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Three Essays on International and Development Economics

Jiayi Wang
MSc in Economics, Monash University

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Abstract

I in this thesis study three topics in international and development economics: how trade barriers or trade openness affects innovation activities, how demographics affect a country's current account position, and how financial market development influences cross country capital flows.

As widely discussed in the literature, innovation is one of the most critical determinants of economic growth. My first chapter investigates how trade protection policy may stimulate innovation. In the standard Ricardian framework, tariff is usually considered bad for welfare as well as economic growth as it leads to resource mis-allocations. I in this chapter provide empirical evidence that the standard Ricardian framework may miss one important channel how trade may affect economic growth and welfare, that is, trade protection policies may boost economic growth by encouraging foreign investment which in turn stimulates technology diffusion. Although this is mainly an empirical work, I develop a simple theoretical model to explain the mechanism. My model shows that exporting activities are more likely to switch to multinational firms when tariff goes up. As analysed in a large number of works in the literature, the growing multinational firms have a positive impact on the innovation capability of domestic producers, the overall effect of a trade protection policy, hence, is ambiguous. I then provide empirical evidence that trade protection policy does lead to increasing innovation activities. I consider the patent as the measure of innovation capability and use a dataset consisting of bilateral patent and tariff rates over 140 years for 21 OECD countries. Running gravity regressions, I show that the non-resident patent increases by 13.5 per cent as tariff rises by 10 percentage points, suggesting that trade policies have strong impacts on innovations. I also show that a 10 per cent increase on non-resident patent leads to a 5.5 per cent increases on the resident patent, which implies sizable spillover effect of cross-border technology diffusion. The result is robust when we conduct a number of robustness checks and instrument variable regressions.

In the second chapter, I aim at providing evidence how demographics may affect a country's current account position. By definition, current account is the difference between national savings and national investment, I attempt to show that demographics plays an essential role in determining national savings as well as investment, and hence affecting the current account. Using a historical dataset which includes 21 OECD countries from 1870 to 2015, I find that countries with lower dependency ratio, higher life expectancy, lower fertility rate and lower population growth would have a higher current account surplus. I also generate corresponding foreign counterpart for each demographic variable. A standard two-country model implies that the foreign counterpart should

have the opposite effect on home country's current account. Running regressions, I find that foreign demographic variables, especially life expectancy, are important to understand home country's current account position.

I investigate how financial market development affects cross country capital flows in the third chapter. International capital flows, especially long-term foreign investment, are usually considered very important to economic development in emerging economies. However, we have limited understanding on how financial market development affects capital flows. Although there are a large body of works in the literature attempting to connect financial market and cross country capital flows, most of them only focus on aggregate net capital flows. The main contribution of this chapter is I provide a detailed analysis on how financial market development separately affects different types of capital inflows and outflows: foreign direct investment and portfolio equity. My empirical work is based on a dataset including 217 countries from 1980 to 2015. By using the private sector and broad money as two proxies for financial development. I find a country with a more developed financial market encourages more capital outflows. However, financial development has little impact on capital inflows.

Declaration

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.

Signature: …… ……

Print Name: Jiayi Wang

Date: 9 June 2019

This thesis is dedicated to my family whom I love the most.

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Chapter 1

Introduction

Economic development is often seen as one of the most important indicators of a healthy economy. Intensive empirical studies are researching on the factors driving a country's economic development. This thesis aims to present three studies on international and development economics and provide some insights through channels including technology innovation, current account deficit and capital flow. The purpose of this introduction is to discuss the existing literature on international and development economics and provide a preview of the findings in this thesis.

1.1 Trade protection and innovations

The influence of trade liberalisation on economic growth has been a heated discussion topic, often with a debated argument in international economic literature. As one of the trade barriers, tariff plays a vital role in trade liberalisation. It is designed to protect domestic firms from competing with foreign firms. Thus, most of the current literature see tariff as a negative factor to economic growth as it leads to inefficient resources re-allocation. However, the potential positive effect of the tariff on stimulating domestic innovations has not been significantly discovered.

Several studies have approached differently from the standard view and find that tariff may stimulate economic growth by attracting more foreign direct investment. Helpman et al. (2004) establishes a theoretical model and argues that exporting firms may choose to avoid the exporting cost by establishing subsidiaries abroad for production, if the exporting expenses, such as tariff, is very high. Before that, Harrigan (1993) has found a negative correlation between tariff and trade flow.

When the tariff is relatively low, the exporting firms can make a profit by producing domestically and exporting the products abroad. However, when the tariff rises and the profit earned overseas is less than the exporting cost incurred, the exporting firms would choose to avoid the exporting cost by producing their products in the destination country. This would be achieved by authorising factories in the destination country to produce their products or establishing their subsidiaries in the destination country. The latter will involve FDI and potential technology spillovers. This is supported by empirical evidence from Horst (1972). This study uses the data on trade flow from the U.S to Canada and finds that U.S exporting firms are encouraged to establish their subsidiaries in Canada to avoid the high tariff imposed by Canada. As a result, there is a large share of Canadian subsidiary production in U.S firms' sale in the Canadian market.

