ESSAYS ON CAPITAL ACCUMULATION, ECONOMIC GROWTH, INCOME INEQUALITY, AND UNEMPLOYMENT

A thesis submitted for the degree of Doctor of Philosophy

IQTIARUDDIN MD. MAMUN

Department of Economics
Monash University
Australia

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Abstract

The central theme of this thesis is capital accumulation. The thesis reports that increase in economic growth rate and reduction in income inequality boosts capital accumulation that in turn reduces unemployment. Three essays constitute the thesis. The first essay investigates whether saving has been driven by growth or gowth has been driven by saving using data of Asian Miracle Economies (AME) – India, Indonesia, Singapore, South Korea, and Taiwan – over the period 1870-2011.The second essay explores the effect of income inequality on capital accumulation using the data of 20 OECD countries - Canada, USA, Japan, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherland, Norway, Portugal, Spain, Sweden, and UK - over the period 1870-2011. The effect of capital accumulation on unemployment in 21 OECD countries - Canada, USA, Japan, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherland, Norway, Portugal, Spain, Sweden, Switzerland and UK - has been explored in the third essay.

Following the neoclassical revival some economists attribute the amazing productivity growth rate in Asian Miracle Economies (AME) to capital accumulation while assign the backseat to the technological progress – the so called Krugman-Young hypothesis in which saving and schooling are independent of growth. However such assumption is questionable as from the perspective of growth accounting using Cobb-Douglas production function, theories of saving and the scenario that in AMEs prior to WWII living standard was close to subsistence level thus leaving less opportunity of saving and only after WWII with the increase in living standard financial saving and education increase it may be shown that saving and education are not exogenous and independent of growth. The first essay addresses this endogeneity and applying a two-way identification strategy and unique data covering the period 1870-2011 for the AMEs finds that financial saving as well as education comes from productivity growth, financial saving has no significant effect on growth but growth is positively related to the change in educational attainment. These results are robust to choice of instrument set, productivity measurement, the choice of growth model, measurement of saving, inclusion of covariates, and to the choice of estimation period.

The essay contributes to the literature explaining that productivity growth drives fixed and human capital accumulation as in the growth controversy it has never been asked and the

factor accumulation hypothesis never explains from where the savings come and very little work, if any, has investigated whether growth influences education.

The findings of the existing empirical literature suggest that the effect of income inequality on savings is either positive or insignificant. The reason for such findings of the existing empirical literature may be that in estimating the coefficient of income inequality on savings the positive feed-back effect from savings to income inequality has not been dealt with adequately.

The second essay takes this endogeneity arising from positive feed-back effect of savings to income inequality in to consideration and applies a two-way identification strategy and unique data covering the period 1870-2011 for 20 OECD countries andfinds that income inequality affects savings negatively. The finding is robust to variation in estimation periods, different measures of saving and inequality and the inclusion of important confounding variables such as financial development, growth and education.

Following the seminal work of Layard, Nickell, and Jackman (2005) that propounds no linkage between capital accumulation and unemployment based on the assumption of elasticity of substitution between capital and labour equals unity the role of capital accumulation has been deemphasized for long in explaining unemployment. And the emphasis was on labour market deregulation for reducing unemployment as labour market rigidities arising from trade union power; labour taxes, generous welfare benefits, strict employment protection, and other institutional factors were considered to be the main determinants of unemployment. The third essay using the data for the largest number of countries over the longest period of time – 21 OECD countries over the period 1870-2011- with wage push and aggregate demand factors being taken in to account finds that capital accumulation is important in reducing OECD unemployment.

General Declaration

In accordance with Monash University Doctorate Regulation 17/Doctor of Philosophy and Master of Philosophy (MPhil) regulations the following declarations are made:

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

The core theme of the thesis is capital accumulation, and its interaction with economic growth, income inequality, and unemployment. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of me, the candidate, working within the Department of Economics under the supervision of Professor Jakob B. Madsen.

The inclusion of co-author reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of chapter two and three my contribution to the work involved the following:

Thesis Chapter	Publication Title	Publication Status	Extent of candidate's contribution
2	Has the Capital Accumulation in the Asian Miracle Economies been Fuelled by Growth?	Submitted for review	50%
3	Does Income Inequality Fuel Saving? Evidence from 20 Advanced Countries, 1870-2011.	Submitted for review	50%

I have renumbered sections of submitted papers in order to generate a consistent presentation within the thesis.

Signature:

Date:

This thesis is dedicated

to

My Mother

Whom I love the most

Acknowledgement

As I finish writing this thesis a deep sense of gratefulness and indebtedness fills my mind. My praises and gratefulness are to Almighty Allah. His divine blessings I experience every moment and helps me accomplish my study in PhD program with the writing of this thesis.

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Chapter 1

Introduction

1.1 Introduction

The role of capital accumulation on economic outcomes has been debated since long in macroeconomic literature. Karl Marx in the nineteenth century in the first volume of his *Capital* made sombre prediction that the dynamics of private capital accumulation would lead to the concentration of wealth to a fewer people. Economists – for example, Simon Kuznets and Robert Solow - in the twentieth century, however, made optimistic prediction contrary to that of Karl Marx. Kuznets (1955) theorized that with the course of capital accumulation and thus industrialization and economic development income inequality would first increase and then decrease. Solow (1956) also predicted a balanced growth path along which output, profits, wages, and capital would grow at the same rate so that every group in the society would be equally well off. Picketty (2014) attempts to reconcile these opposing views arguing that with the course of capital accumulation the diffusion of knowledge, technological progress, and productivity growth may lead to more egalitarian society while inequality may increase if the return on capital exceeds total output growth rate. Capital accumulation is thus inextricably intertwined to economic growth rate, income inequality, and unemployment and a growing body of both theoretical and empirical literature discussed these issues at a great length.

Theoretical and empirical literature emphasizes the relation between capital accumulation and economic growth rate. But the answer to the question whether capital accumulation causes growth or the growth causes capital accumulation is still unclear. The resolution to this question is of great importance as the development policy hinges on it heavily. Policy that enhances savings should be undertaken if saving turns to capital accumulation and thereby causes growth. On the other hand if savings and thus physical capital accumulation are of less importance for growth and the factors like technological advancement, human capital are the main stimulus of growth development policy should focus on the flourishment of such growth stimulating factors.

The growth model of Harrod (1939) and Domar (1946) may be credited for the first theoretical framework that endeavours to establish the relationship between saving and growth. The simple version of the growth model of Harrod (1939) and Domar (1946) may be featured by capital as the only factor of production and the requirement of capital per unit of output is constant. It implies that output growth rate is proportional to saving rate. Therefore the insight of the growth model of Harrod (1939) and Domar (1946) is that for constant marginal return to capital growth rate is proportional to saving rate. In other words if the marginal return to capital is constantit follows that higher saving rate leads to higher growth rate.Solow (1956), on the other hand, using the production function with decreasing return to capital argues that high saving rate leads to high steady state level of income per capita. In fact in Solow- style growth model saving has temporary growth effect. That means growth rate eventually halts because of diminishing marginal return to capital but high saving results in high steady state level of income per capita and increasing saving increases growth rate of income in the transition path. However saving has permanent growth effect i.e. higher saving leads to higher growth in thefirst-generation endogenous growth models such as Romer (1986), Lucas (1988), Rebelo (1991) that feature constant returns to capital like Harrod - Domar model.

Following such neoclassical revival some economists attribute the amazing productivity growth rate in Asian Miracle Economies (AME) to capital accumulation while assign the backseat to the technological progress – the so called Krugman-Young hypothesis. However question may arise – can capital accumulation be considered to be an independent force of growth? Or high growth rate leads to higher saving rate and thus increasing capital accumulation. In the growth debate it has never been questioed from where the capital accumulation comes or more specifically whether the capital accumulation has been caused by gowth. The first essay of this dissertation thus investigates whether saving has been caused by growth or gowth has been caused by saving using data of Asian Miracle Economies (AME) – India, Indonesia, Singapore, South Korea, and Taiwan – over the period 1870-2011.

The second essay explores the effect of income inequality on capital accumulation using data of 20 OECD countries over the period 1870-2011. As Picketty (2014) shows that increase in saving rate results in higher capital income ratio and thus leads to higher income inequality. But how does income inequality affect saving rate? Because of the idea that the Marginal Propensity to Consume (MPC) of the poor exceeds that of the rich and thus the rich or the

capitalists are savers it supposes that income inequality enhances saving. And relatively scant empirical studies on this issue report that the effect of income inequality on savings is either positive or insignificant. But the problem with such findings is that the positive feed-back effect from savings to income inequality has not been dealt with and consequently because of this endogeneity the estimated coefficient of income inequality on saving rate is upward biased. Once the positive feed-back effect from savings to income inequality is taken out by applying Instrumental Variable (IV) estimation the estimated coefficient of income inequality on saving rate may be otherwise instead of positive or insignificant. The second essay takes this issue of endogeneity in to consideration and with IV estimation finds that the effect of inequality on savings is negative.

Dusenberry's (1949) relative income hypothesis that an individual's consumption depends not only on his/her current income but also on the level of income of his/her reference group may lend the theoretical underpinning of the negative effect of income inequality on savings. The reference group for the rich is only the rich while the reference group of the poor is the weighted average of the poor and the rich. Based on Dusenberry's (1949) relative income hypothesis, Alvarez-Cuadrado and El-Attar (2013) show both theoretically and empirically that income inequality has negative effect on aggregate saving rate.

The third essay examines the effect of capital accumulation on unemployment in 21 OECD countries over the period 1870-2011. Unemployment in OECD countries has long been attributed to the labour market rigidities arising from trade union power, labour taxes, generous welfare benefits, strict employment protection, and other institutional factors (See, for example, OECD 1994, 1999; Nickell 1997, 1998; Siebert 1997; IMF 2003; Nickell, Nunziata, and Ochel 2005). In particular Layard, Nickell, and Jackman (1991, revised in 2005; henceforth referred as LNJ (2005))theorisesthat unemployment has nothing to do with capital accumulation. According to this strand of literature the problem of unemployment is to deal with encouraging more employment on existing capital stock and hence the emphasis is on labour market deregulation for reducing unemployment.

That capital accumulation has no effect on unemployment is based on the assumption that the elasticity of substitution between capital and labour(σ) equals unity for which production function is essentially Cob Douglas. However such assumption is empirically questionable as many researchers report that the elasticity of substitution between capital and labour is less than one (See, for example, David and Klundert, 1965;Nadiri, 1970; Griffin and Gregory,

1976; Chirinko, 1993;Chirinko, Fazzari, and Mayer, 1999; Rowthorn, 1999; Krusell, Ohanian, Rios-Rull, and Violante, 2000; and Antras, 2004).

Rowthorn (1999) further argues that for $\sigma < 1$ capital accumulation essentially reduces unemployment. Bean (1989, 1994),Bean and Gavosto (1990), Carlin and Soskice (1990),Dreze (1991) ,Dreze and Bean (1990),Minford and Riley (1994) , Rowthorn (1977, 1995) emphasise the effect of capital stock on employment through the channel of capacity utilisation. More recent works, for example, Stockhammer (2004), Arestis, Baddeley, and Sawyer (2007), Karanassou, Sala, and Salvador (2008), Stockhammer and Klar (2011), Stockhammer (2011) also document the importance of capital accumulation in reducing unemployment.

Amid one strand of literature emphasizes while another rules out the effect of capital accumulation in reducing unemployment the third essay examines the role of capital accumulation in reducing unemployment or enhancing employment with the factors that give rise to labour market rigidities being taken in to account. The essay empirically examines the effect of capital accumulation on unemployment in a panel of 21 OECD countries over the period 1870-2011 thus contributes to the literature studying the largest number of countries over the longest period of time.

Long historical data 1870-2011 are used in all the three essays of this dissertation. Parameter estimated using long data sample has the benefit of being less subject to finite sample bias. Unlike small sample IV estimation using long data sample are not biased in the same direction as OLS estimation (Murray, 2006). Fixed effect estimator is more consistent and IV estimated parameter is less biased in long data sample (Davidson and McKinnon, 2006). Tests of over-identifying restrictions suffer from size distortions in small samples by failing to reject the null hypothesis too often (Murray, 2006). Also several cycles in the period 1870-2011can be identified; thus giving lots of identifying variation in the data.

The identification strategy, suggested by Blanchard and Perotti (2002) and developed further by Brückner (2013), is used in the first two essays to ensure the parameter estimates are not biased due to endogeneity.The advantage of this identification strategy over alternative strategies is that instruments are only required for one of the endogenous variables. In the first essay saving is instrumented by young age dependency ratio, the gender ratio at the ages 10-24, and life expectancy at the age of ten. In the first step, the response of growth to saving is estimated. In the second step, after the causal response of real per capita GDP growth to

gross saving is quantified by the instrumental variable estimation, the residual variation in growth that is not driven by saving is used as an instrument for growth. In the second essay saving is instrumented by young age dependency ratio and life expectancy at the age of ten. In the first step, the response of income inequality to saving is estimated. In the second step, after the causal response of income inequality to gross saving is quantified by the instrumental variable estimation, the residual variation in income inequality that is not driven by saving is used as an instrument for income inequality.

The thesis is organised as follows. Chapter two investigates whether saving has been driven by growth or gowth has been driven by saving using data of Asian Miracle Economies (AME) – India, Indonesia, Singapore, South Korea, and Taiwan – over the period 1870-2011. Chapter three explores the effect of income inequality on capital accumulation using data of 20 OECD countries over the period 1870-2011. Chapter four examines the role of capital accumulation in reducing unemployment in 21 OECD countries over the period 1870-2011. Finally chapter five concludes the thesis.

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Chapter 2

Has the Capital Accumulation in the Asian Miracle Economies Been Fuelled by Growth?[1]

Jakob B Madsen and IqtiarMamun
Department of Economics
Monash University

Abstract. The Asian growth miracle is often attributed to factor accumulation under the implicit assumption that savings, broadly defined, have been high and increasing due to exogenous forces. Using data for India, Indonesia, Korea, Singapore and Taiwan over the period 1870-2011 this paper examines the causal relationship between growth and saving. The response of growth to savings is first estimated using instruments to generate exogenous variation in savings rates. The residual variation in growth that is *not* driven by savings is then used as an instrument to estimate the effect of growth on savings. The estimates show that the spectacular saving rates in the Asian Miracle Economies have been fuelled by growth, and not the other way around.

JEL classification: E21, E4
Key words: saving, growth, Asian miracle economies, factor accumulation, schooling

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2. 1 Introduction

Following the neoclassical revival in the 1990s, capital accumulation has been regarded by some economists as the key driver behind the spectacular productivity growth performance in the Asian Miracle Economies (AME), whereas technological progress has played only a subsidiary role – the so-called Krugman-Young hypothesis (Hsieh and Klenow, 2010; Lee and Hong, 2012; van der Eng, 2010). These findings, which are based on growth accounting exercises, suggest that the miraculous productivity growth (henceforth growth) experienced in the East Asian economies is predominantly driven by transitional dynamics in the neoclassical growth framework. Lu (2012)has extended the growth accounting framework for the East Asian economies and shows that factor accumulation was the driving force behind the early growth experience, while TFP growth became the prime mover of growth during the later stages of the economic expansion.[2]

However, several economists have questioned whether factor accumulation can be considered to be an independent force of growth and argue that the high and the increasing savings rates in East Asian economies have, to some extent been an outcome of growth. Modigliani (1986)has stressed that the positive relationship between savings and growth is the most central and important prediction of his life-cycle model. Furthermore, Carroll, Overland, and Weil (2000) show that, under plausible assumptions, savings are positively related to growth under habit persistence, and Deaton (1999) suggests that East Asia's contemporaneously high savings rates have been partly driven up by these countries' high growth rates. Finally, the seminal papers of Lewis (1954) and Kaldor (1957) show that growth drives saving rates up because it increases the share of income of the capitalists who are the savers.

This paper asks whether the high growth rate in the AMEs can be seen as a consequence of increasing savings rates or whether the savings spurts have been caused by high growth rates, where savings in this exposition are broadly defined as gross financial saving (henceforth saving) following national account systems as well as investment in education (henceforth schooling). Mankiw, Romer, and Weil (1992), among others, argue that education is a critical part of saving and show that the Solow model is consistent with the data when education is included as a part of saving.

[2] Several papers have been critical to the capital accumulation hypothesis and argue that too much of the growth has been attributed to capital accumulation in growth accounting exercises, particularly the AMEs (see, for example,Aghion and Howitt, 2007; Ang and Madsen, 2011; Easterly and Levine, 2001; Hsieh and Klenow, 2010; King and Rebelo, 1993; Klenow, 2001; Klenow and Rodriguez-Clare, 1997; Robertson, 2002)

The identification strategy, suggested by Blanchard and Perotti (2002) and developed further by Brückner (2013), is used to ensure the parameter estimates are not biased due to endogeneity. In the first step, the response of growth to financial saving is estimated using young age dependency rates, the gender ratio at the ages 10-24, and life expectancy at the age of ten as instruments for gross saving to generate exogenous variation in savings rates. In the second step, after the causal response of real per capita GDP growth to gross saving is quantified by the instrumental variables estimates, the residual variation in growth that is *not* driven by saving is used as an instrument for growth. The advantage of this identification strategy over alternative strategies is that instruments are only required for one of the endogenous variables. In our case we choose to instrument saving since it is difficult to find good instruments for income. Endogenous growth models predict that, in steady state, growth is driven by investment, R&D and human capital – variables that are all highly endogenous, and theory offers little guidance about exogenous factors that drive these variables in the time-domain.

The tests are carried out using data for private saving, public saving, educational attainment and several other variables are compiled for India, Indonesia, Korea, Singapore, and Taiwan over the period 1870-2011. The historical data on savings rates have been constructed from several different national and international sources as detailed in the data appendix. Recent reconstructions of historical national accounts for Korea (Kim, 2012), Singapore (Sugimoto, 2011), Taiwan (Mizoguchi and Umemura 1988) , India (Sivasubramonian, 2000), and Indonesia (van der Eng, 2010) have enabled us to construct data back to 1870 for the AMEs. The shortcoming of using long historical data is that the quality of the data deteriorates as we go back in time; an issue we address by considering different estimation periods.

Despite this shortcoming there are several benefits from using long historical data. First, the parameter estimates are much less subject to finite sample bias than cross-country studies that typically span 20 or 30 years. It is well-known that IV estimates are biased in the same direction as OLS estimates in small samples; particularly if the instruments are weak (Murray, 2006). Furthermore, Davidson and MacKinnon (2006) show that instrument variable parameter estimates can be severely biased in small samples. Second, tests of over-identifying restrictions suffer from size distortions in small samples by failing to reject the null hypothesis too often (Murray, 2006). Third, several cycles in the long savings and income data can be identified in the period 1870-2011, therefore, giving lots of identifying variation in the data.

The AMEs considered here have high growth rates after WWII in common. For India and Indonesia the high growth rates have, particularly, been concentrated in the metropolitan areas. Except for India these economies have further in common that a large fraction of the population is of Chinese ethnicity. Confucian culture has often valued thrift and it has always been taken for granted that parents in these cultures save up for their children's education and house purchases (Liang, 2010). In the context of the present paper it is crucial that the increasing growth enabled the parents to enhance their savings to fulfill their desires to provide for their children's future. In Taiwan "in the 1970s and 1980s, as saving increased along with the higher standard of living, this customary practice imperceptibly evolved into 'buying a house for one's eldest son,' then 'buying a house for each of one's sons,' and 'buying a house for each of one's children" (Liang, 2010, p. 211). In other words there has been a great urge to enhance savings as the economic opportunities developed.

Although the factor accumulation versus TFP growth controversy has been on-going for two decades, very little work has been done to address the key question of whether the factor accumulation was driven by growth in the first place and the extent to which growth has been caused by saving in the AMEs. In the most extreme cases in which saving is caused entirely by growth, or if saving does not affect growth, the factor accumulation hypothesis loses ground and factor accumulation cannot be seen as an independent force of growth.

The empirical work on saving and growth has been predominantly limited to gross financial saving using a world sample typically spanning two or three decades and endogeneity has not been dealt with adequately (for example, see, Aghion, Comin, and Howitt, 2006; Baumol, Blackman, and Wolfe, 1991; Bosworth, 1993; Carroll and Weil, 1994; Deaton and Paxson, 1994; Edwards, 1995; Loayza, Schmidt-Hebbel, and Servén, 2000; Modigliani and Cao, 2004; Radelet, Sachs, and Lee, 2001). Radelet, Lee, and Sachs (1997)is one of the few studies that have investigated the determinants of savings in Asia. Although some of the aforementioned papers have addressed endogeneity, the exclusion restriction is highly unlikely to hold; particularly because mostly lagged independent variables have been used as instruments. Finally, very little work, if any, has investigated whether growth influences education.

The rest of the chapter is organized as follows. Section 2.2 briefly discusses the theory of saving and growth, section 2.3 presents the empirical estimates, section 2.4 provides estimation results, section 2.5 describes growth-saving nexus before and after the Second World War. Section 2.6 investigates the relationship between investment and growth, and Section 2.7 concludes the chapter.

2.2 Factor Accumulation, Saving and Growth

Theories of savings give contradictory predictions about the financial saving effect of growth. The theories of Lewis (1954), Kaldor (1957), Modigliani (1970) and Carroll *et al*. (2000), Chen, İmrohoroğlu, and İmrohoroğlu (2006) and Wen (2009) predict that growth affects saving positively, while the permanent income hypothesis (PIH) predicts that growth impinges negatively on saving. For saving in education the model of Bils and Klenow (2000) predicts that growth causes schooling, while several growth models predict that education causes growth (for well-known models, see Lucas, 1988; Mankiw *et al*., 1992; Romer, 1990).

2.2.1 Financial saving

For the PIH the relation between growth and saving can be seen most easily by considering the 'rainy day equation' by Campbell (1988) in which saving is the discounted value of the expected reduction in earnings:

$$S_t = -\sum_1^\infty E_t \frac{\Delta Y_{t+k}}{(1+r)^k}, \quad (1)$$

where*S* is saving, Y_{t+k} is real income (sum of real earnings and real asset income) in year *t*+*k*, *E* is the expectation operator, and *r* is a fixed real interest rate. The model shows that the relationship between saving and growth is negative if positive growth is expected, and zero if income growth is unanticipated. When income is expected to grow, current income is, on average, below the permanent income; thus establishing a negative relationship between saving and growth.

A problem associated with the PIH is the assumption of an exogenous real interest rate. In a production economy the real rates of return to capital are determined by the marginal products of capital, which in turn will respond to changes in productivity growth; the fundamental source of changes in permanent income. A permanent increase in TFP raises the rate of return to capital, so investment demand will increase, resulting in a higher equilibrium saving rate through a higher real interest rate. Consequently, in contrast to the prediction of the PIH, Chen *et al*. (2006) show, in a general-equilibrium growth model, that household saving may increase rather than decrease in response to a higher permanent income. This mechanism will only be active during the transitional period since capital deepening will drive returns down to their initial level in the steady state.

The life-cycle model predicts a positive relationship between growth and savings (Modigliani, 1986). In periods of positive productivity growth each successive cohort will

earn a life-time income higher than the previous cohort and, thus, consume correspondingly higher, because it is assumed that the life-time income is expected to remain constant over the life-cycle for each age cohort. In other words, with positive income growth, the savings of the working population will exceed that of the retirees' dissaving and the aggregate savings will, consequently, be higher than the savings of a stagnant economy. For this mechanism to work one needs to assume that growth expectations are zero; an assumption that is hard to maintain (Carroll *et al.*, 2000); at least to the extent that growth is predictable.

In the model of Carroll *et al*. (2000) a growth spurt will endogenously enhance saving as the utility of consumers depends on past as well as contemporaneous consumption. Based on a non-stochastic perfect foresight *AK* model, Carroll *et al*. (2000) show that the derivative of the gross saving rate with respect to the growth rate of output will be positive in *steady state* if and only if the following condition is satisfied:

$$\sigma < 1 + \frac{\theta}{\delta(1-\gamma)}, \tag{2}$$

where σ is the coefficient of relative risk aversion, δ is the depreciation rate of fixed capital stock, θ is the time-preference, and γ is an index of the importance of habits, $0 \leq \gamma \leq 1$, where $\gamma = 0$ if only the absolute level of consumption matters for utility (CRRA preferences) and $\gamma = 1$ if it is only the consumption relative to habits that is important for utility. From Eq. (2) it can be seen that the inequality is much less likely to be satisfied in the neoclassical model ($\gamma = 0$) than in habit persistence models. Carroll *et al*. (2000) argue that the inequality is likely to be satisfied.

Kaldor (1957) suggests a two-way relationship between growth and saving. The economy is composed of workers (non-savers) and capitalists (savers) and the only way the economy can grow is through capital accumulation, which in turn is driven by capitalists' saving; thus establishing a link from saving to growth. Conversely, growth drives profits and, thus, capitalists' savings. Kaldor's model is quite similar to the model of Lewis (1954). In the model of Lewis (1954) the modern sector develops by utilizing labor from the traditional non-capitalist backward subsistence sector. At an early stage of development, the unlimited supply of labor from the subsistence economy means that the capitalist sector can expand for some time without any need to raise wages. This results in higher returns to capital, which are reinvested in capital accumulation; thus establishing a positive relationship between growth and savings and self-sustained development.

2.2.2 Saving in education

Since households ultimately have to make a portfolio decision about their saving, including investment in schooling, it follows that growth will impinge on schooling through the same channels as financial saving. Furthermore, Bils and Klenow (2000) show that growth is influential for expected returns to schooling and that growth increases the optimal years of schooling. They derive the following equation for the optimal years of education, *E**:

$$E^* = T - \frac{1}{r-g} ln \left[\frac{\phi}{\phi - \mu(r-g)}\right], \quad (3)$$

where r is a constant interest rate, ϕ is the returns to schooling following the Mincerian approach, μ (μ >0) is the ratio of schooling tuition fees and the opportunity cost of student time, g is productivity growth and T is the number of years that the individual is expected to stay in the labor force. Using some algebra it can be shown that $\frac{\partial E^*}{\partial (r-g)} < 0$, i.e., the number of years of schooling that optimizes life income is positively related to the expected growth rate but is negatively related to the real interest rate. The quantitative effects of growth on schooling are potentially large. With a real interest rate of, say, 3 percent and returns to schooling of 7 percent, Eq. (3) implies that an increase in the expected perpetual growth rate from 1 to 4 percent increases the optimal length of schooling by 3.5 years.

