilde{z}\_world + \theta(i) * \left[pe(i) - \tilde{f}epc(i)\right] + \tilde{f}eqc(i) + \tilde{f}eqc\_gen \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.23}$$

$$X = \psi_X\left[X4(1),\ldots,X4(N_c)\right] \tag{1.3.24}$$

$$toft = xpi - mpi \tag{1.3.25}$$

$$pmcr(i) = \tilde{f}pmcr(i) + \tilde{f}pmcr\_gen \quad , i = 1,2,\ldots,N_{COM} \tag{1.3.26}$$

$$\ell\_s(q) = \sum_{j=1}^{N_{IND}} S(j,q) * \ell(j) \quad , q = 1,2,\ldots,N_{SEC}^{(q)} \tag{1.3.27}$$

$$\tilde{a}lab(j) = \sum_{q=1}^{N_{SEC}^{(q)}} M(j,q) * \tilde{f}\_s(q) + f(j) \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.28}$$

$$k(j) = z(j) - \sigma_{\ell k} * \left(rental(j) - pprim(j)\right) - S\_LAB(j) * twist\_\ell k(j) \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.29}$$

$$\ell(j) = z(j) - \sigma_{\ell k} * \left(wage(j) - pprim(j)\right) + S\_CAP(j) * twist\_\ell k(j) \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.30}$$

$$k\_s(r) = \sum_{j=1}^{N_{IND}} S(j,r) * k(j) \quad , r = 1,2,\ldots,N_{SEC}^{(r)} \tag{1.3.31}$$

$$twist\_\ell k(j) = \sum_{r=1}^{N_{SEC}} M(j,r) * \tilde{t}wist\_\ell k\_s(r) + ftwist\_\ell k(j) + \tilde{f}twist\_\ell k\_gen \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.32}$$

$$p0dom(j) = S_\ell(j) * \left(wage(j) + a_\ell(j)\right) + S_k(j) * \left(rental(j) + a_k(j)\right) \\ + S_{int}(j) * \left(p\_int(j) + \tilde{a}\_int(j)\right) \quad , j = 1,2,\ldots,N_{IND} \tag{1.3.33}$$

$$x(i,s,a)=xyz(a)+\tilde{a}c(i)-\sigma_{ARM}*\left(p(i,s,a)-p(i,a)\right)+DUMMY(i,s,a)*twist\_src(i)$$
$$,\quad i=1,2,\ldots,N_{COM}$$
$$s=dom,imp$$
$$a=\text{all agents}\left(\text{industries, capital creators, households and governments}\right) \tag{1.3.34}$$

$$ave\_int=\sum_{j=1}^{N_{IND}}S_{a\_int}(j)*\tilde{a}\_int(j) \tag{1.3.35}$$

$$p0dom(i)=p0dom\_obs(i)+\tilde{f}p0dom \quad ,i=1,2,\ldots,N_{COM} \tag{1.3.36}$$

$$\tilde{c}pi=\sum_{i=1}^{N_{COM}}S_3(i)*p3(i) \tag{1.3.37}$$

$$\tilde{r}or(j)=fror(j)+\tilde{f}\_ror \quad ,j=i=1,2,\ldots,N_{IND} \tag{1.3.38}$$

$$ave\_wage=\frac{\sum_{j=1}^{N_{IND}}\left[WAGE\_J(j)/\tilde{P}OW\_PAYROLL(j)\right]*\left(wage(j)-\tilde{p}\_payroll(j)\right)}{\sum_{j=1}^{N_{IND}}WAGE\_J(j)/\tilde{P}OW\_PAYROLL(j)} \tag{1.3.39}$$

$$wage(j)=\tilde{f}wage\_obs(j)+\tilde{c}pi+fwage\_gen+\tilde{p}\_payroll(j) \quad ,j=i=1,2,\ldots,N_{IND} \tag{1.3.40}$$

$$impftwist(i)=-AVIMPSH(i)*\tilde{f}twist\_src(i)+\tilde{d}ftwist\_h(i) \quad ,i=1,2,...,N_{COM} \tag{1.3.41}$$

$$DTW(i)*impftwist(i)=-AVIMPSH(i)*\tilde{f}twist\_src(i)+dftwist\_f(i)\ ,i=1,2,...,N_{COM} \tag{1.3.42}$$

$$AVIMPSH(i)=\frac{\left\{\begin{array}{c}\sum_{j=1}^{N_{IND}}\left[S_1(i,imp,j)*X1(i,dom,j)+S_2(i,imp,j)*X2(i,dom,j)\right]\\ +S_3(i,imp)*X3(i,dom)+S_5(i,imp)*X5(i,dom)\end{array}\right\}}{\left\{\sum_{j=1}^{N_{IND}}\left[X1(i,dom,j)+X2(i,dom,j)\right]+X3(i,dom)+X5(i,dom)\right\}} \tag{1.3.43}$$
$$,i=1,2,...,N_{COM}$$

$$X=\tilde{A}*F\left(\tilde{L},K\right)-\left(\tilde{C}+\tilde{I}+\tilde{G}-\tilde{M}\right) \tag{1.3.44}$$

$$\tilde{R}OR=H(TOFT)*\tilde{A}*F_K\left(\frac{K}{\tilde{L}}\right) \tag{1.3.45}$$

$$X=\tilde{A}*F\left(\tilde{L},\zeta\left(\tilde{R}OR,\tilde{A},\tilde{L},TOFT\right)\right)-\left(\tilde{C}+\tilde{I}+\tilde{G}-\tilde{M}\right) \tag{1.3.46}$$

$$X=\Xi\left(TOFT,\tilde{F}_{GEN}\right) \tag{1.3.47}$$

$$realp0imp(i)=p0imp(i)-\tilde{c}pi \quad ,i=1,2,...,N_{COM} \tag{2.2.1}$$

Appendix 2: Definitions of Variables

Governments

γ is the ratio of real private consumption to real government consumption;

cr is the percentage change in aggregate real private consumption;

gr is the percentage change in aggregate real government consumption;