As technology is one of the critical stimulators of economic growth, the potential technology spillovers from FDI in a country with relatively high tariff is expected to have a positive impact on this country's economy. It is worth to note that the firms engaging FDI activities are often with a higher level of productivity than the exporting firms due to higher entry cost of the foreign market. This is supported by Melitz and Redding (2014), which finds that the very productive firms will enter the international market, and the less productive firms choose to serve the domestic market only. This implies that when the tariff increases, there are more exporting firms decide to establish their subsidiaries through FDI. As a result, there are more productive firms in the foreign market and more potential technology spillovers.

The patent is designed to protect the right of innovation and to inhibit imitation. It also represents a firm's innovation ability. Since a patent is only valid in its issued country and there is no worldwide patent, a firm establishing its subsidiary abroad is required to apply for a patent in the destination country to protect its technology. This implies that the number of patents applied by foreigners can be used as a measure for the technology inflow through FDI. Based on this measurement, many studies have found a strong effect of technology inflow on innovation. Westney (1994) finds that a foreign firm's subsidiary provides the local firms with an opportunity to access and adapt the advanced technology through workers' mobility. The supply chain is the main channel which the technology transfers from foreign firms' subsidiaries to local firms. Both Kenny and Florida (1993) and Macduffie and Helper (1997) find that the entry of Japanese automobile markets brought in advanced technology and transferred their technology to U.S parts suppliers.

The literature indicate that tariff may not only protect the domestic firms but also stimulate the technology spillovers by encouraging more exporting firms to transfer their production abroad. This provides a fundamental ground for the research on trade protection in this thesis.

1.2 Current account and demographic patterns

Current account deficit plays an important role in economic development for developing and developed countries. In the last two decades, current account deficit has been a concern for many countries as it may lead to potential sudden stops. Interestingly, the demographic patterns in those countries have changed significantly. This implies that the demographic changes may have a significant impact on the current account fluctuations.

The current account is defined as the difference between national savings and national investment. And in the standard life-cycle theory, demographic changes, such as population and

fertility rate, have a significant impact on the incentives for saving and investment. Modigliani (1970) and Modigliani and Cao (2004) both suggest that people make consumption decision according to their lifetime resources rather than the recourses at one time. This means that people will save more when their income is high and will save less when the income is low. And people are expected to have less income when they are young or old and have more income when they are at working age. So if the demographic factors affect the share of working-age people to the total population, the national savings will also be affected. Together with the definition of the current account, the changes in the demographic patterns are likely to have an impact on saving and investment decisions; then the current account will be influenced by the changes in saving and investment decisions.

The first demographic factor being considered is the dependency ratio. The dependency ratio is defined as the ratio of young and old to working age population. There are a large number of literature on how demographics affect national savings. Empirically, Calderon et al. (2002) use panel data to find that the dependency ratio has a significantly negative impact on the current account in developing countries. Unger (2017) estimates the European data and finds similar results. It is worth to note that the dependency ratio is calculated from the total of young and old. While young people's saving behaviours are quite different from the old people's saving behaviours, therefore, only estimating the dependency ratio may overlook the potential opposite effects of young and old. Indeed, there is literature find that young people and old people save differently. Gruber and Kamin (2007) argue that old dependency ratio (the ratio of old population to the working-age population) has a significantly negative impact on current account, while the youth dependency ratio has a negative but much weaker effect on the current. Chinn and Prasad (2003) use the data on industrial countries and find that a negative correlation between youth dependency ratio and current account. The old dependency ratio is found to have a positive impact on the current account.

The second demographic factor that is related to the saving decision is life expectancy. Different from the dependency ratio, life expectancy has two opposite effects on the current account. A higher life expectancy extends the length of retirement periods. Therefore, the population of old people increases and the national savings decreases. However, if people can anticipate the longer retirement period, they will save more in working-age to afford the increased consumption in retirement. This will increase the national saving from the working-age people. Though the aggregate effect of life expectancy on the current account is not clear in theory, there is empirical evidence support that the life expectancy is positively correlated with the current account.

Henriksen (2002) finds that longer life expectancy is associated with a higher private saving. This is also supported by Li et al. (2007). They use a dataset compassing 200 countries and argue that life expectancy has a positive impact on national saving.

The next demographic factor should be considered in the discussion on the current account is the fertility rate. Similar to life expectancy, the fertility rate also has two opposite effects on the current account. On the one hand, when the fertility rate is low, the cost of raising a child also decreases. With less spending on raising children, people have more resources for consumption, thus less national savings. On the other hand, the lower fertility rate implies less young people to support old people in the future. So the old people have to save more when they are working to support themselves in retirement. Empirically, Li et al. (2007) suggest that the fertility rate hurts national saving.