Another reason for expecting a positive relationship between growth and schooling is that growth-induced savings increase investment in education along with investment in other assets. If the real return to education is approximately 7 percent, it compares well with other investments and, unlike financial asset investment, there is no risk of losing the investment through confiscation, inflation or the inability of borrowers to honor their debts. Furthermore, since educated individuals are less affected by unemployment in downturns than their less educated counterparts (Mincer, 1991), it follows that the returns to schooling are countercyclical. Thus, a *negative* risk premium to schooling returns is incurred, noting that risk in the consumption CAPM depends on the covariance between consumption growth and growth in the returns to education. Finally, since Chinese parents have often been dedicated to educating their children (Liang, 2010) it is conceivable that their educational level has been below their desired level because they, at least until recently, are credit constrained. An increase in income will, therefore, increase schooling affordability.

2.3 Empirical Estimates

The following three models are regressed to examine the nexus between savings and growth:

$$s_{it}^{X} = a_0 + a_1 A_{it}^{Y} + a_2 A_{it}^{O} + a_3 r_{it} + a_4 g_{it}^{Z} + \varepsilon_{1,it}, \quad (4)$$

$$GER_{it}^{J} = b_0 + b_1 e_{it}^{10} + b_2 r_{it} + b_3 g_{it}^{Z} + \varepsilon_{2,it}, \quad (5)$$

$$g_{it} = c_0 + c_1 s_{it} + c_2 \left(\frac{Pat}{Pop}\right)_{it} + c_3 \Delta h_{it} + c_4 DTF_{i,t-1} + c_5 \left(\frac{Pat}{Pop} DTF\right)_{i,t-1} + \varepsilon_{3,t}, \quad (6)$$

where s^X is ($X = P, T$) private (P) and total (T) saving, measured as nominal gross financial saving divided by nominal GDP; $g^Z$is ($Z = p, H$) per capita real GDP growth rate (p) and per labor hour real GDP growth rate (H) ; A^Y is the young age dependency (ratio of the population in the 0-14 age group to the working population aged 15 to 64); A^O is the old age dependency (ratio of population in the 65+ age group to the working population aged 15 to 64); r is the real interest rate computed as the nominal interest rate minus the contemporary rate of consumer price inflation;g is the productivity growth rate; GER^J is gross enrolment rates at ($J = P, S, T$) primary (P), secondary (S) and tertiary (T) levels; h is educational attainment of the working age population; (Pat/Pop) is research intensity; Pat is the number of patent applications by residents; $Pop$is the size of the population; e^{10} is life expectancy at the age of ten; and DTF is the distance to frontier; $DTF = (\bar{y} - y)/y$, where y is productivity measured as per capita output in purchasing power parity units; and $\bar{y}$ is per capita output in purchasing power parity units at the frontier (Japan).

Country and time-dummies are included in all regressions. The regressions are undertaken in five-year non-overlapping intervals to allow for dynamic adjustment. Furthermore, five-year estimates appear to be less subject to measurement errors than one-year estimates (Johnson, Larson, Papageorgiou, and Subramanian, 2013).

We have several comments on the models. Eq. (4) is a standard growth-augmented saving model in which saving is expected to be negatively related to young and old age dependency rates as well as real interest rates. The age dependency-induced saving is allowed to differ between young and old because the literature finds that the saving behavior differs substantially between these two groups. Radelet *et al*. (1997) found old age dependency ratio insignificant in their savings regressions for Asia, and Deaton (1999) argues that families are better insurance against the inability to work than relying on saving. Only recently has the demographic transition in the AMEs rendered it more difficult to rely on children for old age support and it may turn individuals into life-cyclers; however it will still take some time

before this effect takes hold. Empirically, there is a great deal of evidence that old people save, or at least do not dissave, as required by the life-cycle model without bequest (Deaton, 1999).

The GER model, Eq. (5), is derived from the Bils and Klenow (2000) model in which schooling depends on growth, life expectancy and the real interest rate. Life expectancy at the age of ten is used as regressor instead of life expectancy at birth because it reflects better the expected returns to schooling at the time at which the would-be students or their parents make their schooling decision. Life expectancy at birth is a poor proxy for age life expectancy at the time at which the schooling decision is made because the increase in life expectancy at birth has, until recently, been dominated by a marked decrease in infant mortality.

Eq. (6) is growth as a function of the saving rate, research intensity, educational attainment, the DTF, and the interaction between the DTF and research intensity. The model encompasses the predictions of the education-extended Solow growth model, in which growth is a function of the savings rate and the change in education as a proxy for the rate of saving in the form of education, and recent endogenous growth models in which productivity advances are driven by technological progress, which is in turn driven by innovations (See, for derivation,Madsen, 2008).

The domestic innovative activity is assumed to influence productivity growth through research intensity following the Schumpeterian growth models of Aghion and Howitt (1998), Dinopoulos and Thompson (1998), Peretto (1998), Howitt (1999), Peretto and Smulders (2002), and Dinopoulos and Waldo (2005). These Schumpeterian models assume that the effectiveness of R&D dilutes due to the proliferation of products as the economy expands; thus, growth is driven by research intensity in the Schumpeterian models. Patents are divided by population to allow for product proliferation. In the steady state the number of product lines is proportional to the size of the population. To ensure sustained growth the number of patents has to increase over time to counteract the increasing range and complexity of products that lower the productivity effects of R&D activity.

DTF and its interaction with research intensity follow the prediction of the Schumpeterian growth models of Howitt (2000)andAghion and Howitt (2006). In these models a country at the technology frontier makes incremental improvements to existing leading edge technology, while countries behind the technology frontier implement technologies that have been developed elsewhere. Furthermore, Howitt (2000) shows that increasing research intensity enhances the capacity to absorb the technology developed at the

frontier. Investment in R&D is required for a country to understand the technologies that are developed at the frontier. Japan is chosen as the frontier country because it has been the regional leader in the period 1870-2011. The strong trade links, geographic proximity and cultural links to Japan renders Japan a better technological leader for these countries than the traditional frontier countries such as the UK and the US. Furthermore, Taiwan and Korea were colonies of Japan in the periods 1895-1945 and 1910-1945, respectively.

Finally, there is no direct link between the schooling (GER) regression and educational attainment in the growth equation. Growth does not directly depend on GERs because the enrolled students are not in the labor force. Instead growth depends on the educational attainment of the working age population. As shown below, educational attainment is generated by combining past GERs, age dependent life expectancies, distribution of population on ages, and the time at which an age cohort exits the labor market at the age of 65.

2.3.1 Identification strategy

Identification is a major issue here since the causality may go in either direction. The identification strategy used here is to instrument savings in the productivity growth equation in the first step and then use growth net of savings-induced growth as an instrument for growth in the savings model, following Blanchard and Perotti (2002) and Brückner (2013). This method can be shown more formally as follows.

To simplify the exposition consider the following bivariate relationship between growth and savings and where country and time sub-scripts are omitted:

$$s = \alpha g + u,$$

$$g = \beta s + e,$$

where$u$ and e are stochastic error-terms. Clearly, the coefficients of g and s are biased because $cov(g,u) \neq 0$and $cov(s,e) \neq 0$. To overcome the endogeneity problem, savings, s, is regressed on its instruments, Z:

$$s = \gamma Z + w,$$

where$w$ is a stochastic error term and $cov(Z,w) = 0$. Using the predicted value of savings, $\hat{s}$, yields g^*, which is the growth rate purged of the influence of savings:

$$g^* = g - \widehat{\beta}\hat{s}.$$

Since g* is purged of the endogenous component it yields consistent estimates in OLS regressions.

To see that this method eliminates the simultaneity bias, consider first the probably limit of the OLS estimator:

$$Plim\ \alpha^{OLS} = \alpha + \frac{\beta}{1-\alpha\beta}\frac{var(u)}{var(g)} + \frac{1}{1-\alpha\beta}\frac{cov(u,e)}{var(g)}, \quad (7)$$

where the second term on the right-hand-side is the simultaneity bias and the third term is the omitted variable bias.

The probably limit of the IV estimator is:

$$Plim\ \alpha^{IV} = \alpha + \frac{1}{1-\alpha\beta}\frac{cov(u,e)}{cov(e,g)}. \quad (8)$$

Comparing Eqs. (7) and (8) indicates that the IV strategy used here eliminates the simultaneity bias.

Although, the two-step identification strategy overcomes the simultaneity bias, the efficiency of this method rests on the ability to find instruments that can explain a large fraction of the variance in saving. We may be able to find instruments that are statistically significant determinants of saving; however, if they only explain a little fraction of the variance in saving we get that g^* and g are highly correlated and unless this high correlation reflects that growth is little affected by saving, the two-step identification procedure may not represent advances over previous identification strategies.

2.3.2 Instruments

As mentioned above, life expectancy at the age of ten, the gender ratio and young age dependency are used as instruments for saving. Instruments are not used for educational attainment since educational attainment is determined by the decision to enroll in education up to 58 years earlier. Old age dependency rate is excluded from the instrument set because of the reasons given above and because it was insignificant in initial regressions.

Life expectancy at the age of ten, e^{10}, is likely to be a good instrument for saving following from the predictions of the life-cycle hypothesis that people save more the longer they expect to live after retirement. Bloom, Canning, and Graham (2003)add health and longevity to a standard model of life-cycle saving and show that a rise in life expectancy increases the optimal length of life spent working, but not by enough to offset the increased need for retirement income. Therefore, savings rates rise at every age as longevity rises in order to meet the increased need for assets to finance consumption during retirement. In the

regressions we have chosen life expectancy at the age of ten as opposed to the life expectancy at birth because the latter is highly influenced by infant mortality, as discussed above, and because infant mortality may be affected negatively by contemporary growth. Life expectancy at the age of ten, however, is not affected by contemporaneous growth but is determined by inflammation and oxygenation throughout life (Finch, 2010).

The gender ratio, (*M*/*F*), measured as the ratio of males and females aged between 10 and 24, is used as an instrument for saving because it is potentially important for the savings behavior and, at the same time, is likely to be exogenous. The significant historical variations in the *M*/*F* rate ensure large identifying variations in the data. Data are used for the 10-24 year age group because it includes the age at which the males start competing in the marriage market. The gender ratio has, traditionally, been highly skewed in favor of boys in South Asia, Southeast and East Asia in the period considered in this paper and the strong male-bias has been achieved through infanticide, abortions, and negligence of baby girls when they are sick.

Male-bias sex ratios are likely to reduce saving for four reasons. First, the AMEs, at least until recently, has relied on their boys for old age support, which implies that a high male gender-ratio will reduce precautionary saving. Furthermore, groom prices such as dowries in which the bride's parents pay a sum to the groom's parents for the gift exchange, has been widely practiced in India. An increasing male-biased sex-ratio will, consequently, lower saving. Second, a male-biased sex ratio increases men's competition for mates. In order to improve their attractiveness men will advertise their financial resources through conspicuous spending of items such as upmarket cars, expensive houses, and fancy clothes (Griskevicius *et al*., 2012). The thesis that consumption is used to show status was already put forward in the late 19th century by Veblen (1899) who argued that each social class tries to emulate the consumption behavior of the class above it, to such an extent that even the poorest people are pressured to engage in conspicuous consumption. Thus, to gain a competitive edge in the marriage market, males will acquire new consumption goods to distinguish themselves from other males.

Third, evolutionary biology in animal behavior finds that an abundance of rivals will lead men to value immediate rewards because there is a trade-off between acquiring immediate resources and waiting in hopes of acquiring more or better quality resources in the future (Griskevicius, Delton, Robertson, and Tybur, 2011). Evolutionary perspective highlights an important drawback of delaying rewards: If a man forgoes picking the fruit immediately, there is no guarantee that any fruit will be left in the future or that he will be around to collect them even if there are remaining fruit. Furthermore, increased competition

for limited resources, such as when there is an abundance of rivals, decreases the likelihood that any fruit will remain accessible in the future.[3]Fourth, examining the financial behavior of males and females in the US Griskevicius *et al*. (2012) find that male-biased sex ratios are significantly associated with having more credit cards and higher debt.

2.3.3 Data

Financial saving is measured as private, s^P as well as total saving, s^T. Private saving is measured as total saving minus public saving, where public saving is the surplus on the government's primary balance net of interest payments on government debt. Theory gives conflicting guidelines whether to use total or private saving in the individual's saving function. According to the Barro-Ricardo equivalence theorem total saving is the relevant saving variable in the saving function since government debt belongs to the individual consumer. If, on the other hand, consumers do not internalize government deficits, it follows that private saving is the essential variable in the saving function. In the basic IS-LM model, for example, there are no counterbalancing private savings effects from discretionary fiscal policies and, therefore, it is private saving that is the essential variable in this model.

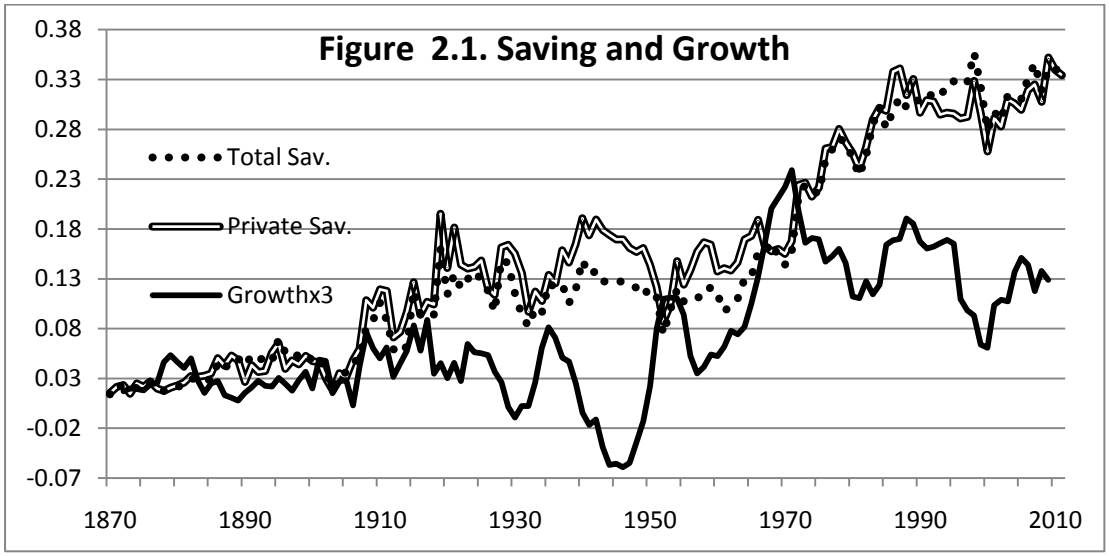
The saving data are constructed using one of two methods for each individual country depending on data availability. The first method estimates total nominal savings as total nominal fixed investment plus the current account on the balance of payments. The second method computes total nominal savings as the nominal GDP minus nominal government and private consumption. Private savings are then total savings minus the surplus on the government budget including interests on government debt. Educational attainment is estimated by combining GER's and the age distribution of the population following the method suggested by Madsen (2010). Total educational attainment is computed as the sum of primary, secondary and tertiary educational attainment.

Growth is measured either as per capita income growth, g^P, or per labor hour income growth, g^H, where labor hours is annual hours worked multiplied by employment in full-time equivalents. The importance of basing growth on labor hours is that the exclusion restriction for savings only holds when labor productivity growth is used as regressor because the young age dependency rate is negatively related to per capita income, while labor productivity is unaffected. Furthermore, labor productivity is a more accurate measure of productivity than

[3]The potential effects of unbalanced sex ratios are likely to be more prominent in males than females. Male-biased sex ratios are likely to increase intrasexual competition of males because they are at an increased risk of failing to attract a mate when there is a scarcity of females (Kvarnemo and Forsgren, 2000)

per capita output in growth models since annual hours worked and labor force participation rates have changed substantially over time for the countries considered here. The downside of using GDP per hour worked is that employment data are mostly based on census data prior to WWII and, therefore, had to be interpolated between the census periods (usually every ten year). This problem is alleviated by our five-year interval estimates.

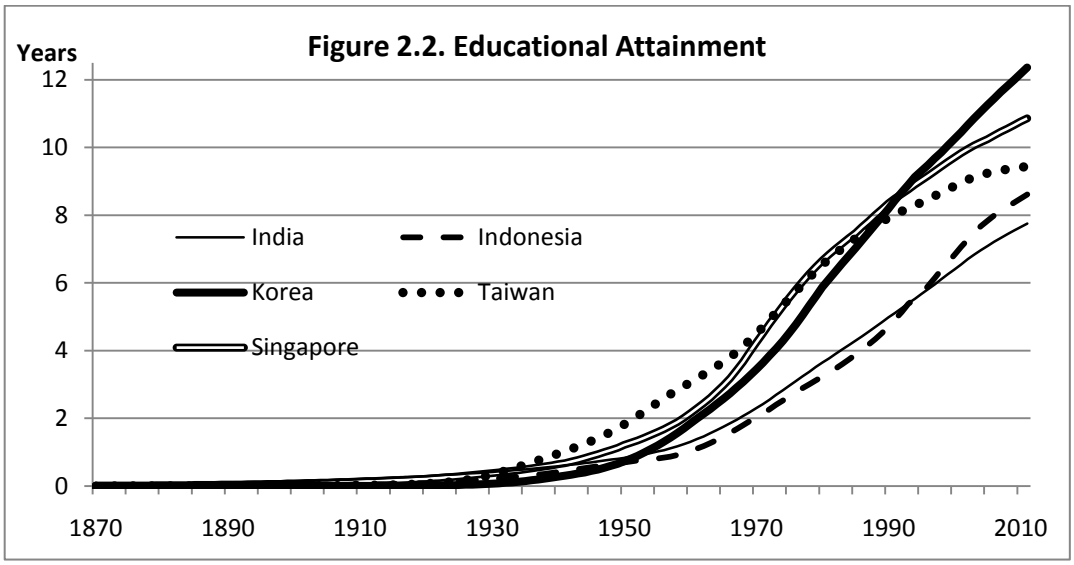
Figure 2.1 traces private and total savings rates and growth rates (multiplied by three) for the AMEs over the period 1870-2011. Private and the total saving rates almost coincide prior to 1920 and after 1970; however, private saving was, on average, higher than total savings in the interim period, 1920-1970, indicating that governments were running government deficits. The private saving rate gradually increased up to WWII, increased markedly during WWII, increased significantly up to the Asian Crisis in 1998 and has since stabilized at around 30%. Growth rates fluctuated around one percent up to 1906, notched up to approximately 1.5% in period 1906-1926 before entering the downturns during the Great Depression and WWII. From 1965 up until today the growth rates have fluctuated around five percent.



Notes. The data are unweighted averages of the AMEs. The growth rates are 5-year centered moving averages of per capita income growth rates. The growth rates are in decimal points and are multiplied by three.

The figure indicates a positive relationship between growth and saving. Saving and growth were both at low levels up to around 1906, shift up to a higher level over the period 1906-1928 and rose to high levels in the post-WWII period. The period 1929-1950 is unusual and dominated by the Great Depression and WWII. Savings rates went up during the Great

Depression as well as during and immediately after WWII, presumably because of goods rationing, forced saving and uncertainty.



Educational attainment is displayed in Figure 2.2. The labor force was incredibly uneducated before WWII. In 1900 the average educational attainment of the working population was 0.05 years; figures that are supported by literacy rates in 1900 - the earliest year at which literacy rates are available. Literacy rates of the adult population in 1900 were between 5 and 10 percent in the AME economies while they exceeded 90 percent in North-West and North Europe, the US, Australia, New Zealand and Canada (Barret, 1982). Educational attainment in 1940 was, on average, one year, which was even well below that of the OECD countries in 1870 (Madsen, 2014). Thus, in 1940 there was little indication that the AMEs would later be among the most successful and highly educated economies in the world. The increase in educational attainment in the post WWII period has been spectacular and the educational attainment of Korea and Singapore is almost on par with that of the mature OECD countries today. Remarkably, the timing of the take-off in educational attainment corresponds to the timing of the productivity take-off. In terms of educational attainment and productivity growth, Korea, Singapore, and Taiwan were the first countries to take off while India and Indonesia have lagged behind these countries.

2.4 Estimation Results

Simple regressions without control variables are first carried out in Sections 2.4.1 and 2.4.2, while, to deal with the effects of omitted variables, full growth regressions are presented in Sections 2.4.3 and 2.4.4.

2.4.1 Simple growth regressions

The first-round regressions, in which saving rates are regressed on their instruments, are presented in the lower panel in Table 1. The *F*-tests for excluded restrictions are between 15 and 12, suggesting that the instruments are sufficiently correlated with savings to serve as potentially good instruments. Furthermore, Sargan's*p*-values for overidentifying restrictions do not reject the null hypothesis of no correlation between the instruments and the residuals from the structural regressions in any case; thus giving further evidence in favor of the instruments. Finally, the coefficients of the instruments are of the right sign and significant, particularly, in the total savings regressions.

Table 2.1.Restricted Growth Regressions (Eq. (6)).

	Per capita real GDP growth rate (g_{it}^{P})				**Per labor hour real GDP growth rate (g_{it}^{H})**			
	LS (1)	**IV (2)**	**LS (3)**	**IV (4)**	**LS (5)**	**IV (6)**	**LS (7)**	**IV (8)**
s_{it}^{Tot}	0.450*** (0.007)	0.016 (0.962)			0.188 (0.449)	-0.458 (0.378)		
s_{it}^{Priv}			0.338** (0.045)	-0.171 (0.740)			0.259 (0.302)	-0.661 (0.400)
Sargan test p value		0.132		0.156		0.821		0.812
First Stage Regression: Total Saving (s_{it}^{T})					**First Stage Regression: Private Saving (s_{it}^{P})**			
	(1b)				(2b)			
$(M/F)_{it}$	-0.189*** (0.000)				-0.155*** (0.003)			
e_{it}^{10}	0.005*** (0.014)				0.005** (0.047)			
A_{it}^{Y}	-0.352*** (0.000)				-0.168* (0.067)			
First Stage *F*-stat	15.247				11.746			

Notes. The results are based on 5-year interval data and the number of observations is 145. The numbers in parentheses are *p*-values. LS = least squares regression, IV = instrument variable regression. The Instrumental Variables (IVs) are male–female ratio in the age group 10-24, (*M*/*F*), life expectancy at age 10, e^{10}, and young age dependency ratio for both total and private savings. Asterisks denote significant difference from zero at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

Considering the structural regressions in the upper panel in Table 2.1, the OLS regressions give mixed results. When growth is based on per capita income, the saving rate has a statistically significant effect on growth as predicted by the standard Solow growth model (columns (1) and (3)) and the coefficients of savings are close to the prediction of ½ in the

Solow model when capital's share is set to 1/3 (Mankiw *et al*., 1992). However, the coefficients of saving become insignificant when growth is based on GDP per hour worked (columns (5) and (7)); showing that the results, crucially, depend on the way productivity is measured and that per capita income may be a misleading measure of productivity. Turning to the IV regressions, the coefficients of savings are all statistically insignificant regardless of whether private or total saving is used as regressor and whether productivity is based on population or hours worked (columns (2), (4), (6), (8)).

These results are highly surprising given that capital accumulation is often stressed as the fundamental factor of growth and capital accumulation has been assumed to be driven by saving under the assumption that investment follows saving (the Feldstein-Horioka puzzle, Feldstein and Horioka, 1980). However, Jiranyakul and Brahmasrene (2009) fail to find evidence for the Feldstein-Horioka puzzle for Southeast Asia, suggesting that capital accumulation may not have been driven entirely by saving because part of the saving flows overseas. Furthermore, a large fraction of investment consists of unproductive investment in property and if a large and changing fraction of saving is channeled into real estate, the relationship between savings and growth may break down.

Characteristic for AMEs is that the current account balances have often been positive in periods of high growth; a result that is consistent with the empirical estimates of Gourinchas and Jeanne (2007) and, which is counter to the predictions of the standard neoclassical growth model (Gourinchas and Jeanne, 2007). In the context of this paper the finding that saving exceeds investment in high growth periods delinks a potentially positive relationship between saving and growth. Thus, the insignificance of saving in the growth regression may not be a puzzle after all. Since investment plays such a large role for growth in standard growth models, the growth-investment nexus is investigated further below to ensure that the results in Table 1 do not reflect measurement errors.

2.4.2 Simple saving regressions

The results of estimating the saving model are presented in Table 2.2. Growth is a statistically significant and positive determinant of saving in the least squares estimates when growth is based on per capita income but insignificant when growth is based on GDP per hour worked. However, growth is consistently highly significant and positive in the IV regressions regardless of how growth and saving are measured, underscoring the importance

of using instruments in the regresions. The economic significance of the growth rates is also very high. Using the average coefficient of growth of 0.l5 (per capita income) and 0.10 (per hour worked GDP) from the IV regresions, a one percentage point increase in the growth rate is associated with an increase in the savings rate by 0.15 and 0.10; thus, indicating that the savings rates experienced by the AMEs today are, to a large extent, explained by the high growth rates.

Table 2.2 Restricted Saving Regressions (Eq. (4)).

	Dependent variable: Total Saving (s_{it}^T)				**Dependent variable: Private Saving (s_{it}^P)**			
	LS (1)	**IV (2)**	**LS (3)**	**IV (4)**	**LS (5)**	**IV (6)**	**LS (7)**	**IV (8)**
g_{it}^P	0.147*** (0.002)	0.143*** (0.002)			0.116** (0.024)	0.161*** (0.002)		
g_{it}^H			0.044 (0.168)	0.093*** (0.005)			0.048 (0.159)	0.129*** (0.001)
$(M/F)_{it}$	-0.206*** (0.000)	-0.206*** (0.000)	-0.195*** (0.000)	-0.201*** (0.000)	-0.168*** (0.001)	-0.173*** (0.001)	-0.161*** (0.002)	-0.171*** (0.001)
e_{it}^{10}	0.005*** (0.014)	0.005*** (0.014)	0.005*** (0.013)	0.005*** (0.015)	0.004** (0.051)	0.004** (0.056)	0.005** (0.046)	0.005** (0.052)
A_{it}^Y	-0.321*** (0.000)	-0.322*** (0.000)	-0.357*** (0.000)	-0.362*** (0.000)	-0.143 (0.114)	-0.133 (0.142)	-0.172* (0.059)	-0.180** (0.054)

Notes: see notes to Table 1.

Finally, the coefficients of the gender ratio, life expectancy at the age of 10 and young age dependency are all of the right sign and mostly significant; particularly the coefficients of the gender ratio, which are highly significant. As life expectancy at the age of 10 has increased and the young age dependency ratio has decreased since 1960 or earlier, these variables have contributed to increasing saving along with growth. The gender ratio has also mostly contributed to the increase in saving; however its path has differed somewhat across countries.