$x5(i)$ is the percentage change in government demand for commodity i;

$x5\_obs(i)$ is the percentage change implied by observations of government consumption data at the commodity level; and

$f5\_gen$ is the percentage change in a uniform shifter variable on government consumption.

Households

cpi is the percentage change in the consumer price index (exogenous in all closures);

C and c represent nominal total household consumption expenditure in levels and percentage change form, respectively;

G is nominal total government demands in levels form;

APC is the average propensity to consume out of gross national income;

GNP is the level of nominal gross national income;

$x3(i)$ is the percentage change in household demand for commodities undifferentiated by source;

$p3(k)$ is the percentage change in an index of consumer prices for commodities undifferentiated by source;

$x3\_obs(i)$ is the percentage change implied by observed household demand for commodities undifferentiated by source;

$a3(i)$ is the percentage change in the overall movement in household preferences for commodities;

$a3\_ave$ is the percentage change in the average value of household preferences for commodities;

$S_3(i)$ is the share of commodity i in the household budget;

$EPS(i)$ is household expenditure elasticities for commodities;

h is the percentage change in the number of households (exogenous in all closures);

$ETA(i,k)$ is household price elasticities; and

$f3\_adj$ is the percentage change in a macro shift variable used to adjust for data discrepancies.

Investment

$AGGINV$ is the level (or value) of aggregate nominal investment expenditure;

ir is the percentage change in aggregate real investment expenditure;

$VINVEST(j)$ is the nominal value of investment by industry j;

$SECINVEST(r)$ is the nominal value of investment by sector r;

$y(j)$ is the percentage change in investment in industry j;

$k(j)$ is the percentage change in industry j's capital at the beginning of the period;

$ik\_ratio(j)$ is the percentage change in investment-capital ratio shifters by industry;

ik_ratio_u is the percentage change in a uniform shifter in investment-capital ratios;

$MINV(j,r)$ is a coefficient with value 1 if industry j is part of sector r and zero otherwise;

$fy\_s(r)$ is the percentage change in a shift variable that affects investment only for industries in sector r;

$y\_s(r)$ is the percentage change in investment in sector r;

$y\_s\_obs(r)$ is the percentage change implied by observed investment in sector r; and

y_adj is the percentage change in a shifter variable that adjusts sectoral investment to meet the macro target.

Imports

$x0imp(i)$ is the percentage change in total imports of commodity i;

$x1(i,imp,j)$ is the percentage change in intermediate input use of imported commodity i by industry j;

$x2(i,imp,j)$ is the percentage change in inputs for capital creation of imported commodity i by industry j;

$x3(i,imp)$ is the percentage change in household demand for imported commodity i;

$x5(i,imp)$ is the percentage change in government demand for imported commodity i;

$S_1(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in current production;

$S_2(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by industry j in investment activities;

$S_3(i,imp)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by households;

$S_5(i,imp,j)$ is the share in total imports of commodity i that is accounted for by the use of imported commodity i by government;

$x(i,s,a)$ is the percentage change in the demand for commodity i from source s (domestic or imported) by agent a. This covers producers, capital creators, households and governments;

$xyz(a)$ is the percentage in agent a's activity level (e.g., output, investment and aggregate expenditure);

σ_{ARM} is the Armington domestic-import substitution elasticity;

$p(i,s,a)$ is the percentage change in the purchasers' price to agent a of commodity i from source s;

$p(i,a)$ is the percentage change in the purchasers' price to agent a of commodity i. This is a weighted average of the percentages in the $p(i,s,a)$ over s equals dom and imp;

$twist\_src(i)$ is the percentage change in a variable that affects the domestic-import ratio of all agents' purchases of commodity i independently of domestic-import relative-prices;

$\mathrm{DUMMY}(i,s,a)$ is a coefficient defined as follows:

$\mathrm{DUMMY}(i,dom,a) = S(i,imp,a)$

$\mathrm{DUMMY}(i,imp,a) = -S(i,dom,a)$

where $S(i,s,a)$ is the share of source s in agent a's expenditure on commodity i;

ω is a positive parameter that controls the sensitivity of domestic-import twists to growth in domestic output relative to GDP;

$x0dom(i)$ is the percentage change in domestic output of commodity i;

$gdpreal$ is the percentage change in real GDP;

$ftwist\_src(i)$ is a percentage change variable that allows for import-domestic twists by commodity;

$twist\_src\_gen$ is a percentage change variable that allows for a uniform (or all-commodity) import-domestic twist (exogenous in decomposition and historical closures).