Population growth is another demographic factor that may also influence the current account fluctuation. The effect of population growth on current account is found to be depended on economic growth (Deaton and Paxson, 2000). An increasing population growth indicates that the number of children will also increase. This will increase the cost of raising a child and lead to lower private savings. However, increasing population growth also implies that the share of old people in the total population increases. Since the old people are expected to dis-save their resources, the smaller share of dis-saving old people leads to larger national savings.

Many current works of literature have examined the demographic factors influencing the current account fluctuation. However, most of these studies estimate the recent data and few studies explore the impact with historical data.

1.3 Capital flows and financial market development

In the recent two decades, capital flows have played an important role in economic development in both developing and developed countries. In developing countries, capital flows fill the resources shortage and provide investment opportunities for increasing productivity. In developed countries, capital flows bring in additional resources which support sustainable economic growth. Therefore, it is critical to explore the factors that influence capital flows. However, most of the current studies on capital flow concentrate on the aggregate capital flow. Given that capital inflow and outflow may have the opposite impact on economic growth, it is important to estimate the single effect of having a comprehensive understanding of capital flows.

There is a large body of literature exploring the factors influencing capital flows. Financial market development, as one of the measures for the domestic financial condition, has been found to have a significant impact on capital flows. In the literature on foreign direct investment (FDI) capital flows, Afraro (2004) finds that a country with a better financial market provides agents with advantages of knowledge spillovers. Therefore, such country is more competitive in attracting FDI from abroad. Furthermore, Giovanni (2005) finds a strong positive correlation between a country's size of financial markets and the firms' foreign investment. Chinn and Ito (2006) use a panel data of 108 countries to argue that a country with high level of financial market development would stimulate domestic equity market with more credit available, alleviating information asymmetry, and reducing adverse selections and moral hazard. There is also empirical evidence show that, during the financial crises, developing countries prefer FDI to the other types of capital flows as it is more resilient during financial crises.

Portfolio equity flows are another type of capital flows which has been intensively discussed in the literature. Portes and Rey (1999) provide a new data set of cross-border equity transaction flows and find that the transaction flows are largely determined by market size, openness, the efficiency of transactions, and distance. Forbes (2010) focuses on the home bias and argues that foreigners who have less developed financial markets invest larger amount of money into U.S. equity and bond markets which has a higher level of financial market development. Further, Stulz (1999) uses a case study of the Swiss firm Nestle to finds international diversification provides a lower cost of equity which reducing the investors' risk without cutting down the expected return. La Porta et al. (1997, 1998) focuses on the aspect of the legal system and argues that a country with poorer investor protections, such as weak law enforcement and legal rules, has a smaller and narrower equity market.

A country's financial market development plays a critical role in determining its capital flows including FDI and equity. Most of the current literature explore this effect at an aggregate level. However, financial market development may have opposite impacts on capital inflows and capital outflows. Examining the aggregate capital flows overlooks the potential differences. Therefore, it is important to distinguish the effects between capital inflows and outflows to have a comprehensive understanding of the capital flow movements.

1.4 Contribution of this Thesis

Economic development has been in the centre discussion in literature for many years. There are a large number of theoretical and empirical studies on the international and development

economics. Among those studies, few studies explain the long-term effects of using historical data. Therefore, this thesis uses a over hundred-year historical data to examine the effects of technology and current account on economic growth. In addition to economic growth, it analyses the linkage between capital flows and financial market development

Chapter 2 investigates economic development through the innovation channel. Technology spillovers play an important role in stimulating technology growth as it benefits firms from research and innovation from other firms. This chapter analyses the technology spillovers in an international context through foreign direct investment. In the international trade chapter, the tariff is often considered bad for economic growth as it leads to inefficient resources allocation. However, in this chapter, I examine whether tariff stimulates domestic technology spillovers by discouraging imports from abroad. I start by developing a model for international technology diffusion. In this model, I explain how exporting firms are encouraged to switch their trading model and to establish their subsidiaries abroad when facing a high tariff rate. Following that, I use a historical dataset of tariff, patent and other related variables of OECD countries from 1870 to 2010. Using this dataset, I perform a gravity regression analysis and find that when a country increases its tariff by 10 per cent, the patents applied by foreigners in this country increase by 13.5 per cent. This provides evidence for my theoretical model that tariff has a positive impact on technology inflow. Furthermore, to examine how domestic innovation would be affected by foreign technology inflow, I estimate the correlation between patents applied by domestic residents (domestic patents) and patents applied by foreigners (foreign patents). The estimation results show a strong positive correlation between domestic patents and foreign patents. A 10 per cent increase in foreign patents is associated with a 5.5 increase in domestic patents. My findings imply that there is a possible and sizable technology spillover effect in the foreign direct investment activities, especially during the establishment of multinational firms' foreign subsidiaries.