2.4.3 Unrestricted growth regression

Control variables are included in the growth regressions in Table 2.3. The coefficients of saving are insignificant except for the OLS regressions for total saving and where growth is based on per capita GDP. The coefficients of human capital are consistently significant and of the right sign. The approximately 10 year increase in educational attainment for the average AME in the post-WWII period has resulted in a 253 percent increase in GDP per

hour worked and 170 per cent increase in per capita income. Thus, improved education has been an important force behind the productively increase in the AMEs.

Table 2.3. Unrestricted Growth Regressions (Eq. (6)).

	Per Capita Real GDP Growth Rate (g_{it}^{p})					**Per Labor hour Real GDP Growth Rate (g_{it}^{h})**				
	LS (1)	**IV (2)**	**LS (3)**	**IV (4)**	**LS (5)**	**LS (6)**	**IV (7)**	**LS (8)**	**IV (9)**	**LS (10)**
s_{it}^{T}	0.389** (0.031)	-0.200 (0.613)				0.223 (0.426)	-0.291 (0.627)			
s_{it}^{P}			0.283* (0.092)	-0.348 (0.485)				0.284 (0.273)	-0.272 (0.713)	
$\left(\frac{invst}{gdp}\right)_{it}$					0.926*** (0.004)					-0.052 (0.919)
$\left(\frac{Pat}{Pop}\right)_{it}$	-0.063 (0.126)	-0.095** (0.023)	-0.072* (0.076)	-0.098** (0.019)	-0.078** (0.044)	-0.003 (0.951)	-0.032 (0.610)	-0.004 (0.946)	-0.027 (0.658)	-0.016 (0.792)
Δh_{it}	0.165** (0.021)	0.179*** (0.005)	0.176** (0.014)	0.172*** (0.008)	0.079 (0.295)	0.250** (0.025)	0.263*** (0.007)	0.257** (0.020)	0.254*** (0.008)	0.261** (0.034)
$DTF_{i,t-1}$	0.0006 (0.925)	-0.007 (0.332)	-0.003 (0.654)	-0.007 (0.278)	-0.001 (0.874)	0.012 (0.226)	0.005 (0.643)	0.011 (0.241)	0.008 (0.436)	0.009 (0.347)
$\left(\frac{Pat}{Pop}DTF\right)_{i,t-1}$	0.251*** (0.005)	0.238*** (0.003)	0.241*** (0.008)	0.244*** (0.003)	0.212** (0.017)	0.237* (0.089)	0.226* (0.062)	0.231* (0.096)	0.234* (0.053)	0.234* (0.096)
Sargan test p value		0.445		0.522			0.584		0.557	

Note. See notes to Table 1.

The coefficients of the interaction between research intensity and the *DTF* are significant and positive; however, individually the coefficients of the *DTF* and research intensity are not growth stimulating. Thus, innovations have been growth enhancing because they have enabled the AMEs to adapt and imitate the technology that has been developed at the frontier (Japan). The insignificance of the coefficients of *DTF* suggests that formal and informal R&D have to be undertaken in order to adapt the technology developed at the frontier – being backward is not a sufficient condition for growth.

2.4.4 Unrestricted savings regressions

The savings regressions in Table 2.4 extend the regressions in Table 2.2 with old age dependency, the real interest rate and urbanization as additional regressors. In line with other empirical literature, the real interest rate as well as the old age dependency ratio is insignificant except in one case. In terms of statistical significance, the inclusion of control variables has not changed the basic regression results in Table 2.2. Per capita income growth is a positive and significant determinant of saving in all regressions, while per hour worked income growth is only a significant determinant of saving in the IV regressions.

Table 2.4. Unrestricted Saving Regressions (Eq. (4)).

	Dependent variable: Total saving (s_{it}^T)				Dependent variable: Private saving (s_{it}^P)			
	LS (1)	IV (2)	LS (3)	IV (4)	LS (5)	IV (6)	LS (7)	IV (8)
g_{it}^P	0.162*** (0.001)	0.158*** (0.000)			0.133** (0.011)	0.180*** (0.000)		
g_{it}^H			0.0466 (0.152)	0.0960*** (0.001)			0.0528 (0.129)	0.134*** (0.000)
$(M/F)_{it}$	-0.190*** (0.000)	-0.189*** (0.000)	-0.184*** (0.000)	-0.188*** (0.000)	-0.151*** (0.004)	-0.154*** (0.000)	-0.147*** (0.005)	-0.155*** (0.001)
e_{it}^{10}	0.005** (0.013)	0.005*** (0.003)	0.005** (0.015)	0.006*** (0.004)	0.004** (0.040)	0.005** (0.016)	0.005** (0.039)	0.005** (0.016)
A_{it}^Y	-0.277*** (0.002)	-0.278*** (0.000)	-0.332*** (0.000)	-0.333*** (0.000)	-0.0973 (0.310)	-0.0814 (0.320)	-0.143 (0.137)	-0.145* (0.084)
A_{it}^O	0.909 (0.146)	0.897* (0.091)	0.529 (0.407)	0.634 (0.249)	1.000 (0.146)	1.139* (0.052)	0.718 (0.295)	0.889 (0.137)
r_{it}	0.008 (0.836)	0.008 (0.805)	0.010 (0.802)	0.007 (0.852)	-0.012 (0.778)	-0.014 (0.708)	-0.012 (0.794)	-0.018 (0.649)

Note. See notes to Table 1.

2.4.5 Schooling and growth

The GERs regressions (Eq. (5)) are presented in Table 2.5. Three sets of estimates are presented: Estimates with and without time-dummies over the period 1870-2011, and estimates including time-dummies in the post-WWII period (1950-2011). Separate regressions are carried out in the post-WWII period because school enrollment rates were negligible before WWII. Country fixed effect dummies are included in all regressions. As noted above, growth is not instrumented because there is no feedback effect from GERs to growth. Changes in educational attainment - the ultimate growth outcome of schooling - are determined by changes in historical GERs, age-dependent survival rates and relative sizes of GERs between age cohorts; factors that are quite independent of economic growth.

Table 2.5.GER Regressions 1870-2011 (Eq. (5)).

	Total GER		**Primary GER**		**Secondary GER**		**Tertiary GER**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
g_{it}^P	0.445*** (0.004)	0.208 (0.257)	0.255** (0.017)	0.120 (0.262)	0.286*** (0.000)	0.169*** (0.005)	-0.097 (0.228)	-0.082 (0.407)
e_{it}^{10}	0.068*** (0.000)	0.019** (0.015)	0.035*** (0.000)	0.013*** (0.005)	0.021*** (0.000)	0.0003 (0.904)	0.012*** (0.000)	0.006 (0.170)
r_{it}	0.156 (0.250)	0.287* (0.074)	-0.084 (0.374)	0.080 (0.389)	0.115** (0.050)	0.090* (0.079)	0.126* (0.080)	0.116 (0.178)
Observations	145	145	145	145	145	145	145	145
R^2	0.906	0.940	0.848	0.931	0.849	0.945	0.483	0.652
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes

Notes. The numbers in parentheses are *p*-values. Asterisks denote significant difference from zero at * 10% significance, ** 5% significance, *** 1% significance.

In the regressions covering the period 1870-2011 the coefficients of growth are positive and highly significant for all levels of schooling as well as for GER^P and GER^S in the regressions in which the time-dummies are excluded. However, the coefficients of growth become insignificant when time-dummies are included in the regressions. This result reveals an important methodological dilemma: Including time fixed effects purges informative variation from the data; however excluding them may introduce a potential omitted variable bias. Since the time-fixed effects purge informative variation - the common element in the variation over time - it is questionable whether the time-dummies belong to the regression model. In any event, the insignificance of growth when time-dummies are included in the regressions is, to a large extent, driven by the pre-WWII data. In the post-WWII regressions in Table 6 growth is significant in the GER^P and GER^S regressions regardless of whether time-dummies are included (results without time-dummies are not shown).

Table 2.6.GER Regressions 1950-2011 (Eq. (5)).

	Total GER		**Primary GER**		**Secondary GER**		**Tertiary GER**	
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
g_{it}^P	0.658** (0.021)		0.426** (0.021)		0.369*** (0.001)		-0.138 (0.407)	
g_{it}^h		0.289* (0.086)		0.116 (0.292)		0.125* (0.073)		0.0480 (0.621)
e_{it}^{10}	0.0780*** (0.000)	0.0622*** (0.001)	0.0294** (0.015)	0.0185 (0.103)	0.0160** (0.028)	0.00671 (0.337)	0.0326*** (0.004)	0.0370*** (0.000)
r_{it}	0.697** (0.019)	0.377 (0.189)	0.329* (0.084)	0.145 (0.445)	0.162 (0.154)	-0.00509 (0.965)	0.205 (0.239)	0.238 (0.159)
A_{it}^Y	-1.350*** (0.003)	-1.432*** (0.003)	0.416 (0.137)	0.423 (0.164)	-0.429** (0.013)	-0.443** (0.022)	-1.337*** (0.000)	-1.412*** (0.000)
Observations	65	65	65	65	65	65	65	65
R^2	0.907	0.902	0.739	0.713	0.922	0.908	0.816	0.814
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes. The numbers in parentheses are *p*-values. Asterisks denote significant difference from zero at * 10% significance, ** 5% significance, *** 1% significance.

Overall it can be concluded that growth is highly influential for schooling after WWII but less so before WWII. A problem associated with the pre-WWII data is that GERs were minuscule and not very reliable because of the informality of the schooling systems and the lack of adequate reporting of school enrollment. Since school funding is dependent on number of pupils, schools would have incentives to over report the number of enrolled children; particularly back in time when it was difficult to monitor schools (Madsen, 2014).

2.5 The Growth-Saving Nexus before and after WWII

WWII is a landmark in the AMEs growth history. Before that time people were uneducated, innovative activity was close to zero and growth rates were very low. This raises the question of whether the growth and saving dynamics as well as the growth-saving relationship were different before and after WWII. To examine these issues the estimation period is split into the periods 1870-1945 and 1945-2011.

Consider first the result of estimating Eq. (6) (growth regression) over the period 1870-1945 in Table 2.7. All the coefficients of educational attainment, research intensity, and the interaction between research intensity and DTF are insignificant. However, the coefficients of DTF are positive and significant in three of the four cases. Finally, the coefficients of saving are all insignificant.

Table 2.7. UnrestrictedGrowth Regressions, 1870-1945, 1945-2011 (Eq. (6)).

	1870-1945				**1945-2011**			
	Per Capita Real GDP Growth Rate (g_{it}^{p})		**Per Labor hour Real GDP Growth Rate (g_{it}^{h})**		**Per Capita Real GDP Growth Rate (g_{it}^{p})**		**Per Labor hour Real GDP Growth Rate (g_{it}^{h})**	
	IV(1)	IV(2)	IV(3)	IV(4)	IV(5)	IV(6)	IV(7)	IV(8)
s_{it}^{T}	0.845 (0.152)		0.485 (0.522)		-0.403 (0.311)		-0.0899 (0.905)	
s_{it}^{P}		1.313 (0.117)		0.508 (0.613)		-0.115 (0.796)		0.287 (0.735)
$\left(\frac{Pat}{Pop}\right)_{it}$	-4.105 (0.117)	-4.957 (0.100)	-1.934 (0.565)	-1.836 (0.611)	-0.121*** (0.005)	-0.102** (0.015)	-0.0209 (0.796)	-0.000306 (0.997)
Δh_{it}	-0.226 (0.482)	-0.408 (0.290)	-0.121 (0.768)	-0.170 (0.714)	0.167** (0.013)	0.162** (0.018)	0.268** (0.036)	0.276** (0.033)
$DTF_{i,t-1}$	0.0812 (0.103)	0.118* (0.065)	0.183*** (0.004)	0.192** (0.012)	-0.0150 (0.138)	-0.00924 (0.306)	0.00856 (0.656)	0.0138 (0.423)
$\left(\frac{Pat}{Pop}DTF\right)_{i,t-1}$	2.788 (0.298)	0.740 (0.838)	0.296 (0.931)	-0.0607 (0.989)	0.196** (0.016)	0.196** (0.015)	0.105 (0.494)	0.103 (0.504)
Sargan test p value	0.306	0.512	0.0675	0.0656	0.00254	0.00143	0.178	0.184
	First Stage Regression: Total Saving (s_{it}^{T})		**First Stage Regression: Private Saving (s_{it}^{P})**		**First Stage Regression: Total Saving (s_{it}^{T})**		**First Stage Regression: Private Saving (s_{it}^{P})**	
	(1b)		(2b)		(3b)		(4b)	
$(M/F)_{it}$	-1.391*** (0.000)		-1.304*** (0.001)		-0.196*** (0.000)		-0.187*** (0.000)	
e_{it}^{10}	0.00808** (0.010)		0.00788** (0.029)		0.00426 (0.197)		0.000420 (0.902)	
A_{it}^{Y}	-0.811** (0.026)		-0.584 (0.159)		-0.392*** (0.000)		-0.255*** (0.006)	
First Stage F-stat	5.820		5.725		19.01		11.08	

Note. See notes to Table 1.

Turning to the post-WWII regressions, the coefficients of saving are insignificant regardless of whether total or private saving is used as regressor and whether growth is based on per

capita income or output per hour worked. This result suggests that the high post-WWII growth rates have not been driven by saving, which, therefore, challenges the hypothesis that growth in the AMEs has been fuelled by high savings rates. Among the covariates, educational attainment is consistently positive and significant and the coefficients of the interaction between research intensity and DTF remain positive and significant in the per capita income growth regressions.

Table 2.8. UnrestrictedSavings Regressions, 1870-1945, 1945-2011 (Eq. (4)).

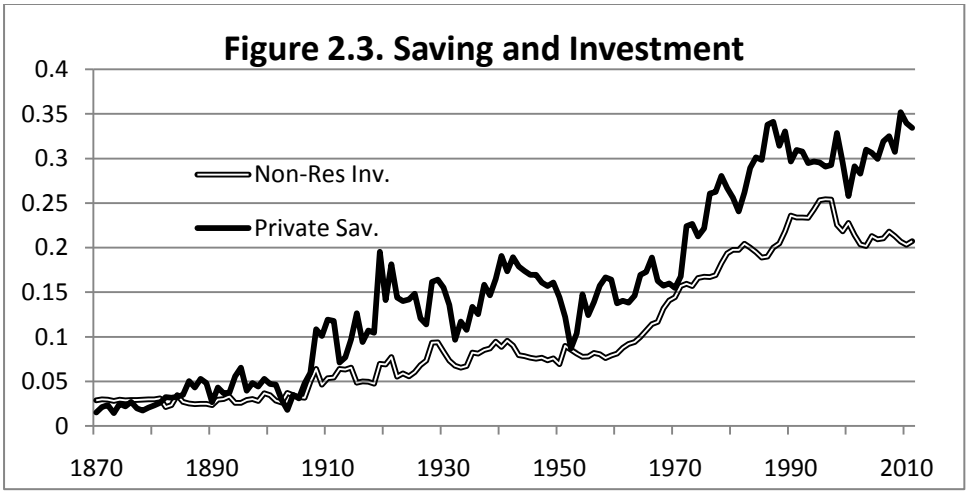
	1870-1945				**1950-2011**			
	Dependent variable: Total Saving (s_{it}^T)		**Dependent variable: Private Saving (s_{it}^p)**		**Dependent variable: Total Saving (s_{it}^T)**		**Dependent variable: Private Saving (s_{it}^p)**	
	IV(1)	IV(2)	IV(3)	IV(4)	IV(5)	IV(6)	IV(7)	IV(8)
g_{it}^p	0.143*** (0.008)		0.162*** (0.010)		0.110** (0.020)		-0.018 (0.710)	
g_{it}^H		0.179*** (0.000)		0.209*** (0.000)		0.056** (0.024)		0.063** (0.013)
$(M/F)_{it}$	-1.420*** (0.000)	-1.421*** (0.000)	-1.299*** (0.000)	-1.297*** (0.000)	-0.201** (0.010)	-0.199*** (0.000)	-0.178*** (0.000)	-0.189*** (0.000)
e_{it}^{10}	0.007*** (0.004)	0.008*** (0.003)	0.008*** (0.005)	0.009*** (0.005)	0.005* (0.097)	0.004 (0.226)	-0.002 (0.497)	-0.001 (0.798)
A_{it}^y	-0.763** (0.012)	-0.721** (0.020)	-0.406 (0.248)	-0.349 (0.343)	-0.329*** (0.000)	-0.340*** (0.000)	-0.158* (0.073)	-0.178** (0.045)
A_{it}^o	-2.791 (0.534)	-6.310 (0.162)	0.843 (0.870)	-3.182 (0.554)	0.798 (0.115)	0.723 (0.157)	0.953* (0.072)	0.996* (0.060)
r_{it}	-0.091** (0.022)	-0.079** (0.049)	-0.121*** (0.008)	-0.107** (0.024)	-0.031 (0.505)	-0.064 (0.159)	-0.054 (0.267)	-0.053 (0.259)

Note. See notes to Table 1.

The results of estimating the unrestricted savings models in the split periods are presented in Table 2.8. The coefficients of growth are significant in seven of the eight regressions regardless of estimation period or the measurement method of saving and growth rates. The significance of the finding that savings are positively affected by growth in the pre-WWII period is that it has not been the high growth rates in the postwar period that has triggered the high savings rates; the result appears to have general validity for the AMEs. Of the control variables, the gender ratio is consistently negative and significant in both estimations periods and the young age dependency ratio is negatively significant in six of the eight cases. The coefficients of life expectancy at ten are significantly positive in six of the eight cases. Finally, the coefficients of the real interest rates are negative and significant in the pre-1945 regressions, suggesting a higher income than substitution effect in savings during this period.

2.6 Investment and Growth

The finding that saving is consistently an insignificant determinant of growth raises the question as to whether this insignificance reflects that saving is a bad proxy for investment or that investment has not contributed to growth in the AMEs. To investigate this issue the investment rate is used instead of savings in the growth regressions. Before turning to the regression results consider the investment rate (real investment divided by real GDP) and the private savings rate displayed in Figure 2.3. Non-residential investment is used instead of total investment because residential investment is a large fraction of investment and, yet, it does not impinge directly on growth.



Note. Unweighted average of the AMEs.

The figure shows that investment follows the same broad trend as private saving. Starting out with low investment in 1870, the investment ratio climbs to a higher plateau in 1906, which lasts to 1960 after which the ratio continuously increased up to the mid-1990s. However, there are several instances of discrepancies between saving and investment; particularly in the period 1906-1960 during which private saving fluctuated markedly while the investment rate was relatively stable. Furthermore, the investment ratio starts increasing in 1960, which is ten years before private saving starts ascending to a higher plateau. This profile suggests that investment in the AMEs has been fuelled by factors other than saving during the crucial take-off phase. Finally, private saving and investment rates have moved in reverse over the past 25 years. Thus, overall, private savings rates appear not to be adequate proxies for non-residential investment because of wedges created by changing government

budget positions, changing current account balances and fluctuations in residential investment.

The non-residential investment ratio is substituted for the saving rate in the extended growth regression in Table 2.3 in columns 5 and 10. The coefficient of the investment rate is statistically and economically highly significant when the growth rate is based on per capita GDP; however, it becomes insignificant when per hours worked GDP is the dependent variable. The coefficient of the investment rate in the regression in column 5 is higher than the predictions of 0.5 in the Solow model when labor's income share is set to 2/3 of national income. This result has two implications. First, investment is a much more significant determinant of growth than the savings rate, indicating that saving is a noisy and inadequate proxy for non-residential investment. Second, the finding that the coefficient of the investment ratio strongly exceeds the predictions of the Solow model in the per capita income growth regression suggests that there are potentially large positive externalities to non-residential investment as advocated and found by Romer (1987)and De Long and Summers (1991).

2.7 Concluding Remarks

Several economists have long argued that accumulation of fixed and human capital have been the driving forces behind the AMEs high growth rates over the past half century and, therefore, that the human capital-extended Solow model is well-equipped to explain the Asian growth miracle. This prediction rests on the assumption that saving and schooling are independent of growth and that saving induces investment in fixed productive capital. Theories of saving, however, often predict that growth enhances saving and, therefore, that accumulation of fixed and human capital cannot be assumed to be exogenous and independent of productivity growth. Furthermore, the Confucian value system that has dominated the AMEs cultures for centuries, values education and thrifty lifestyles highly; however, living standards close to subsistence levels almost up to WWII offered households in the AMEs only a few saving opportunities. The increasing living standards after WWII gave the East Asians the opportunity to increase their financial saving and improve their children's education; thus rendering the assumption that saving and education are exogenous dubious.

Utilizing a two-way identification strategy and unique data covering the period 1870-2011 for the AMEs this paper has shown that 1) financial saving as well as education has

been driven predominantly by productivity growth; 2) growth is independent of the level of saving; and 3) growth is positively related to the change in educational attainment. These results were robust to choice of instrument set, productivity measurement, the choice of growth model, measurement of saving, inclusion of covariates, and to choice of estimation period.

The finding of a one-way relationship from growth to financial saving is a major challenge to the hypothesis that capital accumulation, enabled by saving, has been the prime mover behind the Asian growth miracle and a major challenge for the early workhorse growth model of Harrod (1939) and Domar (1946) in which growth directly and nearly exclusively is linked to the savings rate. The markedly increasing saving rates starting after WWII were primarily set in motion by growth while fluctuations in saving have often been channeled overseas and to residential investment.

The results in the paper point towards a more complicated growth scenario in the AMEs than hypothesized by the factor accumulation hypothesis. Forces other than saving have set growth in motion and the high growth rates have resulted in spectacular savings rates, which in turn have financed investment. Bloom and Williamson (1998) showed that the demographic transition has been influential for the Asian growth miracle and Hsieh and Klenow (2010) have shown that the reallocation of unproductive firms to productive entities has boosted growth in China, an effect that could well have applied to the countries considered here. Ang and Madsen (2011) haveshown that growth has been, predominantly, innovation driven.

Data Appendix

Total Saving-GDP ratio: Two methods are used depending on data availability: **Method 1 (M1)**. S (Total Savings) = I (Investment) + CA (Current Account) (M1) where Gross Fixed Capital Formation (GFCF) and Capital Formation (CF) are said to be Investment. **Method 2 (M2)**. S (Total Savings) = Y (Nominal GDP) – C (Consumption) – G (Government Purchases). Total Saving-GDP ratio = Total Savings/Nominal GDP.

Private Saving-GDP ratio: Total Saving-GDP ratio minus Government Saving-GDP ratio where the Government Savings equals Total Government Revenue – Total Government Expenditure. Government Saving-GDP ratio = Government Savings/Nominal GDP

India:

Total Saving-GDP Ratio (M1): 1976-2011 World Development Indicator (WDI) Database: Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account(CA) to Nominal GDP ratio, 1870-1951 Investment, Nominal GDP: : Roy, B., 1996, An Analysis of Long Term Growth of National Income and Capital Formation in India (1850-51 to 1950-51), Firma KLM Private Limited, Calcutta, India. 1951-1975 Investment, Nominal GDP: Mitchell, B. R., 2007. International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York. 1870-1951 Investment, Nominal GDP spliced with 1951-1975 Investment, Nominal GDP, 1870-1922 Current Account: Net Export 1870-1923 spliced with Current Account 1923 : Net Export 1870-1923 , Mitchell B.R. *op cit*., Current Account 1923-1975: Mitchell B.R. *op cit*.

Government Saving-GDP Ratio: Government Revenue 1870 - 1989 , Government Expenditure 1870-1989 : Mitchell B.R. *op cit*., Nominal GDP 1870 – 1951: Roy, B. *op cit*. spliced with Nominal GDP 1951 – 1989 : Mitchell B.R. *op cit*., Government Revenue to GDP ratio 1990-2011, Government Expenditure to GDP ratio 1990-2011 World Development Indicator (WDI) Database.

Indonesia:

Total Saving-GDP Ratio (M1 & M2) : 1991-2011 World Development Indicator (WDI) Database: Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account(CA) to Nominal GDP ratio, Total Saving Rate 1890-1990: Total Saving/Nominal GDP, Total Saving = Nominal GDP – Household Consumption – Government Expenditure, Nominal GDP, Household Consumption: Leeuwen, V. B. 2007, Human Capital and Economic growth in India, Indonesia and Japan: A Quantitative Analysis, 1890-2000, PhD Dissertation, Utrecht University. Government Expenditure: Mitchell B.R. *op. cit*. Total Saving-GDP Ratio 1870-1889: Total Saving-GDP Ratio of Japan 1870-1890 spliced with Indonesia Total Saving-GDP Ratio 1890.

Government Saving-GDP Ratio: Government Revenue 1890 - 1995, Government Expenditure 1890-1995: Mitchell B.R. *op cit*., Nominal GDP 1890 – 1995: Leeuwen, V. B. *op cit*. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database.Government Saving-GDP Ratio 1870-1889: Government

Saving-GDP Ratio of Japan 1870-1890 spliced with Indonesia Government Saving-GDP Ratio 1890.

Korea:

Total Saving-GDP Ratio (M1): 1976-2011 World Development Indicator (WDI) Database: Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account(CA) to Nominal GDP ratio, 1911-1938 and 1955-1976 Investment, Current Account, Nominal GDP: Mitchell B.R. *op cit*., current Account 1955-1976 converted to LCU applying exchange rates: International Financial Statistics Yearbook 1987, International Monetary Fund , Total Saving-GDP Ratio 1939-1954 interpolated, Total Saving-GDP Ratio 1870-1911: Total Saving-GDP Ratio of Japan 1870-1911 spliced with Korea Total Saving-GDP Ratio 1911.

Government Saving-GDP Ratio: 1911-1938 and 1953-1990: Government Revenue, Government Expenditure, Nominal GDP Mitchell B.R. *op cit*., Government Saving-GDP Ratio 1939-1952 Interpolated, Government Revenue to GDP ratio 1990-2011, Government Expenditure to GDP ratio 1990-2011 World Development Indicator (WDI) Database. Government Saving-GDP Ratio 1870-1910: Government Saving-GDP Ratio of Japan 1870-1911 spliced with Korea Government Saving-GDP Ratio 1911.

Singapore:

Total Saving-GDP Ratio (M1): 1994-2011 World Development Indicator (WDI) Database: Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account (CA) to Nominal GDP ratio, 1900-1993: Nominal GDP, Investment : Sugimoto, I. 2011, Economic Growth of Singapore in the Twentieth Century, Historical GDP Estimates and Empirical Investigations. Soka University Japan, World Scientific Publishing Co. Pte. Ltd. Singapore. Current Account: 1900 – 1962: Current Account = (Net Export + Cumulative Net Export* 0.04), Net Export 1900-1962: Sugimoto, I. *op cit*., Current Account 1962-1993 : Mitchell B.R. *op cit*., Current Account 1900 – 1962 spliced with Current Account 1962 – 1993. Total Saving-GDP Ratio 1870-1899: Total Saving-GDP Ratio of Japan 1870-1900 spliced with Singapore Total Saving-GDP Ratio 1900.