$x0imp\_obs(i)$ is the percentage change implied by observed imports by commodity;

$f0imp\_adj$ is the percentage change in a macro shift variable, which could be used, if necessary, to adjust the commodity-level import data to achieve consistency with macro import data;

M is aggregate imports;

$X0IMP(i)$ is the level of imports of commodity i; and

ψ_M is a function used to aggregate imported commodities.

Exports

P_I is the price index for capital goods, i.e., asset price;

P_G is the price index for domestic goods, i.e., GDP deflator;

Q is the rental price of capital;

ROR is the rate of return on capital;

$x4(i)$ is the percentage change in export demand for commodity i;

z_world is the percentage change in global economic activity, i.e., world GDP;

$\theta(i)$ is foreign elasticity of demand for commodity i;

$pe(i)$ is the percentage change in the foreign-currency f.o.b price (value on departure of U.S.) of commodity i;

$fepc(i)$ is the percentage change in price (vertical) shifts in the export-demand schedule for commodity i;

$feqc(i)$ is the percentage change in quantity (horizontal) shifts in the export-demand schedule for commodity i;

feq_gen is the percentage change in a uniform horizontal shifter in the export-demand curves of all commodities;

X is aggregate exports;

$X4(i)$ is the level of exports of commodity i; and

ψ_x is a function used to aggregate exported commodities;

toft is the percentage change in the terms of trade;

xpi is the percentage change in the exports price index (foreign currency f.o.b. export prices);

mpi is the percentage change in the imports price index (foreign currency c.i.f. import prices);

$pmcr(i)$ is the percentage change in the foreign-currency price of imported commodity i;

$fpmcr(i)$ is the percentage change in a shifter variable used to apply import price observations and forecasts; and

$fpmcr\_gen$ is the percentage change in a macro or uniform shifter variable for import prices.

Labour

$\ell\_s(q)$ is the percentage change or growth in employment in sector q;

$\ell(j)$ is the percentage change or growth in employment in industry j;

$S(j,q)$ is the share of sector q's employment accounted for by industry j;

$alab(j)$ is the percentage change in labour-saving technical change in industry j;

$f\_s(q)$ is the percentage change in a shift variable for sector q that can be used to impose labour productivity assumptions in sectors; and

$M(j,q)$ is a coefficient that maps industries to sectors by taking the value 1 if industry j is part of sector q and zero otherwise.

Capital

$k(j)$ is the percentage change in capital growth in industry j;

$\ell(j)$ is the percentage change in employment in industry j;

$z(j)$ is the percentage change in the activity level in industry j;

$\sigma_{\ell k}$ is the labour/capital input substitution elasticity;

$rental(j)$ is the percentage change in the rental price of capital in industry j;

$wage(j)$ is the percentage change in the cost of a unit of labour to industry j;

$pprim(j)$ is percentage change in the primary-factor composite price to industry j, i.e., the weighted average price of all primary factors;

$S\_LAB(j)$ is the share of labour costs in labour-capital input costs in industry j;

$S\_CAP(j)$ is the share of capital costs in labour-capital input costs in industry j;

$twist\_\ell k(j)$ is the percentage change in labour-capital twist in industry j;

$k\_s(r)$ is the percentage change in capital growth in sector r;

$S(j,r)$ is the share of sector r's capital accounted for by industry j;

$twist\_\ell k\_s(r)$ is the percentage change in labour-capital twist in sector r;

$ftwist\_\ell k(j)$ is the percentage change in a shift variable that allows for labour-capital twist by industry (exogenous in historical closure);

$ftwist\_\ell k\_gen$ is the percentage change in an all-industry labour-capital twist (exogenous in historical closure); and

$M(j,r)$ is a coefficient that maps industries to sectors by taking the value 1 if industry j is part of sector r and zero otherwise.

Output and prices

$S_{int}(j)$ is the share of intermediate-input-saving technical change in total inputs by industry j;

$S_{\ell}(j)$ is the share of labour in total inputs by industry j;

$S_{k}(j)$ is the share of capital in total inputs by industry j;

$wage(j)$ is the percentage change or growth in the cost of a unit of labour to industry j;

$rental(j)$ is the percentage change in the rental price of capital in industry j;

$p\_int(j)$ is the percentage change in the price of intermediate inputs in industry j;

$a_{\ell}(j)$ is the percentage change in labour-saving technical change in industry j (elsewhere this is denoted $alab(j)$);

$a_{k}(j)$ is the percentage change in capital-saving technical change in industry j;

$a\_int(j)$ is the percentage change in intermediate-input-saving technical change;

$S_{a\_int}(j)$ is the share of industry j's intermediate-input-saving technical change in overall intermediate-input-saving technical change;

ave_int is the percentage change in the average value of intermediate-input-saving technical change;

$ac(i)$ is the percentage change in input-using technology and taste change. For any given prices and activity level, if ac = 10 then demand for good i,s by all users increased by 10%;

$p0dom\_obs(i)$ is the percentage change in price-observations of domestically-produced commodities;

$p0dom(i)$ is the percentage change in prices of domestically-produced commodities;

$fp0dom$ is the percentage change in a general price shift variable; and

$p3(i)$ is the percentage change in an index of consumer prices for commodities undifferentiated by source, i.e., price of household composites.