Chapter 3 continues to focus on the long-term factors affecting economic development. It examines how demographic changes affect current account fluctuation. Given that the current account is also defined as the gap between national investment and national savings, examining national saving and investment is a fundamental way to analysis the current account fluctuations. As the life-cycle hypothesis suggests, individuals have different saving behaviours at each stage in their life cycle. This implies that demographic structural in a country may have a significant impact on its national saving which leads to a change in the current account balance. Thus, in this chapter, I use a long historical data which covers OECD countries from 1870 to 215 to analysis how demographic variables affect current account fluctuations. This long data also provides an

opportunity to explore the historical variation in the international capital evolution and conduct the analysis at different economic development stages. Empirically, I test four demographic variables including dependency ratio, life expectancy, and fertility rate as well as population growth. Using the panel dataset, I find that a country's dependency ratio, fertility rate and population growth are negatively correlated with its current account, while life expectancy has a positive impact on its current account. Another contribution of this chapter is to link a country's current account fluctuations to the other countries' demographic changes. Based on a two-county model, the demographic changes in the two countries may have opposite effects on one country's current account. Thus it is important to consider the foreign countries' demographic changes when analysing a current country account. However, there are very few studies in current literature estimating through this channel. My empirical results show a strong correlation between a country's current account and foreign countries' demographic changes, especially the changes in life expectancy.

Chapter 4 extends previous historical work to more recent work. This chapter focus on the effect of financial market development's effect on capital flows. The key contribution of this chapter is that it distinguishes the capital inflow and outflow. Instead of using a single form of capital flows data, I use a data set containing two types of capital flows: foreign direct investment and portfolio equity. More importantly, I estimate the single effect from capital inflow, outflow and net flow. This can capture the disparate impact from domestic macro conditions. Using a dataset including capital flows of 217 countries from 1980 to 2015, I find that a country's financial market development has a significant impact on its capital flows, especially the capital outflows. In the estimation, This implies that simply analysing the aggregate capital flows may mistakenly understand how macro variables affect capital flows.

1.3 Structure of the Thesis

This thesis comprises three chapters on economic growth. Chapter two uses a historical dataset compassing 140 years data of OECD countries to examine how tariff would affect the technology spillovers. Chapter three explores the demographic determinants of the current account using a historical dataset including 21 OECD countries from 1870 to 2015. And chapter four discussed the effect of financial market development on capital flows for 217 countries.

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Chapter 2

Trade Protection and Innovations: Evidencefor21Countries, 1870-2010

Abstract

Tariffs are usually considered bad for economic growth. However, the literature predominantly focuses on comparative advantage. I find that a rise in tariff can significantly lead to an increase in foreign patenting which in turn stimulates domestic patenting. The results are robust to endogeneity, periods, and critical covariates.

2.1 Introduction

Trade liberalisation is one of the most debated and controversial argument in the international trade literature. Being one of the trade barriers, the tariff is conventionally considered as protection for domestic firms from foreign competitors. Conventional wisdom usually focuses on the negative impact of tariff such as tariff leads to inefficient resource re-allocations. Hence, most economists consider tariff bad for economic growth.

However, Helpman et al. (2004) and several other studies give another angle on the tariff, arguing that it may boost economic growth by encouraging more foreign direct investment. In theory, high exporting cost including tariff and transportation cost induces exporting firms to set up subsidiaries aboard to avoid the high trading cost. (Wu, 2005). Since more advanced and innovative firms tend to serve foreign markets through multinational productions, the technology inflow of subsidiaries may enhance cross-border technology diffusions in the host country. (Helpman et al., 2004). However, to our knowledge, there is no empirical evidence in the literature for the theoretical prediction that cross-border technology diffusions can be improved by trade barriers such as tariff. In this paper, I aim at filling this void.

One difficulty is to observe the diffusion of inventions. While the inputs into the inventive process can be observed by R&D expenditures, there is no direct measure of inventive output. However, as suggested by Eaton and Kortum (1996), patent, as protection of new and useful invention from imitation, is indirect evidence of research output. In addition to this, there are several reasons why firms choose to apply for a patent during multinational production activities. First, a single patent does not protect an invention worldwide. By applying patent in the host country, the applicant has a better chance of preventing the local and international competitors from entering into the market. Secondly, companies, especially technology-based companies, tend to locate their R&D activities at centres of technological excellence to tap into the strong scientific or technological capabilities of a particular country. Thirdly, the creation of an R&D centre can be a way of penetrating overseas markets, with adapted variants of a current generation of new products. So I use the patent as the indicator to observe the diffusion of inventions.

To estimate the cross-border technology diffusion, I divide the patent into two categories based on the residence of the applicant. The non-resident patent is the patent granted in a given country to an applicant residing in another country. The resident patent is the patent granted an applicant in the country that the applicant is residing in. By these two definitions, I can use the non-resident patent

to estimate the technology inflow from multinational firm to the host country and use the resident patent to estimate the impact on domestic innovations.