Government Saving-GDP Ratio: Government Surplus/Deficit 1900 - 1962, Nominal GDP 1900-1962: Sugimoto, I. *op cit*., 1963-1990: Government Revenue, Government Expenditure, Nominal GDP: Mitchell B.R. *op cit*., Government Revenue to GDP ratio 1991-2011, Government Expenditure to GDP ratio 1991-2011 World Development Indicator (WDI) Database, Government Saving-GDP Ratio 1870-1899: Government Saving-GDP Ratio of Japan 1870-1900 spliced with Singapore Government Saving-GDP Ratio 1900.

Taiwan:

Total Saving-GDP Ratio (M1): 1955-2011 Total Saving-GDP Ratio: Statistical Data Book Taiwan 2011, 1903-1938 and 1951-1954 Investment, Current Account, Nominal GDP: Mitchell B.R. *op cit*., Total Saving-GDP Ratio 1939-1950 Interpolated, Total Saving-GDP Ratio 1870-1902: Total Saving-GDP Ratio of Japan 1870-1903 spliced with Taiwan Total Saving-GDP Ratio 1903.

Government Saving-GDP Ratio: 1903-1938 and 1951-1954 Government Revenue, Government Expenditure. Nominal GDP: Mitchell B.R. *op cit*., Government Saving-GDP Ratio 1939-1950 Interpolated. Government Revenue, Government Expenditure, and Nominal GDP 1955-2011 Statistical Data Book Taiwan 2011.Government Saving-GDP Ratio 1870-1902: Government Saving-GDP Ratio of Japan 1870-1903 spliced with Taiwan Government Saving-GDP Ratio 1903.

Young Age Dependency Ratio: Ratio of population in the 0-14 age group to the working population aged 15 to 64.

Old Age Dependency Ratio: Ratio of population in the 65+ year age group to the working population aged 15 to 64.

The population distributions are classified according to the following age groups: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80+. Principal data sources used were Mitchell, B. R., 2007. International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York and the United Nations (UN), 2012, World Population Prospects: The 2012 Revision, Database, http://esa.un.org/wpp/Excel-Data/population.htm, accessed on 15th of March 2013. All total population data are from Maddison, A. 2010, Historical Statistics of World Economy*:* 1-2008AD, Organization for Economic Cooperation and Development: Paris.

India

1870 was backdated using total population from Maddison, A. *op. cit*. and age distributions from 1881 as proxy. 1881, 1891, 1901, 1911, 1921, 1931, 1951, 1961, 1971, 1981, 1993 and 2001 population by age groups was obtained from Mitchell, B.R. *op. cit*. The 60-64, 65-69, 70-74, 75-79, 80+ age group data for 1881, 1891 and 1901 was obtained by decomposing Mitchell B.R. *op cit.*'s combined age groups data using 1911 age distributions. Similarly, the 70-74, 75-79, 80+ populations were obtained using 1961 age distributions as proxy. The intervening years within the census data were growth interpolated. 2002-2010 is from the UN database, while 2011 was obtained using 2010 age distributions and Maddison, A. *op. cit*.'s total population data which was growth extrapolated to 2011.

Indonesia: 1870-1949 was backdated using age distributions from India as proxy and total population from Maddison, A. *op. cit*. 1950-1960 data is from the UN database, and 1961 is from Mitchell, B.R. *op. cit*. The population within the 25-80+ age group was decomposed to the default distributions using 1971 proportions as proxy. 1971, 1980, 1993, 1995 and 2003 is from Mitchell, B.R. *op. cit.* All intervening years were growth interpolated. 2003-2010 was obtained from the UN database. 2011 was extrapolated using total population from Maddison, A. *op. cit*. and the 2010 age distributions.

Korea

1870-1929 was backdated using age distributions from India as proxy and total population from Maddison, A. *op. cit*. 1930, 1944, 1960, 1975, 1980 and 1994 census data was obtained from Mitchell, B.R. *op. cit.* The 1870-1929 backdated data was then spliced to the level census data using 1930 as base year. 1995-2010 is from the UN database. 2011 was obtained using

2010 age distributions and Maddison, A. *op. cit*.'s total population which was growth extrapolated to 2011. All intervening years were growth interpolated.

Singapore

1870-1949 was backdated using age distributions from India as proxy and total population from Maddison, A. *op. cit*. 1950-2010 is from the UN database. 2011 was obtained using 2010 age distributions and Maddison, A. *op. cit*.'s total population which was growth extrapolated to 2011.

Taiwan

1870-1904 was backdated using age distributions from India as proxy and total population from Maddison, A. *op. cit*. 1905, 1915, 1920, 1930, 1940, 1956, 1966, 1970 and 1980 census data was obtained from Mitchell B.R. *op. cit*. The backdated 1870-1904 data was then spliced to the level of census data using 1905 as base year. The 70-74, 75-79 age group data for 1905, 1915 and 1920 was obtained by decomposing Mitchell B.R. *op. cit*.'s age groups using the 1940 age distributions as proxy. The 70-74, 75-79 and 80+ data for 1970, as well as the 70-74, 75-79 populations for 1980 were also computed using age distributions from 1966 as proxy. 1981-2011 was obtained using age distributions from India as proxy and total population from Maddison, A. *op. cit*. This was subsequently spliced to the level of actual census data using 1980 as base year. All intervening years were growth interpolated.

Educational attainment and gross enrolment rates. See Madsen (2010) for estimation method.

Population distribution data sources are detailed above.

School Enrolment:

India

Primary
Combined primary and secondary enrolment from 1870-1876 was obtained from Mitchell, B. R., 2007. International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York and the decomposed using 1877 proportions. Separate primary and secondary enrolments data for 1877-1879 is also from Mitchell, B.R. *op. cit*. 1880-1996 is from Leeuwen, V. B. 2007, Human Capital and Economic growth in India, Indonesia and Japan: A Quantitative Analysis, 1890-2000, PhD Dissertation, Utrecht University; and 1997-2000 from Mitchell, B.R. *op. cit*., while 2001-2009 was growth extrapolated.

Secondary
Combined primary and secondary enrolment for 1870-1876 was obtained from Mitchell, B.R. *op. cit*. and then decomposed using 1877 proportions. Enrolments for 1877-1996 are from Leeuwen, V. B. *op. cit*., and 1997-2009 is growth extrapolated.

Tertiary

1870-1872 enrolment was backdated using the first 20-year average growth rate from 1873; 1873-1879 is from Mitchell, B.R. *op. cit.* and 1880-1999 is from Leeuwen, V. B. *op. cit*. 2000-2009 enrolment was growth extrapolated.

Indonesia

Primary
1870-1974 enrolment was backdated using the first 20-year average growth rate from 1875. 1875-1877 and 1879 is from Mitchell, B.R. *op. cit*. 1878 is growth interpolated. Enrolment figures for 1880-1999 are sourced from Leeuwen, V. B. *op. cit*., while 2000-2009 is from World Development Indicators. The World Bank, WDI (http://data.worldbank.org/indicator).

Secondary
1870-1875 enrolment was backdated using the first 20-year average growth rate from 1876. Data for 1876-1879 is from Mitchell, B.R. *op. cit*.; 1880-1941, 1946, 1949-1999 is from Leeuwen, V. B. *op. cit*.; and 2000-2009 WDI, *op. cit*. All intervening gaps are growth interpolated.

Tertiary
1870-1919 was backdated using the first 20-year average growth rate from 1920. 1920-1941, 1946, 1950-2000 is from Leeuwen, V. B. *op. cit*. while 2001-2009 figures are from the WDI, *op. cit*.

Korea

Primary
1870-1909 enrolment was backdated using the first 20-year average growth rate from 1910. 1910-1937, 1939 is from Mitchell, B.R. *op. cit*.; 1948-1966 from Banks, A.S. 1971, Cross Polity Time Series Data. The MIT Press: Cambridge, Massachusetts and London, England and 1967-2003 was obtained from Mitchell, B.R. *op. cit*. All intervening gaps were growth extrapolated. 2004-2009 was growth extrapolated.

Secondary
1870-1911 enrolment was backdated using the first 20-year average growth rate from 1912. 1912-1937, and 1939 is from Mitchell, B.R. *op. cit*.; 1948-1966 Banks, A.S. *op. cit*.; 1967-2003 is from Mitchell, B.R. *op. cit*. All intervening gaps are growth interpolated. 2004-2009 was growth extrapolated.

Tertiary
1812-1949 enrolment was backdated using the first 20-year average growth rate from 1950. 1950, Mitchell, B.R. *op. cit*.; 1951-1966 from Banks, A.S. *op. cit*.; 1967-2003 is from Mitchell, B.R. *op. cit*.; 2004-2009 was growth extrapolated.

Singapore

Primary

1870-1946 enrolment was backdated using the first 20-year average growth rate from 1947; 1947-1991, 1992-1993 is growth interpolated and 1994-2003 is from Mitchell, B.R. *op. cit*. 2004-2010 enrolments data is from WDI, *op. cit*.

Secondary
1870-1946 enrolment was backdated using the first 20-year average growth rate from 1947; 1947-1991, 1992-1993 is growth interpolated and 1994-2003 is from Mitchell, B.R. *op. cit*. Enrolment data for 2004-2010 is from WDI, *op. cit*.

Tertiary
1870-1949 enrolment was backdated using the first 20-year average growth rate from 1950. Data for 1951-2003 was sourced from Mitchell, B.R. *op. cit*., while the enrolment figures for 2004-2010 are from the WDI, *op. cit*.

Taiwan

Primary
1870-1909 enrolment was backdated using the first 20-year average growth rate from 1910. Combined primary and secondary enrolment data for 1910-1937 is from Mitchell, B.R. *op. cit*. This was subsequently decomposed using constant 1938 proportions. Enrolment data for 1938-1940 and 1946-1949 is also from Mitchell, B.R. *op. cit*., and 1950-2010 was obtained from the Taiwan Statistical Yearbook, 2011. All intervening gaps are growth interpolated.

Secondary
1870-1909 enrolment was backdated using the first 20-year average growth rate from 1910. Combined primary and secondary enrolment for 1910-1937 from Mitchell, B.R. *op. cit*. was decomposed using constant 1938 proportions. 1938-1940 and 1946-1949 enrolment is from Mitchell, B.R. *op. cit*.; 1950-2010 is from Taiwan Statistical Yearbook, 2011. All intervening gaps are growth interpolated.

Tertiary
1870-1919 enrolment was backdated using the first 20-year average growth rate from 1920. Enrolment for 1920, 1926, 1931, 1935, 1940 and 1946-49 is from Mitchell, B.R. *op. cit*., while 1950-2010 was sourced from the Taiwan Statistical Yearbook, 2011. All intervening gaps are growth interpolated.

Domestic Patent

WIPO: Patent Application by Patent Office, by resident and non-resident, http://www.wipo.int/ipstats/en/statistics/patents.

Per Capita Real GDP Growth Rate

Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) for population and Real GDP data except Singapore Real GDP 1900-1960: Sugimoto, I., 2011, Economic Growth of Singapore in the Twentieth Century, Historical GDP Estimates and Empirical Investigations, World Scientific Publishing Co. Pte. Ltd., Singapore.

Real interest rate: Nominal interest rate in a long-term government bond minus contemporaneous consumer inflation rate.

Nominal interest rate:

India

1870-1894 same as 1895. 1895-1906: Calculated from Price of 3.5% Indian Government Bond in London, SARBI (various issues). 1907-1929: Interpolated. 1930-1954: Treasury Bills Rate, Homer, S., Sylla, R., A History of Interest Rates, John Wiley and Sons Inc. 1955-1989: Official Discount Rate, Homer, S., Sylla, R., *op. cit.* 1990-1993: Interpolated. 1994-2011: 3-Month Treasury Bill Rate, Datastream (Thomson Reuters).

Indonesia

India 1870-1970 spliced with 1970. 1970-2011: Deposit interest rate, World Development Indicator (WDI) Database.

Korea

Japan 1870-1948 spliced with 1948. 1948-1964: International Financial Statistics (supplement to 1965/66 issues). 1965-1999: interpolated. 2000-2011: 1 Year Government Bond Rate, Datastream (Thomson Reuters).

Singapore

Japan 1870-1977 spliced with 1977. 1977-1989: Deposit interest rate, World Development Indicator (WDI) Database spliced with 1989. 1989-2011: 3-Month Treasury Bill Rate, Datastream (Thomson Reuters).

Taiwan

Japan 1870-1982 spliced with 1982.1982-2011: 3-Month Money Market Rate. (Thomson Reuters).

Consumer inflation rate: Calculated from Consumer Perice Index (CPI)

India

1870-1940: kumar, D., Desai, M. 1982, The Cambridge Economic History of India 1757-1970, volume 2, Cambridge University Press spliced with 1940-2005: Mitchell, B. R., 2007. International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York spliced with 2005-2011: International Financial Statistics.

Indonesia

Cost of Living Index for Indonesia 1870-1925: Williamson, J., 2000, Real Wages and Relative Factor Prices in the Third World 1820-1940: Asia published as: Globalization, Factor Prices and Living Standards in Asia Before 1940, in A.J.H. Latham and H. Kawakatsu (eds.), Asia Pacific Dynamism 1500-2000 (London: Routledge, 2000): 13-45 spliced with 1925-2005: Mitchell B.R. *op. cit*. spliced with 2005-2011: International Financial Statistics.

Korea

1870-1906: CPI Japan spliced with Cost of Living Index of Korea 1906-1912: Williamson, J., 2000 *op. cit.*, spliced with 1912-2005: Mitchell B.R. *op. cit*. spliced with 2005-2011: International Financial Statistics.

Singapore

1870-1880: CPI Japan spliced with 1880. 1880-2011: 1880-1900: Sugimoto, I. Estimates of Private Final Consumption Expenditure in the Colony of Singapore, 1880-1939: Progress and Perspective, Soka University spliced with 1900-1961: Sugimoto, I. 2011, Economic Growth of Singapore in the Twentieth Century, Historical GDP Estimates and Empirical Investigations, World Scientific Publishing Co. Pte. Ltd. spliced with 1961-2005: Mitchell B.R. *op. cit*. spliced with 2005-2011: International Financial Statistics.

Taiwan

1870-1897: CPI Japan spliced with Cost of Living Index of Taiwan 1897-1903: Williamson J., 2000, op. cit. spliced with 1903-2005: Mitchell B.R. *op. cit*. spliced with 2005-2011: Taiwan Statistical Data Book 2012, downloaded from: http://www.cepd.gov.tw/encontent/m1.aspx?sNo=0017349.

CPI of Japan 1870-1906: Mitchell B.R. *op. cit*.

Life Expectancy at the Age of 10

India

1870-1880 same as 1881. 1881-1891: Gupta, P. D., 1971, Estimation of Demographic Measures for India, 1881-1961, Based on Census Age Distributions, Population Studies, 25(3), pp. 395-414. 1891-1999: Human Lifetable Database, (www.lifetable.de). 1999-2010: WHO data downloaded from http://apps.who.int/gho/data/view.main.

Indonesia

1870-1960 same as India. 1961-2010: WHO data: http://apps.who.int/gho/data/view.main.

Korea

1870-1926 spliced with Japan. 1926-1931: Dublin, L. I., Lotka, A. J., Spiegelman, M., 1949, Length of Life: A Study of the Life Table, Ronald press company, New York. 1931-1938: Demographic Year

Book, United Nations, New York. 1938-1970: Human Lifetable Database, (www.lifetable.de). 1970-2010: Korea Statistics Office (KOSIS), downloaded from http://kosis.kr/nsieng/view/stat10.do .

Singapore

1870-1956 spliced with Netherland. 1957-1962: Keyfitz, K., Flieger, W., 1968, World Population: An Analysis of Vital Data, The University of Chicago Press, Chicago. 1963-1969 Interpolated. 1970-2009: Human Lifetable Database, (www.lifetable.de). 2010: WHO data, downloaded from http://apps.who.int/gho/data/view.main .

Taiwan

1870-1925 spliced with Netherland. 1926-2007: Human Lifetable Database, (www.lifetable.de). 2008-2010: Taiwan Life Table, downloaded from http://sowf.moi.gov.tw/stat/english/elife/elist.htm.

Gender Ratio: Ratio of the number of males to females in the age between 10 and 24

India

1870-1880 same as 1881. 1881, 1891, 1901, 1911, 1921, 1931, and 1951: Mitchell, B. R., 2007, International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York. 1882-1890, 1892-1900, 1902-1910, 1912-1920, 1922-1930, 1932-1950 interpolated. 1951-2010: United Nations' Population Division (http://esa.un.org/unpd/wpp/Excel-Data/population.htm) spliced with 1951: Mitchell, B. R., *op.cit*.

Indonesia

1870-1950: Gender ratio Japan spliced with 1950: United Nations' Population Division, *op. cit*. 1950-1961: United Nations' Population Division, *op. cit*. spliced with 1961: Mitchell B.R. *op. cit*. 1961, 1971, 1980, 1993, 1995, and 2003: Mitchell B.R. *op. cit*. 1962-1970, 1972-1979, 1981-1992, 1994, and 1996-2002 interpolated. 2003-2010: United Nations' Population Division, *op. cit*. spliced with 2003: Mitchell, Africa, Asia and Oceania, 2007, *op.cit*.

Korea

1870-1930: Gender ratio Japan spliced with 1930: Mitchell B.R. *op. cit*. 1930, 1944, 1960, 1975, 1980, 1994 and 2003: Mitchell B.R. *op. cit*. 1931-1943, 1945-1959, 1961-1974, 1976-1979, 1981-1993, and 1995-2002 interpolated. 2003-2010: United Nations' Population Division, *op. cit*. spliced with 2003: Mitchell B.R. *op. cit*.

Singapore

1870-1931: Gender ratio Japan spliced with 1931: Gender ratio Malay, Mitchell B.R. *op. cit.* Gender ratio Malay, 1931, 1957: Mitchell B.R. *op. cit.* 1932-1956 interpolated. 1950-2010: United Nations' Population Division, *op. cit*. spliced with 1950: Mitchell B.R. *op. cit.*

Taiwan

1870-1905: Gender ratio Japan spliced with 1905: Mitchell B.R. *op. cit.* 1905, 1915, 1920, 1930, 1940, 1956, 1966, 1970 and 1980: Mitchell B.R. *op. cit.* 1906-1914, 1916-1919, 1921-1929, 1931-1939, 1941-1955, 1957-1965, 1967-1969 and 1971-1979 interpolated. 1980-2010: Taiwan Statistical year book 2011 spliced with 1980: Mitchell B.R. *op. cit.*

Japan

1870-1883 same as 1884. 1884, 1893, 1903, 1913, 1920, 1930, 1940, 1950: Mitchell B.R. *op. cit*. 1885-1892, 1894-1902, 1904-1912, 1914-1919, 1921-1929, 1931-1939, 1941-1949 interpolated. 1950-2010: United Nations' Population Division, *op. cit*. spliced with 1950: Mitchell B.R. *op. cit*.

Hours worked: Total Working Force multiplied by Hours Worked per Worker.

India

Total Working Force: 1870-1951: Roy, B., 1996, An Analysis of Long Term Growth of National Income and Capital Formation in India (1850-51 to 1950-51), Firma KLM Private Limited, Calcutta, India. 1952-1959: Interpolated. 1960-2011: The Conference Board Total Economy Database, 2013, http://www.conference-board.org/data/economydatabase/

Hours Worked Per Worker: 1870, 1900: Huberman, M., Lewis, F., 2007, Bend It Like Beckham: Hours and Wages across Forty Eight Countries in 1900, Queen's Economics Department Working Paper no. 1229. 1871-1899: Interpolated. 1901-2011: same as 1900.

Indonesia

Total Working Force: 1870-1880: Population from Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) spliced with 1880. 1880-2008: van der Eng, P., 2010, The Sources of Long Term Economic Growth in Indonesia, 1880-2008, Explorations in Economic History, 47, 294-309 spliced with 2008-2011: The Conference Board Total Economy Database *op. cit.*

Hours Worked per Worker: 1870-2011: same as India.

Korea

Total Working Force: 1870-1955: Population from Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) spliced with 1955. 1955-1960: Mitchel, B. R., 2007, International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York.

Hours Worked per Worker: 1870-1949: same as 1950, 1950-1960: The Conference Board Total Economy Database *op. cit.*

Total Annual Hours Worked: 1963-2011: The Conference Board Total Economy Database *op. cit.* 1961-1962: Interpolated.

Singapore

Total Working Force: 1870-1947: Population from Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) spliced with 1947. 1947-1957: Mitchel, B. R., 2007, *op. cit.*

Hours Worked per Worker: 1870-1949: same as 1950, 1950-1957: The Conference Board Total Economy Database *op. cit.*

Total Annual Hours Worked: 1960-2011: The Conference Board Total Economy Database *op. cit.* 1958-1959: Interpolated.

Taiwan

Total Working Force: 1870-1905: Population from Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) spliced with 1905. 1905-1956: Mitchel, B. R., 2007, *op. cit.*

Hours Worked per Worker: 1870-1949: same as 1950, 1950-1956: The Conference Board Total Economy Database *op. cit.*

Total Annual Hours Worked: 1960-2011: The Conference Board Total Economy Database *op. cit.* 1957-1959: Interpolated.

Real Investment – GDP Ratio: Ratio of real investment (Residential Investment excluded) to Real GDP.

India

1870-1951: Roy, B., 1996, An Analysis of Long Term Growth of National Income and Capital Formation in India (1850-51 to 1950-51), Firma KLM Private Limited, Calcutta, India. spliced with 1951-1967 Mitchell, B. R., 2007, International Historical Statistics: Africa, Asia and Oceania, 1750-2005, 5th Ed. Palgrave Macmillan, New York spliced with 1967-1980: World Development Indicator (WDI) Database spliced with 1980-2010: Statistical Abstract India, Central Statistical Organization, Department of Statistics, Ministry of Planning and Program Implementation, Government of India, New Delhi.

Indonesia

1870-1879: Same as 1880. 1880-2008: van der Eng, P., 2010, The Sources of Long Term Economic Growth in Indonesia, 1880-2008, Explorations in Economic History, 47, 294-309 spliced with 2008-2011: World Development Indicator (WDI) Database.

Korea

Japan real investment to real GDP ratio 1870-1913 spliced with 1913-1994: Timmer, M. P., Ark, B. V., 2000, Capital Formation and Productivity Growth in South Korea and Taiwan: Beating Diminishing Returns through Realizing the Catch-Up Potential, Groningen Growth and Development Centre spliced with 1994-2010: OECD Database.

Singapore

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Chapter 3

Does Income Inequality Fuel Saving? Evidence from 20 Advanced Countries, 1870-2011

Jakob B. Madsen* and IqtiarMamun

Department of Economics, Monash University

Abstract. One of the most established suppositions in economics is that inequality enhances saving because the propensity to consume of the poor exceeds that of the rich. This paper constructs panel data for 20 advanced countries over the period 1870-2011 to investigate the effects of income inequality on saving. Instruments are used to deal with the feedback effects from saving to inequality. We find robust and strong negative effects of inequality on saving suggesting that savings rates will be reduced in the future if the prediction of Piketty's *Capital in the 21st Century* of increasing inequality materializes.

JEL classification: E21, E25
Keywords: Inequality and saving; IV estimates; long historical data

* Corresponding author: Department of Economics, Monash University, 900 Dandenong Rd., Caulfield East, VIC 3145, Australia. E-mail: Jakob.Madsen@monash.edu.

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3.1 Introduction

Following the predictions of standard consumer and growth models, probably one of the most established paradigms in economics is that higher income inequality leads to higher saving, which in turn leads to higher per capita income and temporarily higher productivity growth rates. The consensus in the theoretical literature is confirmed by the relatively scant empirical macro literature, which finds income inequality to be either significantly positive or insignificant in standard macro savings regressions (see, e.g. Hong, 1995; Sahota, Darity and Taubman, 1993; Cook, 1995; Edwards, 1996; Schmidt-Hebbel and Serven, 2000; Smith, 2001; Leigh and Posso, 2009). An exception is Alvarez-Cuadrado and El-Attar (2013) who, based on post-1960 data for six OECD countries, find a negative relationship between savings and inequality.

Using a panel of annual data for 20 OECD countries over the period 1870-2011 this paper challenges the conventional wisdom that inequality is good for saving. The paper extends the previous literature in the following two dimensions; first, by using instruments to deal with feedback effects from saving to inequality and, second, by constructing a data sample that spans much further back in time than the data used in previous studies. Despite feedback effects from savings to inequality the literature has thus far not dealt with endogeneity, which may have driven the oft-found positive savings effects of inequality. As argued in Section 3, the coefficient of inequality tends to be biased upwards because of strong positive feedback effects from saving to inequality.

The identification strategy of (Brückner, 2013) is used to deal with endogeneity because it allows us to use instruments for savings and not inequality. This gives crucial advantages over conventional identification strategies since it is incredibly difficult to find good instruments for inequality, which may explain why the literature has thus far not adequately dealt with identification.[4] An instrument for inequality is created as follows. In the first step, the response of inequality to financial saving is estimated using young age dependency ratio and life expectancy at the age of ten as instruments for gross saving in order to generate exogenous variation in savings rates. In the second step, after the causal response of inequality to saving is quantified by the instrumental variables estimates, the residual variation in inequality that is *not* driven by saving is used as an instrument for inequality. In

[4]We tried the following instruments for inequality at the initial stages of the project: land prices, strikes per worker, marriage ages, various tax rates, the agricultural share of GDP, urbanization, real exchange rates and several variables reflecting culture. However, their coefficients were either insignificant or had signs opposite to those predicted by economic theory and, consequently, we abandoned this identification strategy.

other words this identification strategy nets out the savings effects on inequality and, therefore, yields consistent parameter estimates.

This study is one of first studies to use long continuous historical data on savings and inequality. To the best of our knowledge the only study that thus far uses long historical data is Leigh and Posso (2009) who use data for 11 OECD countries covering the period 1921-2002. Most studies use cross sectional data, which cannot deal with unobserved country heterogeneity, or use the income inequality data from the Deininger and Squire database (Deininger and Squire, 1996), which has been heavily criticized by Atkinson and Brandolini (2001). Furthermore, most existing studies have relied on data for developing countries that are often of notoriously bad quality. Johnson, Larson, Papageorgiou, and Subramanian (2013), for example, argue that "in general, annual data from non-OECD countries should be treated with caution" (p. 273).