Wages

$wage(j)$ is the percentage change or growth in the cost of a unit of labour to industry j;

$fwage\_obs(j)$ is the percentage change or growth in wages as observed in industry j;

$fwage\_gen$ is the percentage change in an overall wage shifter;

$p\_payroll(j)$ is the percentage change in the power of the payroll tax in industry j (this did not change in the period 1992 to 1998 therefore it was not shocked and equals zero);

ave_wage is the percentage change in the average nominal wage rate;

$WAGE\_J(j)$ is the total wage bill in industry j;

$POW\_PAYROLL(j)$ is the power of the payroll tax in industry j;

$ror(j)$ is the percentage change in the rate of return in industry j;

$fror(j)$ is the percentage change in a shifter variable for the rate of return in industry j; and

f_ror is the percentage change in the average rate of return shifter.

Forecast closure

$impftwist(i)$ is the percentage change in the impact of twist trends on non-margin and non-inventory domestic demand, i.e., it reflects the contributions of technology and preference-related twists to domestic demand growth for domestically-produced goods;

$dftwist\_h(i)$ is the percentage change in a shift variable that is exogenous on zero in historical simulations but endogenous in forecast simulations (exogeneity in historical activates the equation such that $impftwist(i)$ can be determined for all i);

$dftwist\_f(i)$ is the percentage change in a shift variable that is exogenous on zero in forecast simulations but endogenous in historical simulations (exogeneity activates the equation for all i and ensures that the value for $ftwist\_src(i)$ is determined by this equation, where it subsequently impacts domestic demand through equations such as (1.3.34));

$AVIMPSH(i)$ is a coefficient that gives the average import share of good i across non-margin and non-inventory uses; and

$DTW(i)$ is a coefficient with values in the [0,1] interval, and that increases from zero to one as the share of imported good i in domestic sales of good i rises from zero to 10%;

$X1(i, dom, j)$ is the level of intermediate input use of domestic commodity i by industry j;

$X2(i, dom, j)$ is the level of inputs for capital creation of domestic commodity i by industry j;

$X3(i, dom)$ is the level of household demand for domestic commodity i; and

$X5(i, dom)$ is the level of government demand for domestic commodity i.

Forecasts for exports, capital and terms of trade

X is aggregate exports;

Φ is the level of the nominal exchange rate;

P_D is the f.o.b. domestic-currency price index of U.S.-produced commodities;

P_F is a shifter for foreign-currency prices of competing products in the rest of the world; and

F_{GEN} allows for a uniform shift in demand for competing products in the rest of the world.

Real import-price projections for TCF commodities

$realp0imp(i)$ is the percentage change in CPI-deflated landed-duty-paid prices; and

$p0imp(i)$ is the percentage change in the landed-duty-paid basic price of imported goods.

Appendix 3: USAGE Commodities

AbrasivePrd	Abrasive products
AccountServ	Accounting, auditing and bookkeeping, and miscellaneous services, n.e.c.
AccStrucSMD	Access structures for solid mineral development
AddAlter	New residential additions and alterations, nonfarm
Adhesives	Adhesives and sealants
Advertising	Advertising
AgForFshserv	Agricultural, forestry, and fishery services
Aircraft	Aircraft
AircrftEngin	Aircraft and missile engines and engine parts
AircrftEquip	Aircraft and missile equipment, n.e.c.
AirTrans	Air transportation
AluminCast	Aluminum castings
AluminumRoll	Aluminum rolling and drawing
Ammunition	Ammunition, except for small arms, n.e.c.
Apparel	Apparel made from purchased materials
ArchMtlWork	Architectural and ornamental metal work
ArrangPTrans	Arrangement of passenger transportation
AsbestosPrd	Asbestos products
AsphaltFelts	Asphalt felts and coatings
AsphaltPav	Asphalt paving mixtures and blocks
AutoAppTrim	Automotive and apparel trimmings
AutoPark	Automobile parking and car washes
AutoRental	Automotive rental and leasing, without drivers
AutoRepair	Automotive repair shops and services
AutoStamp	Automotive stampings
BagsExtext	Bags, except textile
Ballbearings	Ball and roller bearings
Banking	Banking
Beautyshops	Beauty and barber shops
Blankbooks	Blankbooks, looseleaf binders and devices
BlastFurnace	Blast furnaces and steel mills
Boatbuild	Boat building and repairing

Bookbinding	Bookbinding and related work
Bookprint	Book printing
BookPublish	Book publishing
BootCutStock	Boot and shoe cut stock and findings
BowlingCentr	Bowling centers
Boxes	Paperboard containers and boxes
Bread	Bread, cake, and related products
BrickClyTile	Brick and structural clay tile
Broadfabric	Broadwoven fabric mills and fabric finishing plants
Brooms	Brooms and brushes
Burialcasket	Burial caskets
BusinAssoc	Business associations and professional membership organizations
BusinessForm	Manifold business forms
Butter	Creamery butter
Calculatmach	Calculating and accounting machines
Candy	Candy and other confectionery products
Canndspecial	Canned specialties
Cannedfish	Canned and cured fish and seafoods
Cannedfruit	Canned fruits, vegetables, preserves, jams, and jellies
Canvasprods	Canvas and related products
CarbonBlack	Carbon black
Carbonpaper	Carbon paper and inked ribbons
Carbonprods	Carbon and graphite products
Carburetors	Carburetors, pistons, rings, and valves
Cardboard	Die-cut paper and paperboard and cardboard
CarpetsRugs	Carpets and rugs
CblePyTVserv	Cable and other pay television services
CellMmdeFibr	Cellulosic manmade fibers
Cement	Cement, hydraulic
CeramicTile	Ceramic wall and floor tile
Cereal	Cereal breakfast foods
ChBusInvent	Change in business inventories
Cheese	Natural, processed, and imitation cheese
Chemfertiliz	Chemical and fertilizer minerals