Since both non-resident patent and resident patent can be crucial for economic growth (see, e.g., Madsen, 2008 JOEG, 2010 JME), our paper suggests that tariff may positively affect economic growth through innovations, which has been largely overlooked in the literature. By using the patent as the measurement of technology innovation, I develop a model of the international technology diffusion which I use to explain the impact of tariff on innovations. The model shows that when tariff increases, the exporting firm has a greater incentive to switch to a multinational firm. This change increases the R&D activities in the host country. To be competitive and prevent from imitation, the multinational firms apply for patent in the country which they establish subsidiaries at. The non-resident patent inflows from multinational firms' subsidiaries enhance the technology diffusion and increase the resident patent in the host country. As a result, when one country imposes a higher tariff rate on imports, it may receive more patent applications from foreign firms.

Using gravity regressions, I show that, as tariff rises, a patent from the source country to the host country increases, which supports the theoretical prediction. Our estimation result shows that as tariff rises by 10 percentage points, the non-resident patent will go up by 13.5 per cent, which is economically significant. I also show the impact of a rise in non-resident patenting on a domestic patent held by residents. Approximately, as non-resident patent rises by 10 per cent, domestic patent held by residents will increase by 5.5 per cent. This result implies a possible and sizable spillover effect of the cross-border technology diffusion.

The structure of the paper is as follows. Section 2.2 outlines the model of tariff and technology diffusion. Section 2.3 discusses the data and a number of measurement and econometric issues. Section 2.4 presents the empirical methodology and results. In section 2.5, several robustness checks are performed. And section 2.6 provides concluding remarks.

2.2 Background

There is a growing interest in foreign trade, either on exports or foreign direct investment. The unit cost of exporting includes the cost of moving goods across borders, such as transportation and insurance, and the cost due to the trade barriers, such as tariff. (Helpman et al. 2003). Thus, the delivered price of imports to consumers rises when transportation costs increase. By the same reasoning, tariff, as one of the trade barriers, is found to be negatively correlated with trade flow. (Harrigan 1993). One important effect of a rising tariff is that the higher exporting cost yield more

existing exporters establishing foreign subsidiaries in the foreign market and directly serve customers without suffering the tariff cost. The result is supported by the empirical evidence provided in Horst (1972). In a study of the trade flow from U.S to Canada, Horst finds that tariff imposed by Canada encourage U.S firms to substitute subsidiary production for exporting and the higher the Canadian tariff is, the smaller the share of U.S exports to Canada and the larger the share of Canadian subsidiary production in total U.S sales to the Canadian market. This is consistent with the view that higher tariff encourages more FDI to substitute from exporting activities.

More importantly, the firms engaging in FDI are more productive than the firms engaging export. Since entry into the foreign market is more costly and risky than the domestic market, firms would be very cautious about weighing their expected profits and the irreversible entry cost to foreign market. Hence, only productive firms enter foreign market, while unproductive firms serve the domestic market only or even exit the market. (Melitz, 2003). Among the firms entering the foreign market, the most productive firms serve foreign market via FDI and relatively less productive firms export since the FDI duplicates production facilities and therefore requires higher fixed costs. (Helpman et al. 2003). As in previous analysis, more firms switch from exporting mode to FDI under high tariffs. One impact on the foreign market is that the average productivity in foreign market increases.

When a firm engages in exporting or FDI, it is important to protect the invention from potential imitations. Note that patents in the home country do not protect firms' innovations worldwide. For instance, the modern French patent system was created in 1791, and the first Patent Act of the U.S Congress was passed in 1790, the patent application is required to be filed separately in each country. Even though the PCT (Patent Cooperation Treaty), which was introduced in 1970, allows a single international application, it only facilitates the application in some countries simultaneously and does not grant a worldwide patent. All patent rights are granted by national or regional patent systems. Therefore, firms serving foreign markets usually apply for patents in each destination country to secure protections. For example, a U.S firm serving China market is not protected under U.S patent law, and a patent in China will be needed for protection purpose. (Smith, 2001). This implies that the number of patents by foreign firms can be a reasonable measure for the number of multinational enterprises (MNEs henceforth). Therefore, the rise in the FDI under high tariff would also increase the patent applied by FDI in the destination country.

Before applying for the patent in a foreign country, the firms need to decide on the location of the filling country. Besides the trade purpose, the cost of application is one of the consideration factors. The application costs, such as filing fees, agent fees and translation fees, depending on the

intricacies of the invention and the filling location. Since the patent is granted nationally, the international patent application can be costly if filling in a few countries. As a result, MNEs would prefer to file the patent in the countries with large markets where the innovations are most likely to yield higher returns.

Some studies in the literature also point out that exporters also apply for patents in the host country to sell their products. Though this is likely, numerous studies have found that the foreign subsidiaries are more likely to apply patent than exporters. Smith (2001) indicates that exporters retain their key skills or knowledge within the source country, while the MNEs transfer knowledge into the host country which potentially faces a higher likelihood of imitation. Saggi (2001) also finds that, if firms in other countries can export freely to the domestic market and have better products or technologies, a domestic patent is quite useless in granting monopoly power which makes the exporter less invention to apply for foreign patent. Hence, I consider the number of foreign patents is mainly a measure of MNEs.