Econometrically there are large benefits from using a long data sample. First, the fixed effect estimator becomes more consistent as the sample grows, and instrument variable parameter estimates can be severely biased in small samples; particularly if the instruments are weak (Davidson and McKinnon, 2006). Second, the parameter estimates are much less subject to finite sample bias than previous panel studies that typically span 20 or 30 years. It is well-known that IV estimates are biased in the same direction as OLS estimates in small samples (Murray, 2006). Third, tests of over-identifying restrictions suffer from size distortions in small samples by failing to reject the null hypothesis too often (Murray, 2006). Fourth, several cycles in the long savings and income inequality data can be identified in the period 1870-2011; thus giving lots of identifying variation in the data.

The rest of the chapter is organized as follows. Section 3.2 briefly discusses the empirical framework, data and identification strategy, section 3.3 presents the empirical results, section 3.4 provides robustness checks, Section 3.5 discusses theories that can explain the results that find a negative relationship between savings and income inequality, and Section 3.6 concludes the chapter.

3.2Empirical Framework

In order to examine the effects of inequality on saving we start from a simple life-cycle model and subsequently extend the model to allow for financial development, educational attainment, per capita real GDP growth rate, public saving, the real interest rate, interaction

between financial development and inequality, old age dependency and urbanization. Consider the following life-cycle model of saving:

$$s_{it}^{X} = a_0 + a_1 I_{i,t}^{M} + a_2 A_{it}^{Y} + a_3 e_{it}^{10} + Z + CD + TD + \varepsilon_{1,it}, \quad (1)$$

where s^X is (X = P, T) private (P) and total (T) savings rate, measured as nominal gross financial saving divided by nominal GDP; I^M is income inequality measured by the Gini coefficient (I^{Gini}), the top 5% income share (I^5) and the top 10% income share (I^{10}); A^Y is the young age dependency ratio (ratio of the population in the 0-14 age group to the working population aged 15 to 64); e^{10} is life expectancy at the age of ten; Z is a vector of control variables; CD is country dummies; TD is time-dummies; and ε is a stochastic error term. Following the convention in the literature the regressions are undertaken in five-year non-overlapping intervals to filter out business cycle influences and because five-year interval data appear to be less subject to measurement errors than one-year interval data (Johnson *et al*., 2013).

Private as well as total saving (public plus private) are used as dependent variables because economic theory does not give clear guidelines as to the extent to which private saving is affected by public saving. The Barro-Ricardo equivalence theorem suggests that total saving is the relevant savings measure in the individual consumer's saving decision because s/he is liable for the government debt. But if the consumers exclude government debt from their intertemporal decision, such as in the conventional IS-LM framework, it follows that private saving is the relevant decision variable in the saving function. As an additional robustness check the government's saving rate is included in the private savings regression in Section 4.

Life expectancy at the age of ten, e^{10}, is included in the model following the predictions of the life-cycle hypothesis that people save more the longer they expect to live after retirement. Bloom, Canning, and Graham (2003) add longevity to a standard model of life-cycle saving and show that an increase in life expectancy increases the optimal length of life spent working, but not sufficiently to offset the increased need for retirement income. Therefore, savings rates rise at every age as longevity rises in order to meet the increased need for assets to finance consumption during retirement. In the regressions we have chosen to use life expectancy at the age of ten as opposed to the life expectancy at birth in the regressions because the latter is heavily influenced by infant mortality, particularly before WWII. Finally, the young age dependency ratio is included in the model following the

predications of the life-cycle hypothesis that savings rates follow an inverse U-shaped profile over the life cycle.

3.2.1 Identification

Inequality is instrumented to deal with feedback effects from saving to inequality. An exogenous saving-induced investment shock influences the *K-Y* ratio and, therefore, inequality through two channels. First, Bentolila and Saint-Paul (2003) show analytically and empirically that the *K-Y* ratio is a key determinant of labor's income share and, as discussed below, income inequality is strongly ngatively related to labor's income share. Second, according to Piketty (2014) and Piketty and Zucman (2014) the ratio of gross saving divided by total income growth drives the wealth-income ratio – at least in models with fixed capital as wealth. This analysis is closely related to the steady state condition in the Solow model in which the capital-output ratio is determined by the savings rate divided by the sum of the growth in total real income and the depreciation rate of fixed capital stock. According to the model of Piketty and Zucman (2014) an increase in the savings rate results in a higher wealth-income ratio and, consequently, in higher income inequality.

The identification strategy used here is to instrument savings in the inequality equation in the first step and then use inequality net of savings-induced growth as an instrument for inequality in the savings model, following the methods of (Blanchard and Perotti, 2002) and (Brückner, 2013).This method can be shown more formally by considering the following bivariate relationship between inequality and savings:

$$s = \alpha I + u, \quad (2)$$

$$I = \beta s + e, \quad (3)$$

where$u$ and e are stochastic error-terms, and I and s stand for inequality and saving. The coefficients of I and s are biased because $cov(I, u) \neq 0$and $cov(s, e) \neq 0$. To overcome the endogeneity problem, saving, s, is first regressed on its instruments, W:

$$s = \gamma W + v, \quad (4)$$

where$v$ is a stochastic error term and $cov(W, v) = 0$.

The predicted value of the savings rate, $\hat{s}$, from regressing Eq. (4) is used as an instrument for *s* to get a consistent estimate of β, $\hat{\beta}$, in estimates of Eq. (3). Thus, *I*, purged of the influence of saving can be recovered from the equation:

$$I^* = I - \hat{\beta}\hat{s}. \quad (5)$$

Substituting *I** for *I* in Eq. (2) yields consistent estimates of Eq. (2) since *I* is purged of its endogenous component. To see this, consider first the probability limit of the OLS estimator:

$$Plim\ \alpha^{OLS} = \alpha + \frac{\beta}{1-\alpha\beta}\frac{var(u)}{var(I)} + \frac{1}{1-\alpha\beta}\frac{cov(u,e)}{var(I)}, \quad (4)$$

where the second term on the right-hand-side is the simultaneity bias and the third term is the omitted variable bias.

The probability limit of the IV estimator is:

$$Plim\ \alpha^{IV} = \alpha + \frac{1}{1-\alpha\beta}\frac{cov(u,e)}{cov(e,I)}. \quad (5)$$

Comparing Eqs. (4) and (5) indicates that the IV strategy used here eliminates the simultaneity bias since the IV strategy eliminates the second right-hand-side term in Eq. (4).

3.2.2 Instruments

As mentioned above, life expectancy at the age of ten, e^{10}, and the young age dependency ratio, A^Y, are used as instruments for saving in the first-stage regression in which inequality is regressed on saving. These are likely to be good instruments for saving because they are essential determinants of saving in the standard life-cycle model and because the exclusion restrictions that e^{10} and A^Y influence inequality through saving is likely to be satisfied. Nowhere in his book does Piketty (2014) mention inequality over the past century having been affected by e^{10} and A^Y. Instead, taxation, immediate post-WWI and post-WWII wealth confiscations, biased technological progress, inheritance taxation, rent controls, minimum wages and saving rates are emphasized Piketty (2014) and Piketty and Zucman (2014) as the most important drivers of inequality in the 20th century. Since none of these factors, except

saving, are likely to be affected by e^{10} and A^{Y}, the exclusion restrictions are highly likely to be satisfied.

3.2.3 Data

Income inequality is measured as the top 5% and top 10% top income shares and the Gini coefficient and the regressions are carried out for the following 20 OECD countries over the period 1870-2011: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Switzerland, the UK and the US. The top 5% income shares are *not* available for Austria, Belgium, Greece, Ireland, Italy, Norway, and Portugal and these countries are consequently omitted from the regressions in which the top 5% income share is used as inequality measure. The Gini coefficients data are mainly from Solt (2011) in the post-1960 period and are backdated and interpolated using data from various historical sources as detailed in the Data Appendix. The historical data for the top 5% and 10% income share are from Roine, Vlachos, and Waldenstrom (2009). The inequality data are backdated using labour's share of total income because between group (workers/capitalists) income inequality dominated the income distribution before WWII (see, e.g., Piketty, 2014; Prados de la Escosura, 2008). Within group inequality was small and did not vary much over time in the pre-WWII period (Prados de la Escosura, 2008). Prados de la Escosura (2008) argues that the workers were prominently unskilled in the early stages of economic development and within group income inequality has consequently contributed little to income inequality. Therefore, income inequality was driven mainly by between group income inequality until the second half of the twentieth century.

Labor's income share is estimated as compensation to employees divided by nominal GDP and modified by imputed labor of the self-employed since all income of the self-employed, including their labor, is accounted for as profit in national accounts. Compensation to employees is backdated for a few countries using hourly labor costs times employment and annual hours worked. Private saving is computed as total saving minus public saving, where public saving is measured as the surplus on the government's primary balance including interests on government debt. Summary statistics are provided in Table 3.1. Negative savings rates are observed for Finland and Italy during WWI and the minimum savings rate in Table 3.1 refer to Finland in 1917, a period with large deficits on the government's budget. The maximum total savings rate refers to New Zealand for the year 1919 and the maximum

private savings rate is for New Zealand in 1870. The maximum growth rate of 0.69 is for Greece in 1918 following successive years of strongly negative growth rates and the minimum growth rate of -0.58 is for Austria in 1945.

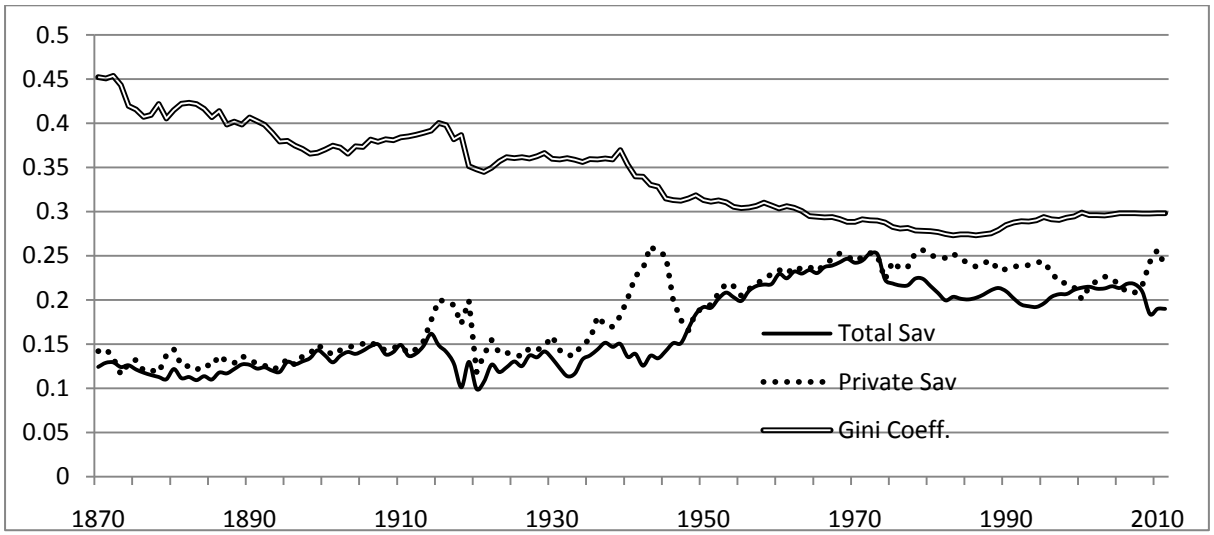
Table 3.1: Summary Statistics of Key Variables

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
S^T	0.17	0.17	0.08	-0.23	0.63
S^P	0.19	0.19	0.09	-0.22	0.68
I^{Gini}	0.34	0.32	0.09	0.20	0.89
I^{10}	0.35	0.34	0.08	0.19	0.67
I^5	0.26	0.24	0.07	0.12	0.52
g^y	0.02	0.02	0.06	-0.58	0.69
Credit	0.49	0.33	0.41	0.002	2.35
A^Y	0.48	0.48	0.14	0.22	0.84
e^{10}	55.53	57.75	14.57	34.11	72.74
A^O	0.13	0.12	0.06	0.02	0.34
Urban	0.54	0.56	0.23	0.07	0.97

Notes. The data pertain to annual data. S^T and S^P refer to the total saving rate and the private saving rate, respectively. I^{Gini}, I^{10}, I^5 stand for Gini Coefficient, top 10% income share, and top 5% income share respectively. g^y is the per capita real GDP growth rate and *Credit* is the private credit to GDP ratio. A^Y, e^{10}, A^O, and *Urban* are young age dependency ratio, life expectancy at 10, old age dependency ratio, and urbanization ratio, respectively.

Figure 3.1 traces private and total savings rates and income inequality as measured by the Gini Coefficient for 20 OECD countries over the period 1870-2011. Income inequality shows a long run downward trend up to the mid-1980s, while both private and total savings rates exhibit a long run upward trend, indicating a negative long-run relationship between income inequality and saving. The decline in inequality up to the mid-1980s is particularly associated with inflation taxes and asset confiscation/war damage during and immediately after the world wars (Piketty, 2014). The private and the total saving rates almost coincide and have the same long run upward trend except in the world wars and economic downturns, during which they have moved in opposite directions. The slow-moving trends in saving and inequality and the fact that the inequality-saving nexus is blurred at business cycle frequencies underscore the importance of using long historical data.

Figure 3.1.Savings Rates and the Gini coefficient.



Notes. The data are unweighted averages of the 20 OECD countries used in this study.

3.3 Estimation Results

3.3.1 First-round regressions

The instrument for inequality, which will be used in the savings regression, is created in this section by 1) regressing saving on e^{10} and A^Y; and 2) regressing inequality on instrumented saving to create the predicted value/instrument for inequality. Intuitively, the instrument for inequality nets out saving-induced inequality. The regressions from the first two stages are presented in Table 3.2. Considering the 'first-stage' regressions in the lower panel of the table, the coefficients of e^{10} and A^Y are significant determinants of saving in all cases and have the expected signs and the *F*-tests for excluded instruments are sufficiently close to the rule-of-thumb critical *F*-value of 10 to act as potentially good instruments for saving. Furthermore, Sargan's tests of overidentifying restrictions are not significant in any case, suggesting that the exclusion restrictions are satisfied.

OLS and the 'second-stage' IV regressions are presented in the top panel in Table 3.2. The coefficients of saving are all positive in the IV regressions and significant in four of the six cases, while they are negative in the OLS regressions, underscoring the importance of using the IV approach. In the IV regressions the coefficients of saving are, on average 0.46, implying that a 10 percentage point increase in the savings rate increases inequality by 4.6%, which is a large economic impact given that the maximum and minimum values of inequality

rarely fluctuate beyond 20 percentage points for each individual country considered here in the period 1870-2011. This result underscores the importance of netting-out the feedback effects from saving to inequality in the structural regressions. The finding that saving affects inequality significantly and positively in the IV regressions is consistent with the findings of Bentolila and Saint-Paul (2003) and Piketty and Zucman (2014).

Table 3.2: Income Inequality Regressions.

	Dependent Variable: Gini Coefficient (I_{it}^{Gini})				Dependent Variable: Top 10% (I_{it}^{10})				Dependent Variable: Top 5% (I_{it}^{5})			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	LS	IV	LS	IV	LS	IV	LS	IV	LS	IV	LS	IV
s_{it}^{T}	-0.10*** (0.01)	0.42 (0.20)			-0.08** (0.01)	0.68** (0.04)			-0.05 (0.13)	0.68** (0.02)		
s_{it}^{P}			-0.11*** (0.00)	0.24 (0.17)			-0.06** (0.03)	0.38** (0.01)			-0.05* (0.08)	0.40*** (0.00)
N	580	580	580	580	580	580	580	580	377	377	377	377
R^2	0.67	0.56	0.67	0.60	0.74	0.44	0.74	0.61	0.74	0.37	0.74	0.55
Sarp		0.15		0.14		0.42		0.37		0.11		0.14
First Stage Regression: Total Saving (s_{it}^{T})			**First Stage Regression: Private Saving (s_{it}^{P})**		**First Stage Regression: Total Saving (s_{it}^{T})**		**First Stage Regression: Private Saving (s_{it}^{P})**		**First Stage Regression: Total Saving (s_{it}^{T})**		**First Stage Regression: Private Saving (s_{it}^{P})**	
	(1a)		(2a)		(3a)		(4a)		(5a)		(6a)	
A_{it}^{Y}	-0.08* (0.06)		-0.15*** (0.00)		-0.08* (0.06)		-0.15*** (0.00)		-0.10* (0.09)		-0.14** (0.04)	
e_{it}^{10}	0.003** (0.01)		0.005*** (0.00)		0.003** (0.01)		0.005*** (0.00)		0.004** (0.02)		0.008*** (0.00)	
R^2	0.48		0.46		0.48		0.46		0.44		0.44	
F	9.91		9.15		9.91		9.15		6.18		6.31	

Notes. The results are based on 5-year interval data. The numbers in parentheses are *p*-values. LS = least squares regression, IV = instrument variable regression. The Instrumental Variables (IVs) are life expectancy at age 10, e^{10}, and young age dependency ratio, A^{Y}, for both total and private savings. Sarp stands for Sargan test *p* value. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

3.3.2 Structural regressions

The results of regressing the savings model (Eq. (1)) without control variables are presented in Table 3.3. The coefficients of e^{10} and A^{Y} are all significant and of the expected signs. The coefficients of inequality are statistically significantly negative in all regressions, regardless of how inequality is measured, whether inequality is instrumented and whether the dependent variable is the total or the private savings rate. Importantly, the coefficients of inequality are approximately five times bigger in the IV than in the OLS regressions, suggesting that OLS-estimated coefficients are seriously biased because of the positive feed-back effect from saving to inequality as predicted by economic theory. The importance of this result is not only that inequality is bad for saving, it also suggest that OLS estimates are unreliable, which

to some extent explains why the existing literature often fails to find any relationship between inequality and saving. Finally, the coefficients of inequality are slightly more negative in total than in the private saving regressions, suggesting that government saving is negatively affected by inequality; possibly because the demand for redistribution is largest in periods of large inequality and governments may bend to popular demand for redistribution by increasing their spending and because governments' budgets tend to be in deficit in periods of high unemployment and inequality.

Table 3.3.Saving Regressions (Eq. (1)).

	Dependent variable: Total Saving (s_{it}^{T})						**Dependent variable: Private Saving (s_{it}^{P})**					
	LS (1)	**IV (2)**	**LS (3)**	**IV (4)**	**LS (5)**	**IV (6)**	**LS (7)**	**IV (8)**	**LS (9)**	**IV (10)**	**LS (11)**	**IV (12)**
I_{it}^{Gini}	-0.14*** (0.01)	-0.62*** (0.00)					-0.21*** (0.00)	-0.57*** (0.00)				
I_{it}^{10}			-0.18*** (0.00)	-1.39*** (0.00)					-0.20*** (0.01)	-1.14*** (0.00)		
I_{it}^{5}					-0.20** (0.03)	-1.79*** (0.00)					-0.31*** (0.00)	-1.56*** (0.00)
A_{it}^{Y}	-0.08* (0.06)	-0.08* (0.09)	-0.09** (0.04)	-0.12** (0.02)	-0.10* (0.10)	-0.09 (0.26)	-0.14*** (0.01)	-0.14*** (0.01)	-0.15*** (0.00)	-0.18*** (0.00)	-0.14** (0.04)	-0.13* (0.09)
e_{it}^{10}	0.003*** (0.01)	0.004*** (0.00)	0.003*** (0.01)	0.006*** (0.00)	0.005*** (0.01)	0.01*** (0.00)	0.005*** (0.00)	0.006*** (0.00)	0.005*** (0.00)	0.007*** (0.00)	0.009*** (0.00)	0.014** (0.00)
N	580	580	580	580	377	377	580	580	580	580	377	377

Notes. The results are based on 5-year interval data. The numbers in parentheses are *p*-values. LS = least squares regression, IV = instrument variable regression. The Instrumental Variables (IVs) are life expectancy at age 10, e^{10}, and young age dependency ratio, A^{Y}, for both total and private savings. The IVs for income inequalities are the residuals from the income inequality regressions. Asterisks denote significant difference from zero at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

Economically, inequality is influential for saving in the IV regressions. A one percentage point decrease in income inequality leads, on average, to a 0.60 (Gini), 1.22 (top 10%) and 1.68 (top 5%) percentage point increase in the savings rate. Thus, the 18 percentage point decrease in the Gini coefficient from its peak in 1870 to its nadir in 1983 for all countries on average (Figure 1) has resulted in a 10.8 percentage point increase in the savings rate.

3.4 Robustness Checks

Thus far the only explanatory variables in the savings function have been young age dependency, life expectancy at the age of 10 and inequality. This section includes variables that are likely to simultaneously influence savings and inequality and, therefore, may control for the possibility that inequality influences saving because a variable that is simultaneously

correlated with inequality and saving is excluded from the regressions. Furthermore, the robustness of the results to different estimation periods is tested.

3.4.1 Confounding variables

This section extends the model to allow for financial development, educational attainment, productivity growth, the real interest rate, urbanization, old age dependency, and, in the private savings model, government saving. Each variable is discussed before the results are presented.

The real interest rate and the old age dependency rate are included in the savings model following the predictions of the permanent income hypothesis and, at the same time, are essential confounding variables. Lower nominal interest rates, for example, reduce inequality directly through capital income and, indirectly, through capital accumulation which increases capital's share, provided that the elasticity of substitution between capital and labor exceeds one (Piketty, 2014). Similarly, the increasing old age dependency ratio experienced over the past 140 years has, to a large degree, been unexpected. As the increasing life expectancy since 1870 has, to a large degree, been unexpected, the savings during the working years may not have been sufficiently high to keep the consumption profile constant throughout life and, consequently, may have increased inequality.

Financial development is often considered to be an essential variable in explaining inequality (see, e.g., Aghion*et al*., 1999; Loayza*et al*., 2000; Benhabib and Spiegel, 2000). Beck *et al*. (2007), for example, find that financial development, measured by the ratio of private credit and GDP, impact negatively on income inequality. Since financial development is also found to stimulate saving (Madsen and Ang, 2015), it follows that financial development is a potentially important confounding variable. Following the literature, we measure financial development by the ratio of credit to the private sector and GDP and the ratio of bank assets and GDP. The interaction between the credit ratio and inequality is included as an additional control variable because theory predicts that the effects of financial development on fixed capital formation are particularly strong in unequal societies (Aghion*et al*., 1999). According to Aghion*et al*., (1999) well-off entrepreneurs with high initial endowments have relatively low marginal productivity of capital and, therefore, have less incentive to invest. Less well-off entrepreneurs, by contrast, have relatively high marginal productivity of capital and, therefore, more incentive to invest but are constrained by limited endowments and limited access to credit. Consequently, under capital market imperfections

and diminishing marginal returns to investment, higher income inequality leads to lower aggregate savings and investment. To cater for this effect the interaction between inequality and the credit ratio are included in the savings regression.

Education is another variable that may simultaneously impinge on inequality and saving. Saving is likely to be affected by education as students may borrow for their education and dissave because they expect higher earnings throughout their life. Education may or may not increase income inequality depending on whether an increasing education is driven by education at the extensive or the intensive margin. Since the percentage of the population with a primary and secondary education has increased from less than 30% in 1870 to almost 100% in 2009, on average, in the OECD countries, (Madsen, 2014) it is likely that educational inequality has decreased during the same time period. Education is measured as the sum of gross enrollment rates at primary, secondary and tertiary levels of education, where gross enrollment rates are the fraction of a school age cohort that is enrolled in education.

Per capita income growth is included as an explanatory variable since it is a potential confounding variable as quite a few economic theories predict that growth influences saving and inequality simultaneously (see, for example, Carroll *et al.*, 2000). Carroll *et al.* (2000), for example, show that, under plausible assumptions, savings are positively related to growth under habit persistence as the utility of consumers depends on past as well as contemporaneous consumption. There are several theories and empirical evidence showing that growth affects inequality. Barro (2000), for example, finds evidence in favor of the Kuznet curve according to which inequality first increases and later decreases during phases of economic development.

Finally, urbanization is included as a confounding variable following Kuznets' hypothesis that inequality widens during industrialization as wages in urbanized centers are kept low by low-paid agricultural workers migrating to cities. Furthermore, the rural savings rates are likely to exceed the national average because agricultural income is more uncertain than urban income, resulting decreasing precautionary saving as the economy urbanizes.

The results of including the confounding variables in the savings-regressions are displayed in Table 3.4. The private savings rate is used as the dependent variable, inequality is measured by the Gini coefficients and the Gini coefficient is instrumented in all regressions. The coefficient of the old age dependency ratio is negative in all regressions and in most cases highly significant, regardless of whether control variables are excluded from the regression (column (1)) or included in the regressions

(columns (2)-(9)). Financial development and the interaction between financial development and inequality are significant and of the expected signs. The coefficient of financial development is significantly positive when the interaction term is excluded from the regression in column (2) as expected, but turns negative when the interaction terms are included in columns (3), (4), (8) and (9). The interaction term is positive regardless of whether financial development is measured by the credit rate or the bank asset ratio; a result that is consistent with the predictions of the theories discussed in Aghion*et al*. (1999) in which capital market imperfections (low credit ratio) and high income inequality (high Gini) are associated with low savings rates.

Table 3.4: Savings Regressions (Eq. (1)). Dependent Variable: Private Saving.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I_{it}^{Gini}	-0.56*** (0.00)	-0.58*** (0.00)	-0.89*** (0.00)	-0.92*** (0.00)	-0.63*** (0.00)	-0.40*** (0.00)	-0.55*** (0.00)	-0.65*** (0.00)	-0.62*** (0.00)
e_{it}^{10}	0.01*** (0.00)	0.00*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.00*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.00* (0.09)
A_{it}^{Y}	-0.18*** (0.00)	-0.18*** (0.00)	-0.21*** (0.00)	-0.19*** (0.00)	-0.22*** (0.00)	-0.15*** (0.00)	-0.17*** (0.00)	-0.21*** (0.00)	-0.14*** (0.00)
A_{it}^{O}	-0.45*** (0.00)	-0.36** (0.02)	-0.47*** (0.00)	-0.53*** (0.00)	-0.50*** (0.00)	-0.63*** (0.00)	-0.51*** (0.00)	-0.77*** (0.00)	-0.17 (0.11)
$Credit_{it}$		0.05*** (0.00)	-0.25*** (0.00)					-0.16*** (0.00)	-0.11* (0.07)
I_{it}^{Gini} *$Credit_{it}$			0.80*** (0.00)					0.51*** (0.00)	0.42** (0.02)
$Bank\ Ass_{it}$				-0.19*** (0.00)					
I_{it}^{Gini} *$Bank\ Ass_{it}$				0.69*** (0.00)					
g_{it}^{y}					0.06*** (0.01)			0.03* (0.08)	0.07*** (0.00)
$Urban_{it}$					-0.16*** (0.00)			-0.12*** (0.00)	-0.08*** (0.00)
S_{it}^{G}						-0.71*** (0.00)		-0.70*** (0.00)	-0.71*** (0.00)
GER_{it}^{T}							0.04** (0.02)	0.04*** (0.00)	0.02** (0.02)
r_{it}								-0.01 (0.56)	-0.01 (0.49)
N	580	580	580	580	580.00	580.00	580.00	580.00	580.00
R^2	0.44	0.45	0.41	0.43	0.45	0.62	0.45	0.61	0.35
F	10.46	10.59	9.98	10.91	10.53	18.09	10.47	16.58	38.55
FE	Y	Y	Y	Y	Y	Y	Y	Y	N

Notes. See notes to Table 3.A^O, *Credit*, *Bank Ass*, g^y, *Urban*, S^G, GER^T, and r are old age dependency ratio, private credit to GDP ratio, bank assets to GDP ratio, per capita real GDP growth rate, urbanization ratio, public savings to GDP ratio, total gross enrollment rate, and real interest rate, respectively.