Chemicalsnec	Chemicals and chemical preparations, n.e.c.
ChildDaycare	Child day care services
Chocolate	Chocolate and cocoa products
Cigarettes	Cigarettes
Cigars	Cigars
ClayRefract	Clay, ceramic, and refractory minerals
ClayRefract	Clay refractories
Coal	Coal
Coatdfabric	Coated fabrics, not rubberized
Coating	Coating, engraving, and allied services, n.e.c.
Coffee	Roasted coffee
CollegeUni	Colleges, universities, and professional schools
ComFishing	Commercial fishing
ComLaundryEq	Commercial laundry equipment
CommercPrnt	Commercial printing
CommunEquip	Communication equipment
CompEmployee	Compensation of employees
ComPerEquip	Computer peripheral equipment
ComPhoto	Photofinishing labs and commercial photography
Computers	Electronic computers
ComputerServ	Computer and data processing services
ConcrtBrick	Concrete block and brick
ConcrtPrdnec	Concrete products, except block and brick
ConstMachin	Construction machinery and equipment
Containernec	Wood containers, n.e.c.
Conveyors	Conveyors and conveying equipment
Cookies	Cookies and crackers
CopperFound	Copper foundries
Copperore	Copper ore
CordageTwine	Cordage and twine
CostumJewel	Costume jewelry
Cottnsdmills	Cottonseed oil mills
Cotton	Cotton
CrdpetNatgas	Crude petroleum and natural gas

Creditagency	Credit agencies other than banks
Cropsmisc	Miscellaneous crops
Crowns	Crowns and closures
Crushedstone	Dimension, crushed and broken stone
Curtains	Curtains and draperies
Cutlery	Cutlery
CutStone	Cut stone and stone products
DairyDCE	Dry, condensed, and evaporated dairy products
Dairyfarmprd	Dairy farm products
Dehydfruit	Dehydrated fruits, vegetables, and soups
DentalEquip	Dental equipment and supplies
DetectiveSer	Detective and protective services
Distliqour	Distilled and blended liquors
DoctorsDent	Doctors and dentists
DogCatfood	Dog and cat food
Dolls	Dolls and stuffed toys
DraphardBlnd	Drapery hardware and window blinds and shades
Drugs	Drugs
Earthenware	Fine earthenware table and kitchenware
EatDrinkPlce	Eating and drinking places
EdblfatsOils	Edible fats and oils, n.e.c.
ElctroMedApp	Electromedical and electrotherapeutic apparatus
ElecGasWeld	Electric and gas welding and soldering equipment
ElecHousware	Electric housewares and fans
ElecLampbulb	Electric lamp bulbs and tubes
ElecteqICE	Electrical equipment for internal combustion engines
ElectIndApp	Electrical industrial apparatus, n.e.c.
ElectMachnec	Electrical machinery, equipment, and supplies, n.e.c.
ElectMetPrds	Electrometallurgical products, except steel
ElectRepair	Electrical repair shops
Electricserv	Electric services (utilities)
ElectronTube	Electron tubes
Elevators	Elevators and moving stairways
Embroideries	Schiffli machine embroideries

EnamSanWare	Enameled iron and metal sanitary ware
EngineerSer	Engineering, architectural, and surveying services
Envelopes	Envelopes
Environcontr	Environmental controls
Explosives	Explosives
ExtrudCopper	Rolling, drawing, and extruding of copper
FabMtlPrdnec	Fabricated metal products, n.e.c.
FabPlateWork	Fabricated plate work (boiler shops)
FabRubPrdnec	Fabricated rubber products, n.e.c.
FabStrMetal	Fabricated structural metal
Fabtxtprods	Fabricated textile products, n.e.c.
Fans	Blowers and fans
FarmMachin	Farm machinery and equipment
Farmresident	New farm residential construction
Fasteners	Fasteners, buttons, needles, and pins
FatsOilsnonv	Animal and marine fats and oils
FedElecUtil	Federal electric utilities
Feedgrains	Feed grains
Fertilzermix	Fertilizers, mixing only
FixturExwood	Partitions and fixtures, except wood
Flavorsyrups	Flavoring extracts and flavoring syrups, n.e.c.
Flour	Flour and other grain mill products
Fluidmilk	Fluid milk
FluidPwEquip	Fluid power equipment
Foodgrains	Food grains
FoodPrdMach	Food products machinery
Foodprepnec	Food preparations, n.e.c.
Forestprds	Forest products
Forestryprds	Forestry products
FreightForw	Freight forwarders and other transportation services
Frozenfruit	Frozen fruits, fruit juices, and vegetables
Froznbakery	Frozen bakery products, except bread
Froznspecial	Frozen specialties, n.e.c.
Fruits	Fruits