Does foreign patenting have any spillover effect on domestic innovations? Literature has considered an increasing knowledge inflow induces more domestic innovations. There are several channels of the technology spillover effect of R&D activities of foreign subsidiaries on local R&D activities, collaboration with domestic suppliers and the workers' mobility from foreign subsidiaries to local firms. First, when the foreign subsidiary collaborates with domestic suppliers on new product development, the foreign subsidiary provides the local firms with an access to their advanced technology and can be used for their innovation and production. (Westney, 1994). In fact, the supply chain is one of the most important collaboration methods between foreign subsidiary and local suppliers and via which, MNEs transfer technology to the local producers (Pack and Saagi, 2001; Blalock, 2002; Javorrik, 2004). Second, foreign subsidiaries have incentives to improve the productivities of their suppliers to minimise technology leakage to competitors. To avoid the risk of depending on a single supplier, the foreign subsidiaries may collaborate with multiple vendors. This certainly benefits all the firms who purchase these vendors' output. The positive technology spillover effect of the foreign subsidiary on chain suppliers have been tested in various countries, such as technology transfer to U.S parts suppliers following the entry of Japanese automobile markets (Kenney and Florida, 1993; Macduffie and Helper 1997), technology transfer from foreign firms through backward linkages in the Indian trucking industry.(Lall, 1980) and technology transfer through the supply chain in production function estimates in Indonesia. (Blalock, 2002). With more foreign subsidiaries established by MNEs under the high tariff, the technology spillover effect through the supply chain will increase as well. Third, the movement of employees between

foreign subsidiaries and local firms can also be a channel of technology spillover. MNEs can transfer superior technology to its foreign subsidiary by training local workers. If trained workers switch jobs, technology can be transferred to other local firms. (Ronde et al. 2001).

2.3 Model

In this section, I present a theoretical model to analyze how tariff affects innovations. I assume that there are two countries (*i* and *j*) in the world. In this model, I consider the innovation activities in country *i*.

2.3.1 Final good sector

There are two types of goods in our model: a final good and intermediate goods. The final good sector uses labour (*L*) and an aggregate of intermediate goods (X) to produce final goods. The production function takes the standard form as in the endogenous growth literature,

$$Y_{it} = A_i L_i^{1-\alpha} \int_0^{N_{it}} X_{li}^{\alpha} dl \tag{1}$$

where Y_{it} is the final output and A_i is the aggregate productivity. This production function implies that the elasticity of substitution between intermediate goods ϵ is a function of parameter $\alpha \in (0,1)$, $\epsilon = \frac{1}{1-\alpha} > 1$.

The final good sector is perfectly competitive and I normalize the price of the final good to one. Final good producers maximise profit by choosing labour and intermediate input. Deriving the first order conditions, I can obtain the labour demand function

$$w_{it} = (1-\alpha)\frac{Y_{it}}{L_i} \tag{2}$$

and the demand for intermediate good *l*

$$X_{li}(p_l) = \left(\frac{A_i \alpha}{p_l}\right)^{\frac{1}{1-\alpha}} L_i \tag{3}$$

2.3.2 Intermediate goods sector

Now I consider the optimisation problems of intermediate good producers. A representative intermediate good producer faces a two-stage problem. In the first stage, the firm decides whether

to pay a sunk cost to develop a new intermediate good. In the second stage, the firm takes the productivity draw and decides i) whether to produce and enter the domestic market, and ii) whether to enter the foreign market by either exporting or becoming a multinational enterprise (MNE henceforth).

I start with the second stage of intermediate good producers. Those producers employ *a* units of the final good to produce one unit of output. I assume monopolistic competition in the intermediate goods market. After obtaining the patent, the firm draws productivity *1/a* from a Pareto distribution

$$G_i(a) = \Pr(aa < a) = \left(\frac{a}{a_0}\right)^k, a \in [0, a_0] \tag{4}$$

where a_0 and *k* are the scale and shape parameters of the distribution and *G(·)* is the distribution function of *a*.

Now I consider the decisions by an *a*-type firm in country *i*. Given the unit cost *a*, the *a*-type firm is now facing four options. First, the firm can produce and sell the goods in the domestic market. Second, the firm may export its products to a foreign country. Third, the firm can also set up a subsidiary in a foreign country and becomes an MNE. Lastly, if the entry costs of production are too high, the firm may quit the market. In the rest of the analysis, I use f_{iit} and f_{xjt} denote the fixed costs of entering the domestic market and foreign market (country *j*'s market) in period *t*, respectively. I let f_{ij} denote the fixed cost of setting up a foreign subsidiary in country *j* by the *a*-type firm in country *i*. For exporters, an ice-berg cost τ (>1) will also be paid to ship the products across borders.

Consider country *i*'s intermediate goods market, there are three types of goods: goods produced by domestic producers, goods produced by foreign exporters and goods produced by foreign MNEs. I also use N_{iit}, N_{xjt} and N_{ijt} denote the number of country *i*'s intermediate good producers in market *i*, the number of country *j*'s exporters, and the number of country *j*'s producers who are MNEs.