Economic growth has the expected positive effect on saving in the regression in column (5) and urbanization has negative savings effects, which is consistent with the hypothesis that the agricultural sector has higher savings rates than other sectors because of larger income uncertainties. The regression in column (6) shows that public saving has the expected negative effect on private saving which is consistent with the Barro-Ricardo

theorem. Turning to education, gross enrollment rates are impacting positively on saving (column (7)); a result that is robust to educational attainment as a measure of education (the results are not shown). Finally, the real interest rate is insignificant in the regressions in the last two columns in Table 4 (results with the real interest rate as sole control variable are not shown as its coefficient remains insignificant).

Common for all regressions in Table 3.4 is that the coefficient of inequality is statistically highly significant and negative in all regressions, suggesting that the principal results are robust to the inclusion of confounding variables. Economically the coefficients of inequality are close to the coefficient of -0.57 in the baseline regression in column (8) in Table 3.3. Note, however, that the absolute value of the coefficient of I^{Gini} is inflated in the regressions where I^{Gini} is interacted with financial development (columns (3), (4), (8) and (9)), because the coefficient of the interaction term is positive. The coefficient of I^{Gini} is also relatively insensitive to whether the fixed effects dummies are included in or excluded from the regressions (columns (8) and (9) in Table 3.4), suggesting that inequality has the same effect on saving in the within and the between country dimension of the data (country dummies) and that cross-country invariant movements over time of excluded variables (time-dummies) have not influenced the nexus between saving and inequality.

3.4.2 Other robustness tests

This subsection tests the robustness of the results to different estimation periods and to various measures of inequality. The regressions include the control variables included in Table 3.4. The dependent variable is private saving except the regression in the last column. The estimation periods considered are 1870-1945 and 1950-2010 in the regressions in the first four columns in Table 3.5, noting that 1950 is the average over the period 1946-1950. 1945/1950 is used as the split period because there was a significant upward shift in the savings rate in that period and because the downward trend in inequality stabilized after that period (see Figure 3.1). The coefficients of inequality are significant in all four regressions, suggesting that their negative coefficients have not been driven by the structural break in saving and inequality around 1950.

Turning to other robustness regressions that cover the entire time-span 1870-2010, the coefficients of inequality remain highly significant and negative when inequality is measured by top 10% and top 5% income earners (columns (5) and (6)), suggesting that the results in the baseline regressions are robust to the inclusion of control variables. The principal results

are also robust to the use of total saving as the dependent variable (column (8)). Overall, the results show that inequality is a robust negative determinant of savings.

Table 3.5: Robustness Regressions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1870-1945	**1950-2010**	**1870-1945**	**1950-2010**	**Top 10%**	**Top 5%**	**No Gini interaction**	**Total saving**
I_{it}^{Gini}	-3.94*** (0.00)	-0.20** (0.05)					-0.46*** (0.00)	-1.06*** (0.00)
I_{it}^{10}			-2.57*** (0.00)	-0.78*** (0.00)	-1.29*** (0.00)			
I_{it}^{5}						-1.92*** (0.00)		
e_{it}^{10}	0.00 (0.80)	0.01*** (0.00)	0.00 (0.18)	0.02*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.00*** (0.00)	0.01*** (0.00)
A_{it}^{Y}	0.12 (0.31)	-0.06 (0.23)	0.13 (0.16)	0.02 (0.76)	-0.27*** (0.00)	-0.32*** (0.00)	-0.19*** (0.00)	-0.23*** (0.00)
A_{it}^{O}	-1.20** (0.01)	-0.34*** (0.00)	-0.92*** (0.01)	-0.28** (0.01)	-0.50*** (0.00)	-0.37 (0.12)	-0.70*** (0.00)	-0.91*** (0.00)
$Credit_{it}$	-1.17*** (0.00)	0.00 (0.97)	-0.78*** (0.00)	-0.11*** (0.00)	-0.17*** (0.00)	-0.27*** (0.00)	0.03** (0.03)	-0.37*** (0.00)
I_{it}^{Gini} *$Credit_{it}$	2.75*** (0.00)	-0.01 (0.94)						1.07*** (0.00)
I_{it}^{10}*$Credit_{it}$			1.75*** (0.00)	0.37*** (0.00)	0.61*** (0.00)			
I_{it}^{5}*$Credit_{it}$						1.11*** (0.00)		
g_{it}^{y}	0.08 (0.11)	0.01 (0.59)	-0.02 (0.63)	-0.00 (0.93)	0.03* (0.10)	0.01 (0.72)	0.04** (0.04)	0.02 (0.34)
$Urban_{it}$	0.30*** (0.00)	-0.10** (0.04)	0.05 (0.48)	-0.07 (0.15)	-0.18*** (0.00)	-0.20*** (0.00)	-0.13*** (0.00)	-0.16*** (0.00)
S_{it}^{G}	-0.59*** (0.00)	-0.71*** (0.00)	-0.59*** (0.00)	-0.66*** (0.00)	-0.71*** (0.00)	-0.72*** (0.00)	-0.69*** (0.00)	
GER_{it}^{T}	-0.16*** (0.00)	-0.01 (0.39)	0.05 (0.20)	-0.02 (0.14)	0.07*** (0.00)	0.06*** (0.00)	0.04*** (0.00)	0.04** (0.02)
r_{it}	-0.02 (0.29)	0.03 (0.60)	-0.02 (0.21)	0.03 (0.69)	-0.01 (0.23)	-0.00 (0.91)	-0.01 (0.55)	-0.01 (0.49)
N	320.00	260.00	320.00	260.00	580.00	377.00	580.00	580.00
R^2	.	0.80	0.40	0.75	0.52	0.39	0.63	0.35
F	5.17	20.84	8.72	16.88	14.53	8.45	17.55	9.82

Notes. See notes to Table 3. The dependent variables are private savings in the regressions in columns (1)-(7) and total savings in column (8). The estimation period in the regressions in columns (5)-(8) is 1870-2011.

The interaction between financial development and the Gini coefficient is excluded from the regression in column (7) because inclusion this interaction term reduces the magnitude of the coefficient of inequality and, therefore, renders it difficult to compare with the baseline regressions. The magnitude of the coefficient of I^{Gini} is -0.46 in the regression in column (7), which is 0.10 points higher than the coefficient of -0.57 in the baseline regression in column (8) in Table 3.3. This result suggests that the effects of inequality on saving are slightly exaggerated in the baseline regression because of the omission of confounding variables.

3.5 Why is Saving Affected Negatively by Inequality?

The finding that inequality is bad for saving is an unusual finding and goes against conventional wisdom, and thus begs the question as to why we find such a robust and significant negative relationship between inequality and saving. There are at least four potential explanations for the negative relationship. First, the marginal propensity to consume (MPC) among wealthy people is reduced by philanthropy and donations; thus artificially lowering the savings of the rich. Second, a large amount of wealth is passed on from generation to generation and Doepke and Zilibotti (2008) show that during and before the Industrial Revolution children of wealthy families had low savings rates and had a strong taste for leisure. Third, the political economy literature advocates negative investment effects of inequality because inequality fosters uncertainty, social tension and demand for redistribution through higher taxes and higher wage claims by unions (see, e.g. Alesina and Perotti, 1996). Alesina and Perotti (1996) find a significant inverse relationship between inequality and investment and Schmidt-Hebbel and Serven (2000) suggest that inequality-induced investment increases corporate saving and although in principle this should be offset by higher shareholder saving, it appears not to be the case.

Fourth, Rajan (2010) argues that, in response to rising income inequality in the US, credit was made increasingly available to the less well off to support their consumption levels in the face of stagnant incomes; thus establishing an inverse relationship between inequality and saving. Similarly, based on the Consumer Expenditure Survey, Bertrand and Morse (2013) find that the consumption of the top quintile of the income distribution predicts higher consumption by the poor and interpret their estimates as supporting the view that rising income inequality translates into more demand for credit by low and middle-income households. While credit-financed consumption by lower income groups is feasible today with well-developed financial markets, this effect is likely to have been less pronounced back in history when credit markets were substantially less developed. However, there is evidence that the keeping-up-with the Jones' effect may even have prevailed in the 1920s. The research of Eichengreen and Mitchener (2004), for example, show that 90 percent of major durables were partly or fully credit financed in the US and that less well-off consumers were often among the borrowers.

3.6 Conclusion

Using long historical panel data for advanced countries this paper has examined the effects of income inequality on savings using an instrumental variable approach to deal with the strong positive feedback effects from saving to income inequality that has plagued most of the previous empirical literature. An instrumental variable (IV) approach, in which the saving-induced inequality changes were netted out from inequality, was used to deal with feed-back effects from saving to inequality. The empirical results showed that the macro savings rate is significantly negatively affected by income inequality; a result that is robust to variation in estimation periods, different measures of saving and inequality and the inclusion of important confounding variables such as financial development, growth and education.

The finding of negative savings effects of inequality stands in contrast to the literature, which in almost all cases finds that inequality in savings-regressions, is either significantly positive or insignificant. Since standard growth models predict saving to be one of the principal determinants of inequality there is likely to be a significant positive feedback effect from saving to inequality. This makes it imperative to use external instruments, and the absence of an adequate identification strategy may, to a large extent, explain the previous findings in the literature. The assumption of a positive feedback effect from saving to inequality was confirmed by in our estimates showing that the coefficients of inequality were substantially more negative in the IV regressions than the OLS estimates.

The results in this paper have important policy implications. First, the market reduction in income inequality during the 1940s was a major driver of the increasing savings rates over the same period, suggesting that policies that seek to reduce inequality promote productivity and, temporary, economic growth. Second, the results shed light on the puzzle of why the savings rate has decreased over the past three decades despite historically low old and young age dependency rates that, according to the life-cycle hypothesis, should have resulted in high savings rates. The decreasing saving rates are likely to have been driven by increasing inequality that has more than counterbalanced the increasing fraction of the population of working age. Third, the prediction of by Piketty (2014) of increasing inequality in the 21st century through increasing s/g (gross saving rate/ total GDP growth rate) will be muted by the feedback effect from inequality to saving. Since s will be negatively affected by increasing inequality, it follows that Piketty's prediction of reduced g will have less impact on inequality than if the feedback from inequality to saving is not accounted for.

Data Appendix

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income share: Islam and Madsen, *op. cit.* 1941-2003: Roine, *et. al, op. cit.* 2003-2010: Gini Coefficient: Solt, *op. cit.* Income Share of Top 5%. 1870-1921: Inverse of labor's income share: Islam and Madsen, *op. cit.*, 1921-2003: Roine, *et. al., op. cit.* 2003-2010: Gini Coefficient: Solt, *op. cit.***New Zealand:** Gini Coefficient. 1870-1963: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1963-2010: Solt, *op. cit.* Income Share of Top 10%. 1870-1924: Inverse of labor's income share: Islam and Madsen, *op. cit.* 1924-2002: Roine, *et. al., op. cit.* 2002-2010: Gini Coefficient: Solt, *op. cit.*Income Share of Top 5%. 1870-1921: Inverse of labor's income share: Islam and Madsen, *op. cit.* 1921-2002: Roine, *et. al., op. cit.* 2002-2010: Gini Coefficient: Solt, *op. cit.***Austria:** Gini Coefficient. 1870-1928: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1928-1964: Flora, P. 1987, State, Economy, and Society in Western Europe 1815-1975, Volume 2, Frankfurt: Campus Verlag. 1964-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1928: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1928-1976: Flora, *op. cit.* 1977-1982: Interpolated. 1983-2001: UNU-WIDER World Income Inequality Database, Version 2.0c, May 2008, downloaded from http://www.wider.unu.edu/research/Database.2001-2010: Gini Coefficient: Solt, *op. cit.* **Belgium:** Gini Coefficient. 1870-1963: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1963-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1969: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1969-2001: UNU-WIDER World Income Inequality Database,*op. cit.* 2001-2010: Gini Coefficient: Solt, *op. cit.***Denmark:** Gini Coefficient. 1870-1920: Income Share of Top 10%. 1920-1961: Flora, *op. cit.* 1961-2010: Solt, *op. cit.*Income Share of Top 10%: 1870-2010: Atkinson, A.B. and Sogaard, J.E., 2013, The Long Run History of Income Inequality in Denmark: Top Incomes from 1870 to 2010, EPRU Working Paper Series 2013/1, Denmark, University of Copenhagen. Income Share of Top 5%: 1870-2010: Atkinson *et. al., op. cit.***Finland:**Gini Coefficient. 1870-1922: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1922-1950: Income Share of Top 10%. 1950-1962: Flora, *op. cit.* 1962-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1922: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1922-1966: Flora, *op. cit.* 1966-2002: Roine, *et. al., op. cit.* 2002-2010: Gini Coefficient: Solt, *op. cit.* Income Share of Top 5%. 1870-1922: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1922-1966: Income Share of Top 10%. 1966-2002: Roine, *et. al., op. cit.* 2002-2010: Gini Coefficient: Solt, *op. cit.***France:**Gini Coefficient. 1870-1962: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1962-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1905: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1905-1998: Roine, *et. al., op. cit.* 1998-2010: Gini Coefficient: Solt, *op. cit.*Income Share of Top 5%. 1870-1905: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1905-1998: Roine, *et. al., op. cit.* 1998-2010: Gini Coefficient: Solt, *op. cit.***Germany:** Gini Coefficient. 1870-1955: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1955-1960: Flora, *op. cit.* 1960-2010: Solt, *op. cit.* Income Share of Top 10%. 1870-1874: Inverse oflabor's income share: Islam and Madsen, *op. cit.* 1874-1926: Flora, *op. cit.* 1926-1998: Roine, *et. al., op. cit.* 1998-2004: UNU-WIDER World Income Inequality Database,*op. cit.* 2004-2010: Gini Coefficient: Solt, *op. cit.* Income Share of Top 5%. 1870-1926: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1926-1998: Roine, *et. al., op. cit.* 1998-2010: Gini Coefficient: Solt, *op. cit.***Greece:** Gini Coefficient. 1870-1967: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1967-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1958: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1958-2001: UNU-WIDER World Income Inequality Database,*op. cit.* 2001-2010: Gini Coefficient: Solt, *op. cit.***Ireland:**Gini Coefficient. 1870-1963: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1963-2010: Solt, *op. cit.*Income Share of Top 10%. 1870-1938: Inverse oflabor's income share: Islam and Madsen, *op. cit.*1938-2000: Roine, *et. al., op.*

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Total Savings-GDP ratio: Two methods are used depending on data availability: **M1**. S (Total Savings) = I (Investment) + CA (Current Account) (M1) where Gross Fixed Capital Formation (GFCF) and Capital Formation (CF) are said to be Investment. **M2**. S (Total Savings) = Y (Nominal GDP) – C (Consumption) – G (Government Purchases). Total Saving-GDP Ratio = Total Savings/Nominal GDP. Updated to 2011 using OECD Country Statistical Profiles.**Canada** (M1). Nominal GDP 1870-1993, Current Account 1870-1993: Mitchell B.R. 2003, International Historical Statistics: The Americas 1750-2000, New York, Macmillan. Investment 1870-1926: Engerman, S. L., and Gallman, R. E. 1986, Long Term Factors in American Economic Growth. The University of Chicago Press, Chicago,

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Nominal GDP 1994-2008: http:// databank.worldbank.org. **Finland** 1870-1985 (M2). Nominal GDP 1870-1985, Consumption 1870-1985, Government Purchases 1870-1985: Hjerppe, R. 1989, The Finish Economy 1860-1985, Helsinki: Bank of Finland, Government Printing Centre. 1986-2008 (M1): Nominal GDP 1986-2008, Current Account 1986-2008, Investment as a percentage of Nominal GDP 1986-2008: http:// databank.worldbank.org. **France** 1870-1913 (M2). Nominal GDP 1870-1913, Consumption 1870-1913, Government Purchases 1870-1913: Levy-Leboyer,M. and Bourguignon, F. 1990,The French Economy in the Nineteenth Century: An Essay in Econometric Analysis , Cambridge: Cambridge University Press; Paris, Total Saving-GDP Ratio 1914-1948 interpolated, 1949-1987 (M2). Nominal GDP 1949-1987, Consumption 1949-1987, Government Purchases 1949-1987: Liesner, T. 1989, One Hundred Years of Economic Statistics, Oxford: The Economist. 1988-2008 (M1). Nominal GDP 1988-2008, Current Account 1988-2008, Investment as a percentage of Nominal GDP 1988-2008: http:// databank.worldbank.org. **Germany** 1850-1959 (M2). Nominal GDP 1850-1912, 1926-1937, 1951-1959, Consumption 1850-1912, 1926-1937, 1951-1959, Government Purchases 1850-1912, 1926-1937, 1951-1959: Hoffmann, W. G., Grumbach, F., and Hesse, H. 1965, Das Wachstum der Deutschen Wirtschaft seit der mitte des 19. Jahrhunderts, Berlin: Springer- Verlag. Total Saving-GDP Ratio 1913-1925, 1938-1950 interpolated, 1960-1987 (M2). Nominal GDP 1960-1987, Consumption 1960-1987, Government Purchases 1960-1987: Liesner, T. 1989, *op. cit*. 1988-2008 (M1). Nominal GDP 1988-2008, Current Account 1988-2008, Investment as a percentage of Nominal GDP 1988-2008: http:// databank.worldbank.org. **Greece** (M1):1976-2011: World Development Indicator (WDI) Database, Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account(CA) to Nominal GDP ratio, 1870-1975: Investment to GDP ratio is the Real Investment to Real GDP ratio; CA 1946-1975: Mitchell 1998, Europe, *op. cit*. CA to Nominal GDP ratio 1870-1900: (CA/Nominal GDP = Net Export/Nominal GDP - Debt GDP ratio* UK Interest Rate), Debt GDP ratio, Net Exports: Mitchell 1998, Europe, *op. cit*., UK Interest Rate 1870-1900, CA to Nominal GDP ratio 1901-1945(CA/Nominal GDP = (Net Export + Cumulative net export* 0.04)/Nominal GDP)), Net Export Mitchell 1998, Europe, *op. cit*., CA to Nominal GDP ratio 1946-1975 spliced with CA to Nominal GDP ratio 1900-1946 spliced with CA to Nominal GDP ratio 1870-1900. **Ireland** (M1):1974-2011: World Development Indicator (WDI) Database: Gross Fixed Capital Formation (GFCF) to Nominal GDP ratio and Current Account(CA) to Nominal GDP ratio, 1870-1973: Investment to GDP ratio is the Real Investment to Real GDP ratio, CA 1931-1973: Mitchell 1998, Europe, *op. cit.*, CA to Nominal GDP ratio 1870-1923: CA to Nominal GDP ratio UK 1870-1923 is spliced by UK 1931 with Ireland 1931, CA to Nominal GDP ratio 1924-1931(CA/Nominal GDP = (Net Export + Cumulative net export* 0.04)/Nominal GDP), Net Export Mitchell 1998, Europe, *op. cit*. CA to Nominal GDP ratio 1924-1931 spliced with CA to Nominal GDP ratio 1931-1973. **Italy** (M2). Baffigi, A. 2011, Italian National Accounts, 1861-2011, BancaD'italia, Economic History Working PapersNo. 18, Eurosistema.**Netherlands** 1870-1998 (M2). Nominal GDP 1870-1912, 1922-1924, 1926-1938, 1947-1998, Consumption 1870-1912, 1922-1924, 1926-1938, 1947-1998, Government Purchases 1870-1912, 1922-1924, 1926-1938, 1947-1998: Centraal Bureau voor de Statistiek, 2001, TweehondredJaarStatistiek in Tijdreeksen, 1800-1999, Centraal Bureau voor de Statistiek, Voorburg, Total Saving-GDP Ratio 1809-1814, 1913-1921, 1925, 1939-1946

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Private saving-GDP Ratio.Total saving-GDP ratio minus Government saving-GDP ratio where the government savings equals Total Government Revenue – Total Government Expenditure.Updated using OECD Country Statistical Profiles.**Canada**. Nominal GDP 1870-1995, Total Government Revenue 1870-1995, Total Government Expenditure 1870-1995:

Mitchell 2003, The Americas, *op. cit*. **USA**. Nominal GDP 1874-1994, Total Government Revenue, and Total Government Expenditure 1874-1994: Mitchell 2003, The Americas, *op. cit*. **Japan**. Nominal GDP 1870-1885: Real GDP from Madison Historical GDP Database (http://www.worldeconomics.com/Data/MadisonHistoricalGDP) spliced with Nominal GDP 1885. Nominal GDP 1885-1944, 1946-1993, Total Government Revenue 1870-1993, Total Government Expenditure 1870-1993 Mitchell 2003, Africa, Asia, and Oceania, *op. cit*. Nominal GDP 1945 interpolated. **Australia**. Nominal GDP 1870-1997, Total Government Revenue 1870-1997, Total Government Expenditure 1870-1997: Mitchell 2003, Africa, Asia, and Oceania, *op. cit*. **NewZealand**. Nominal GDP 1871-2008, Total Government Revenue 1871-2005, Total Government Expenditure 1871-2000: Mitchell 2007, International Historical Statistics: Africa, Asia, and Oceania 1750-2005, New York: Macmillan. **Austria**. Government Revenue 1870-1993 , Government Expenditure 1870-1993 Mitchell 1998, Europe, *op. cit*., Nominal GDP 1913, 1924-1937, 1948 - 1993 Mitchell 1998, Europe, *op. cit*. 1870-1912, 1914-1923, 1938-1947 Nominal GDP, spliced with 1913, 1924, and 1948 Mitchell 1998, Europe, *op. cit*. , respectively. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database.**Belgium**. Government Revenue 1870-1912 , 1920-1993, Government Expenditure 1870-1912 , 1920-1993: Mitchell 1998, Europe, *op. cit*., Government Revenue 1913 – 1919 interpolated, Government Expenditure 1913 – 1919: Flora, P., 1987, State, Economy and Society in Western Europe 1815-1975, Chicago: St. James Press, Nominal GDP 1913, 1924, 1927,1930,1934-1939,1941,1943, 1946 – 1993: Mitchell 1998, Europe, *op. cit*. Nominal GDP: 1870-1912, 1914-1923, 1925-1926, 1928-1929,1931-1933,1940, 1942, 1944-1945 spliced with 1913, 1924,1927,1930,1934,1941,1943, and 1946 Mitchell 1998, Europe, *op. cit*. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database. **Denmark**. Abildgren, K., 2006, Estimates of the Danish Government Budget Balance and Cyclical Budget Volatility 1875-2003, NationaløkonomiskTidsskrift, 144(2), 287-303. **Finland**. 1870-1882 spliced with Norway. Nominal GDP 1882-1960: Hjerppe, *op cit*., Total Government Revenue 1882-1960, Total Government Expenditure 1882-1960: Mitchell 1998, Europe, *op. cit*. **France**. Nominal GDP 1870-1913: Levy-Leboyer and Bourguignon, *op. cit*., Nominal GDP 1960-1987: Liesner, *op. cit*., Nominal GDP 1920-1938 and 1988-1993: Mitchell 1998, Europe, *op. cit*., Government Surplus as a Fraction of GDP 1914-1919, 1939-1950 interpolated, Government Surplus as a Fraction of GDP 1951-1959. L'econnomie nationale Aux xixe Et xxesiecles, par emmanuelchadeau 1988, Total Government Revenue1870-1993, Total GovernmentExpenditure 1870-1993: Mitchell 1998, Europe, *op. cit*. **Germany**. Nominal GDP 1870-1912, 1926-1937, 1951-1959: Hoffmann, *et. al.*,*op. cit*., Nominal GDP 1960-1987: Liesner, *op. cit*., Nominal GDP 1988-1993: Mitchell 1998, Europe, *op. cit*. Government Surplus 1870-1912, 1926-1937, 1951-1959: Hoffmann, *et. al.*,*op. cit*. Total Government Revenue 1960-1987: Liesner, *op. cit*. Total Government Revenue 1988-1993: Mitchell 1998, Europe, *op. cit*. Total Government Expenditure 1960-1993: Mitchell 1998, Europe, *op. cit*. Government Surplus as a fraction of GDP 1913-1925, 1938-1950 interpolated. **Greece**. Government Revenue 1870-1895: Lazaretou, S., Monetary and Fiscal policies in Greece 1833-1914, Athens University of Economics and Business. Government Revenue 1896-1993 , Government Expenditure 1870-1993: Mitchell, 1998, Europe, *op. cit*., Nominal GDP

1927-1939,1957-1993 Mitchell, 1998,Europe, *op. cit*. Nominal GDP 1870-1926, 1940-1945, spliced with 1927, and 1957 Mitchell 1998, Europe, *op. cit*., respectively. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database.**Ireland**. Government Revenue 1922-1993 , Government Expenditure 1922-1993: Mitchell1998, Europe, *op. cit*., Nominal GDP 1926, 1929, 1931, 1933, 1936-1939,1947-1998 Mitchell1998, *op. cit*. Nominal GDP 1870-1925, 1927 -1928, 1930, 1932, 1934-1935, 1940-1946 Spliced with 1926, 1929,1931, 1933,1936, and 1947 Mitchell 1998, Europe, *op. cit*., respectively. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database. 1870-1922: UK Government saving-GDP ratio 1870-1922 is spliced by UK 1922 with Ireland 1922. **Italy** 1870-1993: Mitchell 1998, Europe, *op. cit*. **Netherlands**. Nominal GDP 1870-1912, 1922-1924, 1926-1938, 1947-1993 : Centraal Bureau voor de Statistiek, *op. cit*., Nominal GDP 1913-1921, 1925, 1939-1946 interpolated, Total Government Revenue 1870-1993: Centraal Bureau voor de Statistiek, *op. cit*. Total Government Expenditure 1870-1993: Mitchell, 1998, Europe, *op. cit*. **Norway**. Nominal GDP 1870-1939, 1946-1982, Total Government Revenue 1870-1982, Total Government Expenditure 1870-1982: Mitchell 1998, Europe, *op. cit*. Nominal GDP 1940-1945 interpolated. **Portugal**. Nominal GDP 1953 – 1998, Government Revenue 1879-1993 , Government Expenditure 1879-1993 Mitchell1998, Europe, *op. cit*., Nominal GDP 1870-1952, Spliced with 1953 Mitchell 1998, Europe, *op. cit*. Government Revenue to GDP ratio 1995-2011, Government Expenditure to GDP ratio 1995-2011 World Development Indicator (WDI) Database. 1870-1878: Spain Government saving-GDP ratio 1870-1879 is spliced by Portugal 1879 with Spain 1879.**Spain**. Nominal GDP 1870-1987: Carrearas and Tafunell, *op. cit.*Total Government Revenue 1870-1935, 1940-1987, Total Government Expenditure 1870-1935, 1940-1987: Mitchell 1998, Europe, *op. cit*. Total Government Revenue 1936-1939 interpolated, Total Government Expenditure 1936-1959 interpolated. **Sweden**. 1870-1880 spliced with Norway. Nominal GDP, Total Government Revenue, and Total Government Expenditure 1885-1987: Liesner, *op. cit*. Nominal GDP, Total Government Revenue, and Total Government Expenditure 1881-1884 and 1988-1993: Mitchell1998, Europe, *op. cit*. **UK**. Nominal GDP, Total Government Expenditure 1870-1993: Mitchell1998, Europe, *op. cit*. Total Government Revenue 1870-1884 and 1988-1993: Mitchell 1998, Europe, *op. cit*. Total Government Revenue 1885-1987: Liesner, *op. cit*.