Funeralserv	Funeral service and crematories
Furnaces	Industrial process furnaces and ovens
Furnfixnec	Furniture and fixtures, n.e.c.
Games	Games, toys, and children's vehicles
GardenEquip	Lawn and garden equipment
GardHighrise	New residential garden and high-rise apartments construction
Gaskets	Gaskets, packing, and sealing devices
GenGovInd	General government industry
Glass	Glass and glass products, except containers
Glasscontain	Glass containers
Grassseeds	Grass seeds
Greennursery	Greenhouse and nursery products
Greetingcard	Greeting cards
GrossPrFxInv	Gross private fixed investment
GuidedMiss	Guided missiles and space vehicles
GumWoodchem	Gum and wood chemicals
GypsumPrd	Gypsum products
Handsaws	Saw blades and handsaws
Handtools	Hand and edge tools, except machine tools and handsaws
Hardwarenec	Hardware, n.e.c.
HeatingEquip	Heating equipment, except electric and warm air furnaces
Hhldfurnnec	Household furniture, n.e.c.
Hhldind	Household industry
HighwysBrid	New highways, bridges, and other horizontal construction
HldApplianec	Household appliances, n.e.c.
HldAudioVid	Household audio and video equipment
Hldcookequip	Household cooking equipment
HldfurnrUnup	Wood household furniture, except upholstered
HldfurnUp	Upholstered household furniture
Hldlaundry	Household laundry equipment
Hldrefrig	Household refrigerators and freezers
HldVacuumCl	Household vacuum cleaners
Hoists	Hoists, cranes, and monorails
HomeHealth	Other medical and health services

Hosierynec	Hosiery, n.e.c.
Hospitals	Hospitals
Hotels	Hotels
Housefurnish	House furnishings, n.e.c.
HrdsurFlrCov	Hard surface floor coverings, n.e.c.
Hrdwdfloor	Hardwood dimension and flooring mills
Ice	Manufactured ice
Icecream	Ice cream and frozen desserts
IndComBuild	New office, industrial and commercial buildings construction
IndirBusTax	Indirect business tax and nontax liability
IndMachEquip	General industrial machinery and equipment, n.e.c.
IndMachnec	Industrial and commercial machinery and equipment, n.e.c.
IndPatterns	Industrial patterns
IndTrukTrac	Industrial trucks and tractors
IndustChem	Industrial inorganic and organic chemicals
InstrumElec	Instruments to measure electricity
InsurnceBrok	Insurance agents, brokers, and services
InsurnceCarr	Insurance carriers
IntCombusEng	Internal combustion engines, n.e.c.
InventValAdj	Inventory valuation adjustment
Ironmetlores	Iron and ferroalloy ores, and miscellaneous metal ores, n.e.c.
IronSteel	Iron and steel foundries
IronStlForg	Iron and steel forgings
JewelMater	Jewelers' materials and lapidary work
Jewelry	Jewelry, precious metal
JobTraining	Job training and related services
kitchencab	Wood kitchen cabinets
Knitfabric	Knit fabric mills
Knitoutwear	Knit outerwear mills
Knittingmill	Knitting mills, n.e.c.
Knitundwear	Knit underwear and nightwear mills
LabApparat	Laboratory apparatus and furniture
LabInstrum	Laboratory and optical instruments
LaborOrgan	Labor organizations, civic, social, and fraternal associations

Laundry	Laundry, cleaning, garment services, and shoe repair
LeatherTan	Leather tanning and finishing
LeathrGdsnec	Leather goods, n.e.c.
Leathrgloves	Leather gloves and mittens
Legalserv	Legal services
Libraryetc	Private libraries, vocational schools, and educational services, n.e.c.
LightingFixt	Lighting fixtures and equipment
Lime	Lime
Livestckmisc	Miscellaneous livestock
Lndscaphort	Landscape and horticultural services
Logging	Logging
LubricatOils	Lubricating oils and greases
Luggage	Luggage
MachToolCut	Machine tools, metal cutting types
MachToolForm	Machine tools, metal forming types
Malt	Malt
Maltbevrage	Malt beverages
ManageServ	Management and public relations services
ManuIndnec	Manufacturing industries, n.e.c.
MarkingDevic	Marking devices
Mattresses	Mattresses and bedsprings
MeasurPump	Measuring and dispensing pumps
Meatanimals	Meat animals
Meatpackplnt	Meat packing plants
MechMeasur	Mechanical measuring devices
MecPwrTEquip	Mechanical power transmission equipment
MedicInst	Surgical and medical instruments and apparatus
MembSprtClub	Physical fitness facilities and membership sports and recreation clubs
MetalBarrels	Metal shipping barrels, drums, kegs, and pails
MetalCans	Metal cans
MetalDoors	Metal doors, sash, frames, molding, and trim
MetalHeatTr	Metal heat treating
Metalhldfurn	Metal household furniture
Millwork	Millwork