Now I consider the optimisation problem of an *a*-type firm. The firm will choose the optimal price p_s where $s \in \{ii, xj, ij\}$denotes the three types of firms operating in country *i*'s market. The optimization problem is as follows

$$\max_{p_{si}}(p_s - \tau^q a)X_s(p_s) \tag{5}$$

subject to the demand function Equation (3). Variable *q* takes value *0* or *1* which shows the export status of the firm: when q=1, the *a*-type firm exports; when q=0, the firm does not export. The first order condition implies that the optimal price for domestic, exporting and MNEs serving country *i*'s market is given by:

$$p_{si} = \frac{\tau^q a}{\alpha} \tag{6}$$

Substituting the optimal prices Equation 6 into Equation 5, and combining the demand function Equation 3, I can obtain the profit by the *a*-type firm as

$$\pi_{si}(a) = \frac{1-\alpha}{\alpha}\Lambda_i(\tau^q a)^{-\frac{\alpha}{1-\alpha}} \tag{7}$$

where $\Lambda \equiv \alpha^{\frac{2}{1-\alpha}} A_i^{\frac{1}{1-\alpha}} L_i$

2.3.3 Entry conditions

Due to the existence of fixed cost for entering each market, only firms with sufficiently low unit cost will produce and operate in the markets I have discussed in the previous analysis. Similar to the standard literature, I can find thresholds of *a* for becoming the three types of firms. The threshold a_{ii} below which an *a*-type firm will not operate in domestic market is pinned down by the following entry condition

$$\pi_{ii}(a) = f_{ii} \tag{8}$$

The threshold a_{xj} below which an *a*-type firm will not export can be obtained by

$$\pi_{xj}(a) = f_{xj} \tag{9}$$

For firms who wish to become MNEs, they must have unit costs below the threshold a_{ij} which is pinned down by the following condition

$$\pi_{xj}(a) - f_{xj} = \pi_{ij}(a) - f_{ij} \tag{10}$$

By Equation 6 to Equation 10, I can solve the thresholds as

$$a_{ii} = \left[\left(\frac{1-\alpha}{\alpha}\right)\frac{\Lambda_i}{f_{ii}}\right]^{\frac{1-\alpha}{\alpha}} \tag{11}$$

$$a_{xj} = \frac{1}{\tau}\left(\frac{\Lambda_i}{f_{xj}}\right)^{\frac{1-\alpha}{\alpha}} \tag{12}$$

$$a_{ij} = \left[\left(\frac{1-\alpha}{\alpha}\right)\frac{\Lambda_i\left(1-\tau^{-\frac{\alpha}{1-\alpha}}\right)}{f_{xj}-f_{ij}}\right]^{\frac{1-\alpha}{\alpha}} \tag{13}$$

As in the standard literature, I assume that $f_{ii} < f_{xj} < f_{ij}$. If τ is sufficiently large, I have $a_{ii} < a_{xj} < a_{ij}$ That is, for intermediate good producers, the most productive firms will become MNEs while the least productive firms do not produce. Now I can show the following proposition.

Proposition 1 *When tariff increases, a_{ij} increases while a_{xj} decreases*

Proof. Taking a derivative of (12), I obtain that

$$\frac{\partial a_{xj}}{\partial \tau} = -\left(\frac{\Lambda_s}{f_{xj}}\right)^{\frac{1-\alpha}{\alpha}} < 0$$

That is, a_{xj} is a decreasing function of tariff

By (13),

$$\frac{\partial a_{xj}}{\partial \tau} = \left[\left(\frac{1-\alpha}{\alpha}\right)\frac{\Lambda_i}{f_{xj}-f_{ij}}\right]^{\frac{1-\alpha}{\alpha}} \frac{\partial\left(1-\tau^{-\frac{\alpha}{1-\alpha}}\right)^{\frac{1-\alpha}{\alpha}}}{\partial \tau}$$

$$= \left[\left(\frac{1-\alpha}{\alpha}\right)\frac{\Lambda_i}{f_{xj}-f_{ij}}\right]^{\frac{1-\alpha}{\alpha}}\left[\tau^{-\frac{\alpha}{1-\alpha}-1}\left(1-\tau^{-\frac{\alpha}{1-\alpha}}\right)^{\frac{1-\alpha}{\alpha}}\right] > 0$$

a_{ij} is an increasing function of tarthe iff.

Why tariff has opposite impacts on the threshold of becoming MNEs and threshold of exporting? Here is why. Since MNEs produces in the destination country directly, tariff does not have any negative impact on their output. However, at the same time, when tariff goes up, the profit of a country *i*'s exporter unambiguously falls (which leads to a fall in a_{xj}). This will lead more firms considering becoming MNEs and hence, the threshold of becoming MNEs rises.