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Chapter 4

Does Capital Accumulation Matter for Unemployment in OECD Countries?

Abstract: Unemployment in OECD countries has long been attributed to labour market rigidities. Also many economists argue that capital accumulation has no significant role in reducing OECD unemployment. Using data of 21 OECD countries over the period 1870-2011 this paper however finds that capital accumulation is important in reducing unemployment in OECD countries along with labour market rigidities and aggregate demand factors.

4.1 Introduction

Following the seminal work of Layard, Nickell, and Jackman (1991, revised in 2005; henceforth referred as LNJ (2005)) capital accumulation has taken backseatfor long in explaining unemployment. LNJ (2005) theorise that capital accumulation does not impinge onunemployment. The theoretical underpinning of no linkage between capital accumulation and unemployment as propounded by LNJ (2005) is rooted in the assumption of elasticity of substitution between capital and labour equals unity for which production function is essentially Cob-Douglas. However such assumption is empirically questionable as many researchers report that the elasticity of substitution between capital and labour is less than one (See, for example, David and Klundert, 1965;Nadiri, 1970; Griffin and Gregory, 1976; Chirinko, 1993;Chirinko, Fazzari, and Mayer, 1999; Rowthorn, 1999; Krusell, Ohanian, Rios-Rull, and Violante, 2000; and Antras, 2004).

In particular, Rowthorn (1999) argues that elasticity of substitution between capital and labour (σ) equals 1 is an unrealistic assumption because as he explained that for $\sigma = 1$ and capital share (α) = 0.3 a 2% - 3% reduction in real wage rate is sufficient to eliminate the whole European unemployment without any increase in capital and improvement in technology. Rowthorn (1999), therefore, claims by demonstrating that σ is well below unity. He further argues that for $\sigma < 1$ with the increase in capital deepening capital share decreases and, hence, labour share increases that leads to lower unemployment in order to prevent unionfrom demanding higher wages.

In line with Rowthorn (1999) many other researchers also echo the importance of capital accumulation in reducing unemployment. Bean (1989, 1994),Bean and Gavosto (1990), Carlin and Soskice (1990),Dreze (1991) ,Dreze and Bean (1990),Minford and Riley (1994) , Rowthorn (1977, 1995) emphasise the effect of capital stock on employment through the channel of capacity utilisation. Stockhammer (2004) using time series analysis empirically shows that slowdown in capital accumulation is responsible for unemployment in Germany, France, Italy, UK and USA during 1962-1993. Arestis, Baddeley, and Sawyer (2007) applying vector error correction model for nine European countries and Karanassou, Sala, and Salvador (2008) estimating a three equation system consisting of labour demand, wage setting, and labour supply equations for three Nordic countries report strong effects of capital accumulation on unemployment.Glyn(1998),Sarantis (1993),Stockhammer and Klar (2011), Stockhammer (2011) also emphasize the role of capital accumulation on unemployment.

These recent works show the renewed interest among the researchers in explaining the role of capital in reducing unemployment. However another strand of literature (See, for example, OECD 1994, 1999, 2003, 2006; IMF 2003; Calmfors, Driffill, Honkapohja, and Giavazzi 1988; LNJ (2005); Elmeskov, Martin, and Scarpetta 1998; Nicoletti and Scarpetta 2003; Nickell 1997, 1998; Siebert 1997; Nickell, Nunziata, and Ochel 2005)argues that labour market rigidities arising from trade union power, labour taxes, generous welfare benefits, strict employment protection, and other institutional factors are the main determinants of high unemployment. According to this strand of literature capital accumulation has no influence on unemployment, the problem of unemployment is to deal with encouraging more employment on existing capital stock and hence the emphasis is on labour market deregulation for reducing unemployment.

Amid such diverse views this paper thus aims at investigating the role of capital accumulation in reducing unemployment or enhancing employment with the factors that give rise to labour market rigidities being taken in to account. It contributes to the existing literature in many ways. First, it will empirically examine the effect of capital accumulation on unemployment in a panel set up of 21 OECD countries - Canada, USA, Japan, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherland, Norway, Portugal, Spain, Sweden, Switzerland and UK - over the period 1870-2011 thus contributes to the literature studying the largest number of countries over the longest period of time. Second, it will assess both short and long run effects of capital accumulation on unemployment rate and employment growth rate. Third, following Ball (2009) it will compute NAIRU for all the 21 OECD countries and investigate the effect of capital accumulation on such computed NAIRU. Fourth, as a robustness check it will estimate a system of equations (3SLS estimation) in a panel set up of the largest number of countries over the longest period of time.

4.2 Theoretical Framework: Capital Accumulation, Labour Market Rigidities and Unemployment

With a CES production function it can be shown that capital stock increases employment if the elasticity of substitution between capital and labour is less than one.

Let's consider the following CES production function

$$Y = \left(\propto K^{\frac{\sigma-1}{\sigma}} + (1-\propto)L^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

Here *Y, L,* and *K* are output, employment, and capital respectively, σ is the elasticity of substitution between capital and labour, and α is the capital share of output.

Differentiating equation (1) we get

$$\frac{\partial Y}{\partial K} = r = \propto \left(\frac{Y}{K}\right)^{\frac{1}{\sigma}} \qquad (2)$$

$$\frac{\partial Y}{\partial L} = w = (1-\propto) \left(\frac{Y}{L}\right)^{\frac{1}{\sigma}} \qquad (3)$$

From equations (2) and (3) we get

$$L = K \left(\frac{r(1-\alpha)}{w\ \alpha}\right)^{\sigma} \qquad (4)$$

Equation (4) suggests that employment is a positive function of capital We will test it empirically in this paper.

Differentiation of equation (4) with respect to *K* yields

$$\frac{1}{L}\frac{\partial L}{\partial K} = \frac{1}{K} + \sigma\left(\frac{1}{r}\frac{\partial r}{\partial K} - \frac{1}{w}\frac{\partial w}{\partial K}\right) \qquad (5)$$

The neoclassical assumption of diminishing marginal return implies that $\frac{\partial r}{\partial K} < 0$ while $\frac{\partial w}{\partial K} > 0$. Hence equation (5) suggests that $\frac{\partial L}{\partial K} > 0$ if $\sigma < 1$. In other words employment will increase with the increase in capital if the elasticity of substitution between capital and labour (σ) is less than one.

Rowthorn (1999) also shows that for $\sigma < 1$ capital intensity reduces capital share of output as well as unemployment. He argues that for $\sigma < 1$ as capital intensity reduces capital share of output and hence increases labour share of output. Increased labour share of output thus requires more labour to be employed in order to restrain the union from demanding wage hike. Consequently unemployment in the economy is permanently reduced from before. Rowthorn (1999), however, shows that as σ approaches one, capital intensity influences neither capital share of output nor unemployment.

In LNJ (2005) since $\sigma = 1$ the equilibrium distribution of capital and labour shares of output is independent of capital accumulation. As capital accumulation does not affect labour share of output so the unemployment, as a consequence, remains unaffected. Also with the increase in capital (*K*) according to the neoclassical assumption of diminishing marginal return Marginal Product of Capital (*MPK*) will decrease while Marginal Product of Labour (*MPL*) will increase. Hence in order to maintain the constancy of the ratio of capital share to labour

share that arises from the assumption of σ =1 Labour (L) must decrease with the increase in capital (K). It implies that if labour and physical capital are close substitutes to each other changes in wages will have a large effect on employment. In other words, increase in wage with the investment in new capital results in a loss of employment on existing capital offsets entirely the extra employment created on new capital. Consequently unemployment remains unaffected by capital accumulation when $\sigma = 1$. However for $\sigma < 1$ the reduction of employment on existing capital with increase in wage because of the investment in new capital would be less than the extra employment created on new capital resulting in net increase in employment with the increase in capital accumulation.

The effect of capital accumulation on unemployment may be explained from another perspective. A decrease in capital increases marginal cost of capital and hence prompts the firms to increase price for a given level of wages or alternatively to decrease the wage the firms offer at any level of employment. Whatever the case may be the result is decrease in real wage. If the workers do not accept such fall in real wage and the firms have to compensate for such reduction in real wage the result will be an in increase in unemployment.

Stockhammer (2004) based on Lindbeck (1993) and Nickell (1998) shows that in the long run unemployment is determined by the income claims of workers and capitalists. Income claims of workers essentially reflects the wage push factors - trade union power, labour taxes, generous welfare benefits, strict employment protection, and other institutional factors – that in turn determine the extent of labour market rigidities.

The basic premise upon which the argument that the labour market rigidities are the main determinants of unemploymentstands is that inflation results from a conflict over income claims between workers and capitalists. Workers claim money wages in order to maintain a certain standard of living while firms set prices to cover wages as well as other variable costs and an exogenous mark-up i.e. income claims of capitalists. Worker wage setting in turn depends positively on expected price level and exogenous wage push factors i.e. income claims of workers and negatively on unemployment rate. Since there is a two way feedback from expected price level to expected wage and in turn expected wage to expected price level it therefore gives rise to a conflicting income claims between workers and capitalists and inflation keeps on rising. This two way feedback process and hence the rise of inflation thus halts corresponding to a level of unemployment rate that equilibrates the income claims of workers and capitalists.

The wage bargaining process described above may also explain the effect of capital accumulation on unemployment. Rowthorn (1995) argues that unemployment reduces workers' ability to bargain for further increase in wages while firms' market power of raising prices is hindered because of excess capacity. Thus reduction of excess capacity with decrease in capital accumulation may raise the firms' ability to increase the prices that may in turn feed in to wage bargaining process and induce the workers to ask for higher wages. However this price-wage spiral ends as higher level of unemployment puts downward pressure on the workers to bargain for higher wages. Thus decrease in capital accumulation results in higher unemployment in order to equilibrate the competing income claims of workers and capitalists.

4.3 Empirical Estimates

Based on the theoretical framework as discussed in section 4.2 the following empirical equation is regressed by theLeast Square (LS) estimation in order to estimate the effect of capital accumulation on unemployment rate.

$$U_{it} = a_0 + a_1 kgr_{it} + a_2 ud_{it} + a_3 tax_{it} + \varepsilon_{1,it} \qquad (6)$$

Here U is unemployment rate. kgrstands for non-residential capital growth rate, ud denotes union density as union member per employee, tax measures direct tax to GDP ratio. Equation (6) is estimated based on the previous discussion that unemployment and for that matter employment depends on capital accumulation and labour market rigidities. Here the growth rate of non-residential capital (kgr) proxies for capital accumulation while union density (ud) and direct tax to GDP ratio (tax) are the wage push factors that in turn are the measure of labour market rigidities.

The reason for capital accumulation being proxied by the growth rate of non-residential capital (kgr) is to transform the trended variable non-residential capital stock into trendless. Because unemployment rate is nontrended in the long run. Therefore in order to empirically estimate the effect of capital accumulation on unemployment rate the trended variable non-residential capital stock has been made trendless by transforming it into its growth rate. This is done in line with the existing literature. For example, in Stockhammer (2004)the effect of capital accumulation on unemployment rate is estimated with capital accumulation defined as the growth rate of the business sector gross fixed capital stock. Gordon (1997) finds that unemployment rate increases with the slowdown in the growth rate of capital per labour hour.

Malley and Moutos (2001) show that in the long run capital stock growth rate affects unemployment rate in twenty OECD countries.

Both country and year dummies are included in all the regressions. The regressions are carried out with yearly data in order to estimate the short run effect of capital accumulation on unemployment rate. However to estimate long run effects equations (6) is also regressed with five year non overlapping interval data that will allow for dynamic adjustment. The data used are for 21 OECD countries over the period 1870-2011.

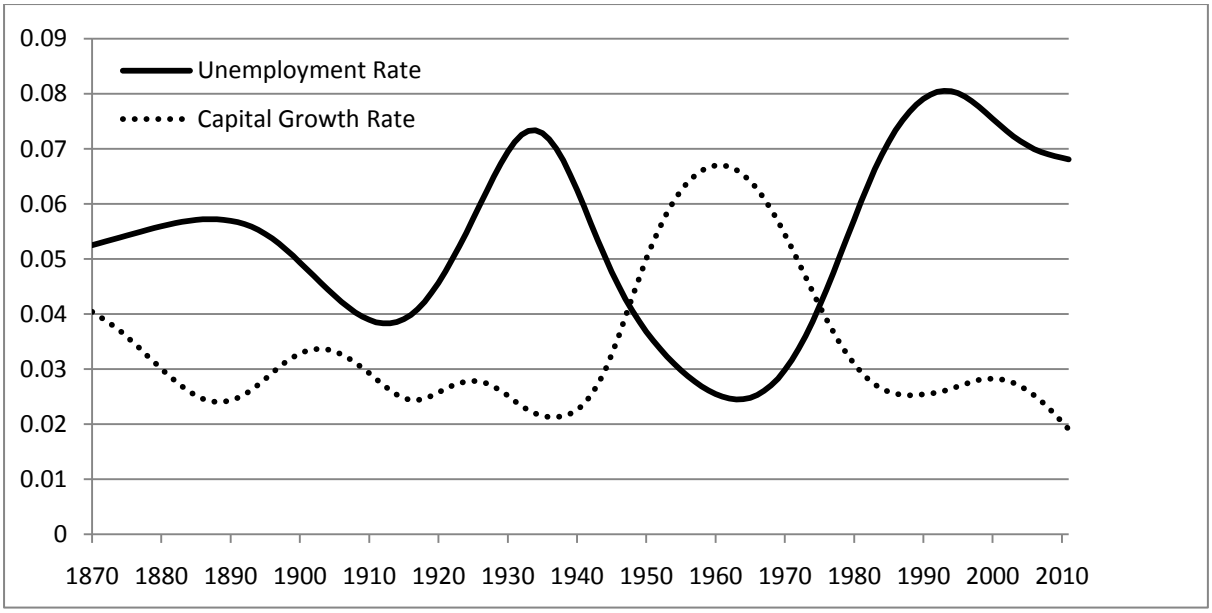
The effect of non-residential capital growth rate (kgr) is expected to be negative on unemployment rate. Union density (ud) and direct tax GDP ratio (tax) – wage push factors – may affect unemployment rate positively.

The coefficient of non-residential capital growth rate (kgr) obtained from LS estimation of equation (6) may suffer from endogeneity bias resulting from the reverse causality of unemployment rate on non-residential capital growth rate (kgr).Because with the increase in unemployment income share of labour decreases while that of capital increases that in turn leads to increase in capital accumulation. Hence unemployment will have positive feed-back effect on capital accumulation and as such the estimated coefficient of non-residential capital growth rate (kgr) will be upward biased in the LS estimation. However such bias would not have any qualitative influence on the conclusion about the effect of capital accumulation on unemployment rate.Because the estimated coefficientof non-residential capital growth rate (kgr) is expected to be negative and as such the removal of upward bias by instrumental variable (IV) estimation will make it more negative. Therefore the conclusion of the negative effect of capital accumulation on unemployment is not qualitatively affected even though the endogeneity bias is not taken in to account. However it is still arguable that estimated coefficient is upward biased and hence IV estimation is warranted. But it is extremely difficult to find instruments for capital accumulation. Because capital accumulation can be explained by the variables like technology, taxation, real wages and neither of these variables are exogenous nor do they hold exclusion restrictions as they have direct effect on unemployment.

4.4 Data

The sources of data used in this chapter are described in data appendix. As this chapter explores the importance of capital accumulation on unemployment the main variables of interest are unemployment rate and non-residential capital growth rate.

Figure 4.1: Average Non-Residential Capital Growth Rate and Average Unemployment Rate



Note: Average non-residential capital growth rate and average unemployment rate of 21 OECD countries over the period 1870-2011. Both average non-residential capital growth rate and average unemployment rate are trended using the Hodrick-Prescott filter with a smoothing parameter $\lambda = 1000$.

Figure 4.1 shows that unemployment rate and non-residential capital growth rate are moving in opposite direction over the period 1870-2011. In particular unemployment is showing a long run increasing trend while the non-residential capital growth rate is showing a long run decreasing trend over the period 1870-2011. The figure also shows that unemployment reaches the peak at about 6%, 7.5%, and 8% in mid 1880's, mid 1930's, and mid 1990's respectively when non-residential capital growth rate dips at about 2 to 2.5%. Conversely unemployment rate falls at about 2.5% in mid 1960's when non-residential capital growth rate records its peak at around 6.5%.

4.5 Estimation Result

Table 4.1 shows the least square estimation results of equation (6). Columns (1) to (3) report the results for the period 1870-2011. Estimation results for the period pre-WWII (1870-1945)

are presented in columns (4) to (6) while columns (7) to (9) show the results for the post-WWII (1946-2011) period. At first, the effect of capital growth rate, and wage push factors on unemployment rate is estimated separately and the results are presented in columns (1) and (2), (4) and (5), (7) and (8) for the period 1870-2011, pre-WWII (1870-1945), post-WWII (1946-2011) respectively. The results show that capital growth rate has significant negative effect, as expected, on unemployment rate without controlling for wage push factors in every period. In the same count wage push factors without controlling for capital growth rate have significant effect on unemployment rate.

Column (3), (6), and (9) exhibit the estimation results with both capital growth rate and wage push factors included in the same regression for the period 1870-2011, pre-WWII (1870-1945), post-WWII (1946-2011) respectively. As it can be seen that capital growth rate with wage push factors being controlled has significant negative effect on unemployment rate in all the periods. However the results suggest that capital accumulation reduces unemployment more in the post war period than does inthe pre-war period. It may be for the reason that the elasticity of substitution between capital and labour is less in the post war period than is in the pre-war period. Consequently employment created in the new capital is less offset by the reduction in employment in the old capital in the post war period than is in the pre-war period. The other reason may be that the measurement of capital is more accurate in the post war period than is in the pre-war period.

Table 4.1: Dependent Variable: Unemployment Rate

	1870-2011			1870-1945			1946-2011		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
kgr	-0.05*** (0.00)		-0.05*** (0.00)	-0.05*** (0.00)		-0.05*** (0.00)	-0.09*** (0.00)		-0.09*** (0.00)
ud		0.02*** (0.00)	0.01*** (0.01)		0.07*** (0.00)	0.07*** (0.00)		0.03*** (0.00)	0.03*** (0.00)
tax		-0.05*** (0.00)	-0.05*** (0.00)		-0.05** (0.02)	-0.05** (0.03)		0.02 (0.38)	0.03 (0.24)
N	2982.00	2982.00	2982.00	1596.00	1596.00	1596.00	1386.00	1386.00	1386.00
r2	0.62	0.61	0.62	0.70	0.70	0.71	0.66	0.66	0.66
F	27.82	27.45	27.65	35.67	36.74	37.35	29.20	28.72	29.00

Notes. The numbers in parentheses are *p*-values. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

As for the wage push factors union density has significant positive effect on unemployment rate in all the periods. Nickell (1997) also reports the similar result. It thus suggests that

increased participation of the workers in union activities increases unemployment. It also implies that union exerts significant influence on wage settlement and thus raises unemployment through higher wage demand. The estimated result also indicates that union density as a measure of labour market rigidity has more influence on unemployment in the pre-war period than in the post war period and thus in turn implies that labour markets in OECD countries are more flexible in the post war period than in the pre-war period as they have experienced reform during post war period (See, for example, Siebert 1997 for details).

Direct tax to GDP ratio (tax) as a wage push factor is expected to be positively related to unemployment. However the estimated result shows that it has no effect on employment in the post war period while reduces the unemployment in pre-war period. One reason for such contrast may be that the *tax* data may suffer from potential measurement error. Other reason may be that the supply side effect of *tax* is prominent than the demand side effect. From the supply point of view *tax* discourages labour supply and thereby reduces unemployment. On the other hand *tax* as a wage push factor increases wage and thereby reduces labour demand and hence decreases employment. In the pre-war period it may be that for the dominance of supply side effect over demand side reduction in unemployment outweighs decrease in employment resulting in the negative effect of *tax* on unemployment.

The negative effect of *tax* on unemployment may also be explained from the perspective of Summers (1981). Firms' after tax profit may be either distributed as dividend to the shareholders or kept as retained earnings for further investment that in turn increases capital stock and value of the firm resulting in the prospect of higher capital gain. Furthermore dividend is subject to personal income tax while capital gain is subject to capital gain tax. Therefore increase in personal income tax decreases the opportunity cost of retained earnings and hence renders incentive to higher capital accumulation that in turn lowers unemployment. It thus suggests that higher personal income tax through the channel of capital accumulation reduces unemployment.

4.6 Robustness Check

4.6.1 Robustness check with alternative estimation: Three Stage Least Square (3SLS)

As robustness check to the LS estimation of equation (6) the influence of capital accumulation on unemployment may be investigated estimating a system of equations. Karanassou, Sala, and Salvador (2008) estimate a three equation system for three Nordic

countries -Denmark, Finland, and Sweden and report strong effects of capital accumulation on unemployment. However they estimated the system of equations for each country separately in a time series set up. In this paper the system of equations will be estimated in a panel set up for more countries (21 OECD) and over a longer period (1870-2011). The following two equation system consisting of unemployment and real wage equations will be estimated by 3SLS.

$$U_{it} = b_0 + b_1 kgr_{it} + b_2 rw_{it} + \delta_{1,it} \qquad (7)$$

$$rw_{it} = c_0 + c_1 ud_{it} + c_2 tax_{it} + \eta_{1,it} \qquad (8)$$

Here equation (7) is the unemployment equation with unemployment rate (*U*) as the dependent variable and non-residential capital growth rate (kgr) and real wage (*rw*) as explanatory variables. Equation (8) is the real wage equation that subsumes real wage (*rw*) as the dependent variable and union density (ud) and direct tax to GDP ratio (tax) as explanatory variables.

Equations (7) and (8) indicate that unemployment and real wage are determined simultaneously in the labour market. Hence if they are estimated separately as a single equation technique applying Ordinary Least Square (OLS) the resulting estimation will be inconsistent as OLS estimation ignores the simultaneous nature of unemployment and wage determination in the labour market. When a relation is part of a system single equation technique provides inconsistent estimates (Bishop and Yoo, 1985). Therefore in order to maintain the simultaneous nature of unemployment and wage determination in the labour market equations (7) and (8) are estimated by 3SLS. Estimation of the system of equations applying 3SLS takes care of potential endogeneity and cross equation correlation (Karanassou*et al.* 2008). This system of equations will also be estimated by 3SLS with employment growth rate (*Egr*) instead of unemployment rate (*U*) as dependent variable in equation (7) in order to estimate the effect of capital accumulation on employment as well.

3SLS estimation results of the system of equations (7) and (8) are presented in Table 4.2. Columns (1) to (3) and columns (7) to (9) show the 3SLS estimation results of equation (7) with unemployment rate (*U*) and employment growth rate (*Egr*) respectively as dependent variables. 3SLS estimation results of equation (8) are presented in columns (4) to (6). Results are reported for the whole sample period (1870-2011), pre-war period (1870-1945), and post war period (1946-2011). The results indicate that non-residential capital growth rate (kgr)

has significant negative effect on unemployment rate (*U*) and significant positive effect on employment growth rate (*Egr*). Also the magnitude of the effect is more in the post war period than is in the pre-war period. As for the wage push factors union density (ud) significantly increases real wage that in turn significantly increases unemployment in the pre-war as well as post war periodThe results are indeed supportive to the LS estimation of equation (6).

Table 4.2: 3SLS Estimation Result

	Dependent Variable: Unemployment			Dependent Variable: Real Wage			Dependent Variable: Employment Growth Rate		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1870-2011	1870-1945	1946-2011	1870-2011	1870-1945	1946-2011	1870-2011	1870-1945	1946-2011
kgr	-0.05* (0.10)	-0.05** (0.02)	-0.07** (0.01)				0.11*** (0.00)	0.09*** (0.00)	0.19*** (0.00)
rw	-0.59** (0.05)	1.58*** (0.01)	0.20*** (0.00)				-0.03 (0.86)	-0.33 (0.22)	0.02 (0.75)
ud				-0.02** (0.04)	0.04*** (0.00)	0.15*** (0.00)			
tax				0.08** (0.03)	-0.02 (0.19)	0.01 (0.90)			
N	2982.00	1596.00	1386.00	2982.00	1596.00	1386.00	2982.00	1596.00	1386.00

Notes. The numbers in parentheses are *p*-values. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

4.6.2 Robustness check with the inclusion of aggregate demand factors

Demand factors such as export growth rate, government deficit to GDP ratio, and real interest rate may have permanent effect in contrast to the conventional wisdom of their temporary effect on unemployment rate. Storm and Naastepad (2009) show that in the long run when real wage and labour productivity grow at the same rate output grows positively with export growth, government deficit to GDP ratio and negatively with real interest rate; and also show that output growth has positive effect on labour productivity growth. Consequently the labour productivity growth rate becomes the function of demand factors - export growth rate, government deficit to GDP ratio, and real interest rate. Rowthorn (1995)on the other hand shows that faster labour productivity growth reduces equilibrium unemployment. Therefore the demand factors - export growth rate, government deficit to GDP ratio, and real interest rate - affect unemployment rate permanently. The effect of aggregate demand on long run unemployment is also endorsed in the work of Rowthorn (1999), Galbraith and Garcilazo (2004), Karanassou and Snower (2004), and Arestis*et al*. (2007).