MineralsGrnd	Minerals, ground or treated
MineralWool	Mineral wool
MiningMachin	Mining machinery, except oil field
MiscEqRent	Miscellaneous equipment rental and leasing
MiscPlPrdnec	Miscellaneous plastics products, n.e.c.
MiscPublish	Miscellaneous publishing
MiscRepair	Miscellaneous repair shops
MiscStMtlWrk	Miscellaneous structural metal work
MisFabWirPrd	Miscellaneous fabricated wire products
MmadeFibOth	Manmade organic fibers, except cellulosic
Mobilehomes	Mobile homes
Motorcycles	Motorcycles, bicycles, and parts
Motorhomes	Motor homes
Motors	Motors and generators
Motorvehicle	Motor vehicles and passenger car bodies
MotvehParts	Motor vehicle parts and accessories
MRpetngwell	Maintenance and repair of petroleum and natural gas wells
MRresident	Maintenance and repair of farm and nonfarm residential structures
MRstreets	Maintenance and repair of highways & streets
MtlFoilLeaf	Metal foil and leaf
MtlStampnec	Metal stampings, n.e.c.
MtlWorkMach	Metalworking machinery, n.e.c.
Musicalinstr	Musical instruments
Narrowfabric	Narrow fabric mills
NatgasDistrb	Natural gas distribution
NatgasTransp	Natural gas transportation
NavigEquip	Search and navigation equipment
Newspapers	Newspapers
NfCastnec	Nonferrous castings, n.e.c.
NferRollnec	Nonferrous rolling and drawing, n.e.c.
NfForging	Nonferrous forgings
NfWireDraw	Nonferrous wiredrawing and insulating
NitPhosFert	Nitrogenous and phosphatic fertilizers
NonClayRefrc	Nonclay refractories

NoncompImps	Noncomparable imports
Nonferrores	Nonferrous metal ores, except copper
NonmetMinPrd	Nonmetallic mineral products, n.e.c.
Nonmetminsrv	Nonmetallic mineral services and miscellaneous
Nonwovenfab	Nonwoven fabrics
Noodles	Macaroni, spaghetti, vermicelli, and noodles
Nresid2to4	New residential 2-4 unit structures, nonfarm
Nresident1	New residential 1 unit structures, nonfarm
NursingFacil	Nursing and personal care facilities
NutsSeeds	Salted and roasted nuts and seeds
OffMachnec	Office machines, n.e.c.
OfFurnExwood	Office furniture, except wood
OilBearCrops	Oil bearing crops
OilGsFldMach	Oil and gas field machinery and equipment
Ophthalmic	Ophthalmic goods
Ordnance	Ordnance and accessories, n.e.c.
OthAmuseServ	Other amusement and recreation services
OthBusServ	Other business services
OthElectronC	Other electronic components
OthFedGovEnt	Other Federal Government enterprises
Othlodging	Other lodging places
OthMedServ	Other medical and health services
OthmemOrg	Other membership organizations
OthMRconst	Other repair and maintenance construction
OthrConstruc	Other new construction
OthSLGentpr	Other State and local government enterprises
OthValueAdd	Other value added
OwnoccDwell	Owner-occupied dwellings
PackagMach	Packaging machinery
Paints	Paints and allied products
PalletsSkids	Wood pallets and skids
PaperCoat	Paper coating and glazing
PaperIndMach	Paper industries machinery
Papermills	Paper and paperboard mills

PapProdsnec	Converted paper products, n.e.c.
PassengTrans	Local and suburban transit and interurban highway passenger transport
PdrivnHandTl	Power-driven handtools
PencilsArt	Lead pencils and art goods
Pens	Pens, mechanical pencils, and parts
Periodicals	Periodicals
PerLeathrGds	Personal leather goods, n.e.c.
PersConsExpn	Personal consumption expenditures
PersonnelSup	Personnel supply services
Pesticidnec	Pesticides and agricultural chemicals, n.e.c.
PetClPrdnec	Products of petroleum and coal, n.e.c.
PetNgDrill	Petroleum and natural gas well drilling
PetNgExplor	Petroleum, natural gas, and solid mineral exploration
PetrolRefin	Petroleum refining
PhotoEquip	Photographic equipment and supplies
Pickles_dres	Pickles, sauces, and salad dressings
PipelinExng	Pipelines, except natural gas
PipeValves	Pipe, valves, and pipe fittings
Plastics	Plastics materials and resins
Platemaking	Platemaking and related services
PlatingPolsh	Plating and polishing
Pleating	Pleating and stitching
Pltryslaught	Poultry slaughtering and processing
PlumbFixFit	Plumbing fixture fittings and trim
Polishes	Polishes and sanitation goods
PorclainElec	Porcelain electrical supplies
PortraitStud	Portrait photographic studios, and other miscellaneous personal services
PostalServ	U.S. Postal Service
Potatochips	Potato chips and similar snacks
PottryPrdnec	Pottery products, n.e.c.
PoultryEggs	Poultry and eggs
PowerTrnsfrm	Power, distribution, and specialty transformers
PrefabBlding	Prefabricated wood buildings and components
PrefabMtlBld	Prefabricated metal buildings and components

PreparedFish	Prepared fresh or frozen fish and seafoods
Prepdough	Prepared flour mixes and doughs
Prepfeeds	Prepared feeds, n.e.c.
PrimAluminum	Primary aluminum
Primarybatt	Primary batteries, dry and wet
PrimMetPrd	Primary metal products, n.e.c.
PrimNfMetnec	Primary nonferrous metals, n.e.c.
PrimSmelting	Primary smelting and refining of copper
PrintingInk	Printing ink
PrintMach	Printing trades machinery and equipment
ProSportClub	Professional sports clubs and promoters
PubBldFurnit	Public building and related furniture
Pulpmills	Pulp mills
PumpsCompres	Pumps and compressors
Racing	Racing, including track operation
RadioTVbroad	Radio and TV broadcasting
RailroadEq	Railroad equipment
Railroadserv	Railroads and related services
Readymix	Ready-mixed concrete
Reconstwood	Reconstituted wood products
Recordmedia	Magnetic and optical recording media
RecordTapes	Prerecorded records and tapes
RefrigHtEq	Refrigeration and heating equipment
Relays	Relays and industrial controls
ReligiousOrg	Religious organizations
ResearchDev	Research, development, and testing services, except noncommercial
ResidCare	Residential care
RestateAgent	Real estate agents, managers, operators, and lessors
RetailTrade	Retail trade, except eating and drinking
Ricemill	Rice milling
Rolmilmach	Rolling mill machinery and equipment
ROWadjFinUse	Rest of the world adjustment to final uses
Royalties	Royalties
RubPlFootwr	Rubber and plastics footwear