In Storm and Naastepad (2009) demand factors have permanent effect on unemployment as with the expansion of demand employment increases permanently in a non-inflationary

manner because demand expansion results in higher labour productivity growth that counters the inflationary pressure of demand expansion. However in Ball (1999) increase in aggregate demand reduces unemployment permanently in a different channel. Ball (1999) segregates unemployment as long term and short term and argues that as long term unemployment does not exert any downward pressure on wage it has no influence in Philips curve – inflation unemployment trade off. He argues that demand expansion increases employment entirely by reducing long term unemployment that does not have any effect on inflation. Hence demand factors have permanent effect on unemployment as increase in aggregate demand increases employment permanently without affecting inflation.

That demand factors have permanent effect on unemployment lends further credence to the role of capital accumulation in reducing unemployment. Because investment as a factor of demand if increases may lead to further expansion of demand through its multiplier effect and thus results in reduction of unemployment. Therefore as robustness check aggregate demand variables - export growth rate (g^X), and real interest rate (r)– are included in the base line model (Equation (6)). For the unavailability of data government deficit to GDP ratio is not included. The inclusion of these variables in the base line model will take care of the effect of cyclical fluctuations. The estimated coefficient of non-residential capital growth rate (kgr) thus reflects the effect of capital accumulation on unemployment with cyclical fluctuations being controlled.

Table 4.3 presents LS estimation results with export growth rate (g^X), real interest rate (r)and labour supply growth rate (g^L) included in the base line model (Equation (6)). As unemployment depends on both labour demand and supply labour supply growth rate (g^L) is included as an explanatory variable. Assuming that in the long run labour supply grows at the same rate of population g^L is measured as the working age (age group 15 to 65 years) population growth rate. The result shows that the effect of capital accumulation on unemployment is negative and significant controlled for aggregate demand variables and labour supply growth rate. It thus implies the robustness of the estimation result of the base line model. Among the aggregate demand variables real interest rate (r) significantly reduces unemployment for the whole period of estimation and also as expected the coefficient of labour supply growth rate (g^L) is significant and positive implying that unemployment increases with the increase in labour supply growth rate.

Table 4.3: Estimation Result with other Control Variables

	1870-2011		1870-1945		1946-2011	
	(1)	(2)	(3)	(4)	(5)	(6)
kgr	-0.05*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.09*** (0.00)	-0.10*** (0.00)
ud	0.01*** (0.01)	0.01*** (0.01)	0.07*** (0.00)	0.07*** (0.00)	0.02*** (0.01)	0.03*** (0.00)
tax	-0.05*** (0.00)	-0.04*** (0.01)	-0.05** (0.02)	-0.03 (0.14)	0.03 (0.23)	0.03 (0.36)
g^X	0.00 (0.70)	0.00 (0.90)	-0.00 (0.83)	-0.00 (0.61)	-0.00 (1.00)	-0.00 (0.99)
r	0.01** (0.02)	0.01*** (0.01)	0.00 (0.72)	0.00 (0.54)	0.01 (0.14)	0.01* (0.10)
g^L		0.71*** (0.00)		0.59*** (0.00)		0.63*** (0.00)
N	2961.00	2961.00	1575.00	1575.00	1386.00	1386.00
r2	0.62	0.62	0.71	0.71	0.66	0.67
F	27.32	27.65	36.43	36.57	28.41	28.48

Notes. The numbers in parentheses are *p*-values. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

4.6.3 Robustness check with 5 year interval data

As a robustness check to the estimation results with yearly data as discussed so far LS estimations are also carried out with 5 year non overlapping interval data. Estimation with 5 year non overlapping interval data has the advantage of avoiding the effects of short run fluctuations and hence the estimated coefficients will reflect the long run effect. Table 4.4 shows the regression resultsfor 5 year non overlapping interval data with unemployment rate (*U*) and employment growth rate (*Egr*) as dependent variable.

As can be seen from the results reported in Table 4.4 that capital growth rate has significant negative effect on unemployment rate in all the regressions. Since 5 year non overlapping interval data allow for dynamic adjustment and capture long run effect it thus implies that capital growth rate reduces unemployment rate in the long run as well. Among the wage push factors union density is showing significant positive effect on unemployment rate consistently in both pre and post warperiods. Real interest rate (*r*) is reported to have significant positive effect on unemployment rate in post war period implying that aggregate demand factoris significant to unemployment rate in the long run as well. Finally labour supply growth rate has significant positive effect on unemployment rate. Overall the regression results with 5 year non overlapping interval data are in line with that of yearly data.

Table 4.4: Estimation Result with 5 Year Interval Data

	Dependent Variable: Unemployment Rate			Dependent Variable: Employment Growth Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
	1870-2010	1870-1945	1950-2010	1870-2010	1870-1945	1950-2010
kgr	-0.01** (0.05)	-0.01*** (0.01)	-0.02** (0.02)	0.10*** (0.00)	0.11*** (0.00)	0.07*** (0.00)
ud	0.01 (0.20)	0.07*** (0.00)	0.05*** (0.01)	-0.05 (0.15)	-0.11* (0.07)	-0.08* (0.09)
tax	-0.05 (0.18)	-0.07 (0.14)	0.05 (0.43)	0.06 (0.55)	0.02 (0.90)	0.30* (0.07)
g^X	0.00 (0.91)	-0.00 (0.16)	-0.00 (0.23)	0.003*** (0.00)	-0.00 (0.76)	0.01*** (0.00)
r	0.00 (0.74)	-0.00 (0.50)	0.25*** (0.00)	0.05*** (0.00)	0.05*** (0.00)	-0.21* (0.07)
g^L	0.59** (0.04)	0.36 (0.26)	0.53 (0.20)			
N	588.00	315.00	273.00	588.00	315.00	273.00
r2	0.63	0.74	0.71	0.44	0.49	0.56

Notes. The numbers in parentheses are *p*-values. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

Capital growth rate, on the other hand, is showing significant positive effect on employment growth rate implying that capital growth rate spurs employment growth rate in the long run as well. Among the aggregate demand factors export growth rate has significant positive effect while real interest rate has significant negative effect on employment growth ratein post war period. Union density as a wage push factor reduces employment growth rate significantlyin the bothpre and post war periods. Overall the results are supportive to that of the yearly data. Moreover the main focus of the paper that the role of capital accumulation is important in reducing unemployment holds in both yearly and 5 year non overlapping interval data as well as with both unemployment rate and employment growth rate as dependent variable.

4.7 Non- Accelerating Inflation Rate of Unemployment (NAIRU) and Capital Accumulation

In this section the effect of capital growth rate, aggregate demand factors, and wage push factors on NAIRU – the long run behaviour of unemployment will be investigated. In previous sections it is argued that capital growth rate, aggregate demand factors, and wage push factors affect unemployment in both short run (estimation with yearly data) and long run (estimation with 5 year non overlapping interval data). To further strengthen the argument that capital accumulation and aggregate demand factors have long run effect on unemployment estimation will be carried out with NAIRU as dependent variable.

In this paper following Ball (2009) NAIRU series for 21 OECD countries have been generated. Ball (2009) essentially improves the NAIRU estimation of Ball and Mankiw (2002) arguing that their estimation is internally inconsistent as they estimate time varying NAIRU assuming a constant NAIRU. Ball (2009) resolves this issue with an iterative procedure. Hence in this paper the following equation will be estimated by OLS to obtain β where π is inflation rate and *U* is unemployment rate.

$$(\pi_t - \pi_{t-1}) = \beta\,(U_t - U^*) + \eta \qquad (9)$$

With the estimated β and by rearranging equation (9) the series U^* is obtained and by smoothing it with Hodrick- Prescott filter the NAIRU series of Ball andMankiw (2002) is generated.

The NAIRU series of Ball and Mankiw (2002) so estimated is termed as U_t^* and following Ball (2009) the following equation is estimated

$$(\pi_t - \pi_{t-1}) = \beta_1\,(U_t - U_t^*) + \eta_1 \qquad (10)$$

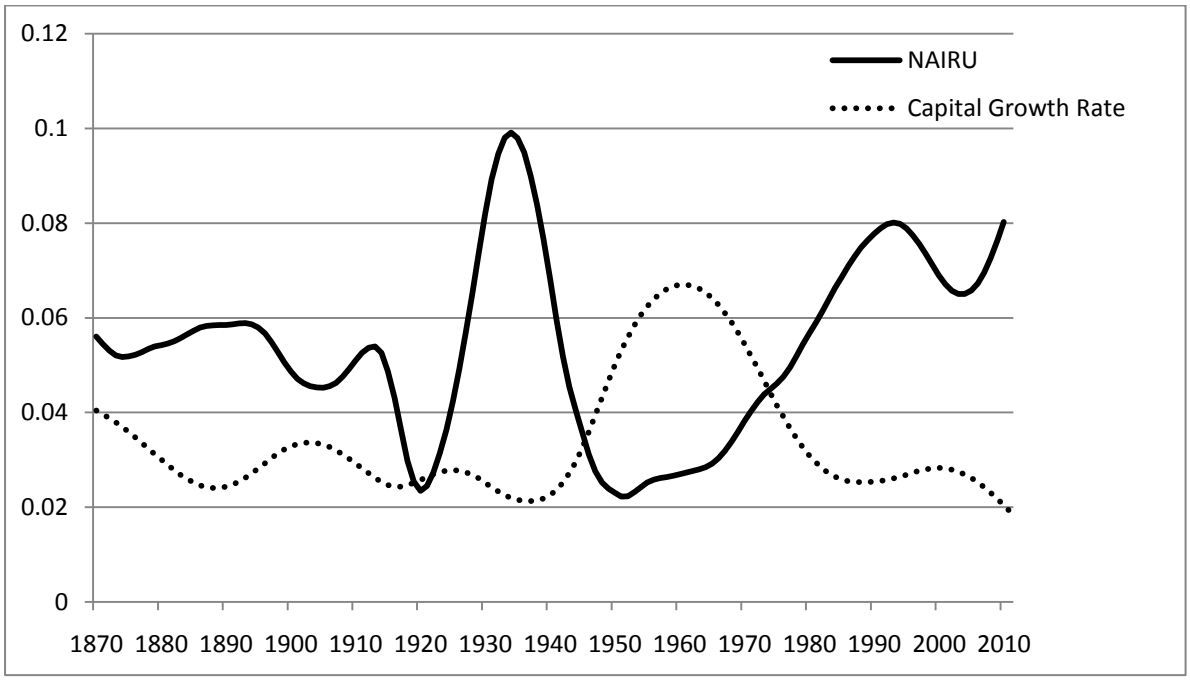
With the estimated β_1 and rearranging equation (7) and applying Hodrick- Prescott filter with smoothing parameter λ = 100 newU_t^* is computed. With this new U_t^* new $\beta_1$is estimated and following the aforementioned procedure newU_t^* is again computed. This iterative procedure continues until the results converge to a $\beta_1$and a U_t^* series that are consistent. The resulting U_t^* series is the NAIRU series that is obtained following Ball (2009). The following figure depicts the average non-residential capital growth rate and average NAIRU of 21 OECD countries over the period 1870-2011.

As it can be seen from the figure 4.2 non-residential capital growth rate is showing a long run downward trend while NAIRU has registered a long run upward trend. Also average NAIRU has fallen from its peak at 10% in Mid 1930s to about 2.5% in mid 1950's and since then NAIRU has again been increasing. During the corresponding period average capital growth rate is showing the opposite trend of NAIRU – it has risen very steadily from the lowest 2% to around 6.5% and then again been falling. The corresponding opposite movement of capital growth rate and NAIRU may lend the insight that the decrease in capital growth rate may lead to the increase in NAIRU.

The increase in NAIRU in 1930's is the effect of Great Depression. Many authors (See, for example, Eichengreen and Sachs 1985; Bernanke and Carey 1996; Beenstock and

Warburton 1986) suggest that because of labour market rigidity and hence wage rigidity demand shock reduced output and increased unemployment during Great Depression. Madsen (2004) however argues that even though both price rigidity and wage rigidity were responsible for supply failure during great depression that resulted in long lasting unemployment the former was more prominent than the latter.

Figure 4.2: Average Non-Residential Capital Growth Rate and Average NAIRU



Note: Average non-residential capital growth rate and average NAIRU of 21 OECD countries over the period 1870-2011. Average non-residential capital growth rate is trended using the Hodrick-Prescott filter with a smoothing parameter $\lambda = 1000$.

The LS estimation results with NAIRU as the dependent variable is reported in Table 4.5. The effect of three sets of independent variables – capital growth rate, aggregate demand factors, and wage push factors – on NAIRU are estimated and reported for the whole period 1870-2011, pre-war period 1870-1945, and post war period 1946-2011.

The results reported in Table 4.5 suggest that capital growth rate has significant negative effect on NAIRU in all the periods. Union density as wage push factors increases NAIRU significantly. The growth rate of labour supply also increases NAIRU significantly. Overall the results documented in this paper with diverse specifications are consistent with each other suggesting the robustness of the reported results.

Table 4.5. Estimation Results: Dependent Variable NAIRU

	1870-2011		1870-1945		1946-2011	
	(1)	(2)	(3)	(4)	(5)	(6)
kgr	-0.02*** (0.01)	-0.02*** (0.00)	-0.03*** (0.00)	-0.02*** (0.00)	-0.04** (0.03)	-0.04*** (0.01)
ud	0.01*** (0.00)	0.01*** (0.00)	0.06*** (0.00)	0.05*** (0.00)	0.03*** (0.00)	0.03*** (0.00)
tax	-0.04*** (0.00)	-0.04*** (0.01)	-0.07*** (0.00)	-0.06*** (0.00)	0.03 0.14	0.03 0.23
g^X	0.00 (0.85)	-0.00 (0.91)	-0.00 (0.61)	-0.00 (0.37)	-0.00 (0.80)	-0.00 (0.80)
r	0.00 (0.70)	0.00 (0.46)	-0.00 (0.14)	-0.00 (0.25)	0.00 (0.82)	0.00 (0.73)
g^L		0.67*** (0.00)		0.59*** (0.00)		0.51*** (0.00)
N	2961.00	2961.00	1575.00	1575.00	1386.00	1386.00
r2	0.67	0.67	0.79	0.80	0.70	0.71
F	33.89	34.41	57.37	58.05	34.14	34.18

Notes. The numbers in parentheses are *p*-values. Asterisks denote significance at * 10% significance, ** 5% significance, *** 1% significance. Country and year fixed effects are included in all regressions.

4.8 Conclusion

In this paper empirically it is found that capital growth rate and increase in aggregate demand reduce unemployment rate in 21 OECD countries over the period 1870-2011in both short run and long run. It is also documented that labour market rigidities are important determinants of unemployment rate of these countries over the same period since wage push factors such as increase in union density increases unemployment rate. Against the theoretical explanation of LNJ (2005) based on the assumption of unitary elasticity of factor substitution that capital accumulation has no effect on unemployment this paper documents that capital accumulation is important in reducing unemployment rate in both short run and long run. Also contrary to the conventional wisdom following Friedman (1968) that aggregate demand has only short run, not any long run, impact on unemployment it is found that aggregate demand affects unemployment in both short run and long run. As a great deal of literature argues that labour market rigidity is the prime driver of European unemployment policy implications are directed towards labour market deregulation in order to promote labour market flexibility and hence to reduce unemployment. In this paper, however, along with labour market rigidities it is found that capital accumulation and aggregate demand are also important determinants of unemployment in 21 OECD countries. It is therefore argued that along with labour market deregulation policies that encourage capital accumulation should also be emphasised.

Data Appendix

Non-Residential Capital: Madsen, J.B. (2008). Semi-endogenous versus Schumpeterian Growth Models: Testing the knowledge Production Function Using International Data.*Journal of Economic Growth*, 13(1), 1-26.

Unemployment Rate: Madsen, J. B., Mishra, V., and Smyth, R.(2012). Is The Output–Capital Ratio Constant in the Very Long Run?*Manchester School*, 80(2), 210-236.

Employment: Madsen, J.B. (2008). Semi-endogenous versus Schumpeterian Growth Models: Testing the knowledge Production Function Using International Data.*Journal of Economic Growth*, 13(1), 1-26.

Real Wage: Total hourly labour costs are first available from the beginning of the 1960s. However, the indirect labour costs were a small proportion of total labour costs in the early 1960s. **Before 1960.**Hourly earnings are spliced to hourly labour costs before early 1960s. Weekly, monthly or annual earnings are converted to hourly earnings using economy-wide annual hours worked in the periods and countries for which hourly wages are not available. Canada. Composite index of real hourly wages in building trades and converted to nominal wages using the consumer prices. J. G. Williamson, 1995, "The Evolution of Global Labour Markets since 1830: Background Evidence and Hypothesis," *Explorations in Economic History*, 32, 141-196. USA. Before 1900, annual earnings of non-farmers divided by annual hours worked. After 1900, hourly earnings in manufacturing. B. R. Mitchell, 1983, *International Historical Statistics: Americas and Australasia*, London: Macmillan. Japan. 1870-1880. consumer prices.1880-1960. Hourly wages in manufacturing. K. Ohkawa, *et al*., 1979, *op. cit.*Australia. Composite of various professions. Williamson, 1995, *op cit*. corrected for hours worked. Belgium. 1870-1914. Manufacturing workers. P. Scholliers and V. Zamagni (eds), 1995, *Labour's Reward*, London: Edward Elgar. 1914-20. Agricultural workers. M. van Meerten, 2003, *op cit*. 1920-1960. Composite or manufacturing weekly earnings corrected for annual hours. Williamson, 1995, *op cit*. Denmark.Hourly wages in manufacturing.Johansen, 1985, *op cit*. Finland. Compensation to employees in manufacturing divided by employment in manufacturing and economy-wide annual hours worked. Hjerppe, 1989, *op cit*. France.1870-1938. Economy-wide.Scholliers and Zamagni, 1995, *op cit*. 1938-1960.Hourly industrial wages.Williamson, 1995, *op cit*. Germany.1871-1943. Hourly wages

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Chapter 5

Conclusion

5.1 Concluding Remarks

This thesis has investigated the causal relationship between capital accumulation and economic growth, the role of capital accumulation in reducing unemployment and the effect of income inequality on capital accumulation over the period 1870-2011. While the causal relationship between capital accumulation and economic growth has been investigated in the context of five Asian countries the influence of capital accumulation on unemployment and how the income inequality affects capital accumulation have been explored for OECD countries. The thesis finds that capital accumulation in Asian Miracle Economies (AME) comes from economic growth. Also decrease in income inequality enhances capital accumulation that in turn reduces unemployment in OECD countries.

Econometric analysis concerning the issue of capital accumulation, economic growth, income inequality, unemployment is plagued with the endogeneity arising from reverse causality. And in the literature it is usually attempted to deal with this issue using lag of the endogenous regressor as an instrument. However the problem with such approach is that if the dependent variable is serially correlated the lags are not exogenous. And also if any other variable, such as good institutions, that affects both dependent and independent variable lags cannot be treated as instruments. This thesis therefore addresses the issue of endogeneity arising from reverse causality using instruments that can well explain and generate exogenous variations of the endogenous regressor instead of using its lag. The subsequent discussion focuses on the main findings and contributions of this thesis.

Essay one examines the causal relationship between saving and growth in AMEs over the period 1870-2011. Contrary to the Young – Krugman hypothesis that stresses the factor accumulation led to the spectacular productivity growth in AMEs, essay one finds that a significant fraction of financial savings and education in AMEs has been driven by high productivity growth; not the other way round. The prediction of many economists following the neoclassical revival that fixed and human capital accumulation is the prime driver of the high productivity growth rate in AMEs is predicated to the assumption that saving and schooling are independent of growth (See, for example, Hsieh and Klenow, 2010; Lee and

Hong, 2012; van der Eng, 2010). However such assumption is questionable as from the perspective of growth accounting using Cobb-Douglas production function it is shown that capital deepening can be explained by productivity growth rate. Also theories of saving often predict that growth enhances saving thus casting further doubt about the exogeneity of fixed and human capital accumulation and of their independence of productivity growth. That in AMEs prior to WWII living standard was close to subsistence level thus leaving less opportunity of saving and only after WWII with the increase in living standard financial saving and education increase lends further credence that saving and education are not exogenous and independent of growth.

This essay thus considered fixed and human capital accumulation as endogenous regressors while assessing their effect on growth and contributes to the literature instrumenting the financial savings with a new set of instruments. Also in the growth controversy it has never been asked and the factor accumulation hypothesis never explains from where the savings come and very little work, if any, has investigated whether growth influences education. Applying a two-way identification strategy and unique data covering the period 1870-2011 for the AMEs this essay also contributes to the literature showing that financial saving as well as education, to a large extent, comes from productivity growth. The essay also finds that financial saving has no significant effect on growth but growth is positively related to the change in educational attainment. These results are robust to choice of instrument set, productivity measurement, the choice of growth model, measurement of saving, inclusion of covariates, and to the choice of estimation period.

The finding of the first essay that the productivity growth in AMEs is independent of financial saving is against the factor accumulation hypothesis that says that capital accumulation enabled by saving drives the spectacular productivity growth in AMEs and is also against the growth model of Harrod (1939) and Domar (1946) in which saving rate is pivotal to the growth.

The results of the first essay indicate that forces other than financial savings are influential to thegrowth scenario in the AMEs. Bloom and Williamson (1998) showed that the demographic transition has been influential for the Asian growth miracle and Hsieh and Klenow (2010) have shown that the reallocation of unproductive firms to productive entities has boosted growth in China, an effect that could well have applied to the countries considered here.Ang and Madsen (2011) have shown that growth has been, predominantly, innovation driven.The essay thus suggests that the literature needs to distract from the capital

fundamentalist view to look more into R&D, human capital and knowledge spill overs as sources of growth.

The second essay investigates the effect of income inequality on savings for 20 OECD countries over the period 1870-2011. It finds that income inequality affects savings negatively and the finding is robust to variation in estimation periods, different measures of saving and inequality and the inclusion of important confounding variables such as financial development, growth and education. However the findings of the existing empirical literature suggest that the effect of income inequality on savings is either positive or insignificant. The reason for such findings of the existing empirical literature may be that in estimating the coefficient of income inequality on savings the positive feed-back effect from savings to income inequality has not been dealt with adequately.

Standard growth model predicts that savings is an important determinant of income inequality and as such savings is likely to have positive feed-back effect on income inequality. That according to Piketty (2014) savings increases capital income ratio that in turn increases income inequality is also supportive to the idea of positive feed-back effect of savings on income inequality. The result of the second essay confirms the positive feed-back effect of savings on income inequality as the coefficient of income inequality on savings is more negative in IV estimation than in OLS estimation.

The second essay thus contributes to the literature taking the positive feed-back effect of saving on income inequality in to consideration applying a two way identification strategy suggested by Blanchard and Perotti (2002) and further developed by Brückner (2013) in which saving is instrumented by life expectancy at the age of ten, and young age dependency ratio and income inequality is instrumented by the residual variation in income inequality not driven by saving.

While the positive effect of income inequality on savings follows from the conventional wisdom of MPC of the rich is higher than that of the poor Dusenberry's (1949) relative income hypothesis that an individual's consumption depends not only on his/her current income but also on the level of income of his/her reference group laysthe theoretical underpinning of the negative effect of income inequality on savings. The reference group for the rich is only the rich while the reference group of the poor is the weighted average of the poor and the rich. Also as Rajan (2010) argues that, in response to rising income inequality in the US, credit was made increasingly available to the less well-off to support their consumption levels in the face of stagnant incomes; thus establishing an inverse relationship between inequalityand saving.

The finding of the essay that the income inequality has negative effect on saving rate has important policy implications. It implies that policies that reduce income inequality promote temporary economic growth via higher savings. Contrary to the prediction of Life Cycle Hypothesis over the past three decades low old and young age dependency ratio is associated with low saving rate. The negative effect of income inequality on savings may shed light to this puzzle. It may be that over the past three decades the reduction in saving rate because of increase in income inequality is more than the increase in saving rate for the decrease in old and young age dependency ratio. Piketty (2014) predicts that in the twenty first century income inequality may rise because of higher capital income ratio via low total GDP growth rate. However such prediction may be less apocalyptic via low saving rate resulting higher income inequality because of the negative effect of income inequality on savings as the second essay argues.

The effect of capital accumulation on unemployment in 21 OECD countries has been explored in the third essay. The essay reports that capital accumulation is important in reducing OECD unemployment. Following the seminal work of LNJ (2005) that propounds no linkage between capital accumulation and unemployment based on the assumption of elasticity of substitution between capital and labour equals unity for which production function is essentially Cob Douglascapital accumulation has taken backseatfor long in explaining unemployment. And the emphasis was on labour market deregulation for reducing unemployment as labour market rigidities arising from trade union power; labour taxes, generous welfare benefits, strict employment protection, and other institutional factors were considered to be the main determinants of unemployment.

The third essay thus contributes to the literature investigating the role of capital accumulation in reducing unemployment for the largest number of countries over the longest period of time with wage push and aggregate demand factors being taken in to account.Conventional wisdom following Friedman (1968) suggests that aggregate demand has only short run, not any long run, impact on unemployment. However in contrast to such conventional wisdom the essay finds that aggregate demand affects unemployment in both short run and long run. The essay also finds that along with capital accumulation wage push factors are important determinants of unemployment. The results are robust to the choice of estimation method, estimation period, and inclusion of control variables.

In order to estimate the coefficient of capital accumulation on unemployment capital accumulation has been proxied by the growth rate of non-residential capital. Because unemployment rate is nontrended in the long run and hence capital accumulation has been made trendless by transforming it into its growth rate to empirically assess the effect of capital accumulation on unemployment in line with the existing literature.

Even though there may be positive feed-back effect from unemployment to capital accumulation and as such LS estimation will be upward biased IV estimation has not been done in the third essay. Because such bias would not have any qualitative influence on the conclusion about the effect of capital accumulation on unemployment rate. Furthermore it is extremely difficult to find instruments for capital accumulation. Because capital accumulation can be explained by the variables like technology, taxation, real wages and neither of these variables are exogenous nor do they hold exclusion restrictions as they have direct effect on unemployment.

Finally in view of the findings of the three essays the thesis reports that increase in economic growth rate and reduction in income inequality boosts capital accumulation that in turn reduces unemployment.

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