RubPlHose	Rubber and plastics hose and belting
SandGravel	Sand and gravel
Sanitaryserv	Sanitary services, steam supply, and irrigation systems
SanitPapProd	Sanitary paper products
Sausages	Sausages and other prepared meat products
Sawmillprod	Special product sawmills, n.e.c.
Sawmills	Sawmills and planing mills, general
Scales	Scales and balances, except laboratory
Schools	Elementary and secondary schools
Scrap	Scrap
ScrewMach	Screw machine products, bolts, etc.
SecCombroker	Security and commodity brokers
SecNfMetals	Secondary nonferrous metals
Semiconduct	Semiconductors and related devices
ServIndMach	Service industry machinery, n.e.c.
ServtoDwell	Services to dwellings and other buildings
SheetMtlWork	Sheet metal work
Shipbuild	Ship building and repairing
ShoesExrub	Shoes, except rubber
SignsAdvert	Signs and advertising specialties
Silverware	Silverware and plated ware
SLGelecutil	State and local government electric utilities
SLGPtransit	State and local government passenger transit
Slippers	House slippers
SmallArms	Small arms
SmArmsAmmun	Small arms ammunition
Soap	Soap and other detergents
SocialSernec	Social services, n.e.c.
Softdrinks	Bottled and canned soft drinks
Soybeanmills	Soybean oil mills
SpecialDies	Special dies and tools and machine tool accessories
SpecIndMach	Special industry machinery, n.e.c.
SportGdsnec	Sporting and athletic goods, n.e.c.
Stationery	Stationery, tablets, and related products

SteelPipe	Steel pipe and tubes
SteelSheet	Cold-rolled steel sheet, strip, and bars
SteelSpring	Steel springs, except wire
SteelWire	Steel wiredrawing and steel nails and spikes
StoragBatt	Storage batteries
StrClyPrdnec	Structural clay products, n.e.c.
Structwood	Structural wood members, n.e.c.
Sugar	Sugar
Sugarcrops	Sugar crops
SurfActAgent	Surface active agents
SurgiclAppl	Surgical appliances and supplies
Switchboard	Switchgear and switchboard apparatus
SyntheticRub	Synthetic rubber
Tanks	Tanks and tank components
TelephonCom	Telephone, telegraph communications, and communications services, n.e.c.
Telephones	Telephone and telegraph apparatus
Textilebags	Textile bags
Textilegoods	Textile goods, n.e.c.
TextMach	Textile machinery
TheatPrducer	Theatrical producers (ex motion picture), bands, orchestras and entertainers
Theatres	Motion picture services and theaters
Threadmills	Thread mills
TirecordFab	Tire cord and fabrics
Tires	Tires and inner tubes
Tobacco	Tobacco
TobaccoSnuff	Chewing and smoking tobacco and snuff
TobStmRedry	Tobacco stemming and redrying
ToiletPrep	Toilet preparations
TravelTraler	Travel trailers and campers
Treenuts	Tree nuts
TrnsprtEqnec	Transportation equipment, n.e.c.
TruckBusBdy	Truck and bus bodies
TruckingServ	Trucking and courier services, except air
Trucktrailer	Truck trailers

Turbines	Turbines and turbine generator sets
TVcabinets	Wood television and radio cabinets
Typesetting	Typesetting
Used2ndhGds	Used and secondhand goods
Vegetables	Vegetables
Vegetmills	Vegetable oil mills, n.e.c.
VendingMach	Automatic vending machines
VeneerPlywd	Veneer and plywood
VetServ	Veterinary services
VideoTpeRent	Video tape rental
VitChinaPlmb	Vitreous china plumbing fixtures
VitChinaTble	Vitreous china table and kitchenware
WarehseStore	Warehousing and storage
Watches	Watches, clocks, watchcases, and parts
WatchRepair	Watch, clock, jewellery, and furniture repair
Watersupply	Water supply and sewerage systems
WaterTrans	Water transportation
Wetcornmill	Wet corn milling
WholesleTrde	Wholesale trade
WinesSpirit	Wines, brandy, and brandy spirits
Wiringdevice	Wiring devices
WmnsHandbag	Women's handbags and purses
Womenhosiery	Women's hosiery, except socks
Woodfixture	Wood partitions and fixtures
WoodOffFurn	Wood office furniture
Woodpreserv	Wood preserving
Woodprodnec	Wood products, n.e.c.
WoodworkMach	Woodworking machinery
XrayAppar	X-ray apparatus and tubes
YarnFinish	Yarn mills and finishing of textiles, n.e.c.