2.3.4 Innovations

Now I consider the first stage problem of intermediate good producers. Given the number of varieties in country *i* (N_{it}), I assume that the cost of innovation is a decreasing function of N_{it}. This assumption implies that producers can innovate more easily by learning from a larger pool of varieties within the country. Let $\Psi(N_{it})$ denote such cost in country *i*. In equilibrium, since firms are risk neutral, they are indifferent between conducting innovations or not. I consider the case that τ is sufficiently large such that $a_{ij} < a_{xj} < a_{ii}$. Hence

$$\int^{a_{ij}} \pi_{ij}(a)dG(a) + \int_{a_{ij}}^{a_{xj}} \pi_{xj}(a)dG(a) + \int^{a_{ii}} \pi_{ii}(a)dG(a) = \Psi(N_{it}) \tag{14}$$

For simplicity, I assume that country *j* is a large economy such that it is always staying in the long run equilibrium. Shocks or changes in country *i* have no impact on country *j*. I then can show the following proposition.

Proposition Consider country *j* is a large economy. As country *i* raises its tariff,

1) more firms from country *j* become MNEs;

2) more firms from country *i* will choose to innovate;

Proof I consider the innovation-decision condition (14) for country *j*. Due to the large economy assumption, the number of firms who innovate in country *j* is a constant in our model. As I showed in Proposition 1, a rise in tariff leads to an increase in the number of MNEs from country *j*. At the same time, I can also show that the number of country *j*'s exporters falls.

Note that the unilateral change in country *i*'s tariff has no impact on intermediate good producers' expected payoff. The total number of varieties in country *i* will remain the same. However, since $a_{xi}(> a_{ji})$ falls, the number of varieties from country *j* in market *i* declines (which means the decline in exporting varieties dominates the increase in MNEs). To keep (14) hold, I must have more country *i* producers innovate.

2.4 Empirical evidence

2.4.1 Baseline estimation

2.4.1.1 Estimates of the bilateral patent equation

I start by estimating a gravity equation where bilateral foreign patent between countries *i* and *j* is determined by the tariff in country *i*. The source of the data is described in Appendix A. The estimation specification is as follows

$$\ln\left(Pat_{ijt}^{t}\right) = \beta_1\tau_{it} + \beta_2 RD_{it} + \beta_3 RD_{jt} + \beta_4 GDP_{it} + \beta_5 GDP_{jt} + \beta_6 RI_{it} + \beta_7 RI_{jt} + \varepsilon_{1,ijt} \quad (15)$$

where Pat_{ijt}^{t} denotes the number of foreign patents in country *i* applied by residents from country j at time *t*. τ_{it} is the tariff rate of country *i* at time *t*. RD_{it} and RD_{jt} are the R&D stocks in domestic country *i* and foreign country *j* at time *t*, respectively. Real GDP per capita in the two countries at time *t* are denoted by GDP_{it} and GDP_{jt}, respectively. RI_{it} and RI_{jt} are research intensity in the two countries at time *t*. Note that it is likely that countries' technology level may affect the new innovations. Therefore, I control R&D stocks and research intensity in the regression. Since I are interested in innovations, I use patent as the dependent variable instead of R&D stock. Theory implies that $\beta > 0$.

Table 2.2.1 reports the results of our baseline gravity regression in the full sample period (1870-2010) with country pair fixed-effect and the time fixed-effect. The findings are unsurprising: the foreign patents applied in domestic country i by foreign country j's residents are increasing in domestic country i's tariff. In column (1), when tariff is the only control variable used in the gravity regression, the coefficient on tariff is positive and significant at one present level. In column (2), (3), (4) and (5), I add controls for countries' GDPs, R&D stocks and research intensity in the regression. The results change little relative to column (1), especially the coefficient on tariff remain positive and significant at 1 per cent level in all columns. Column (6) explores how results may change when I control for domestic and foreign countries fixed effect instead of country-pair fixed effect. Again I obtain positive and 1 per cent significant level coefficient on the tariff. This estimation suggests that, as tariff rises by 10 per cent point, the foreign patent will increase by 5.40 per cent (10·0.54=5.40), which is also economically significant. These results are line with our suggestion in theory that tariff has a positive impact on a country's technology inflow. Equation (15) is re-estimated with standard errors being clustered and the results are represented in Table 2.2.2. The bilateral foreign patents reman significantly correlated with tariff, except in column (5).

Beyond this, both countries' real GDP per capita, R&D stocks and research intensity all have a positive effect on the foreign patents applied in the host country. These results suggest that countries with stronger R&D capabilities have greater innovation ability. These results are by our assumption that countries' technology level may affect new innovations.

2.4.1.2 Estimates of the technology spillovers equation

To identify the impact of the foreign patent on domestic patent, I estimating (16) below using OLS:

$$\log(Pat_{it}^{d}) = \gamma_1 \log(Pat_{it}^{f}) + \gamma_2 RD_{it} + \gamma_3 GDP_{it} + \gamma_4 RI_{it} + \varepsilon_{2,ijt} \quad (16)$$

The key regressor in this estimation, Pat_{it}^{d}, is the total amount of foreign patent in domestic country *i* at time *t*. I also control for the country fixed effect and time fixed effect. If the coefficient on log foreign patent is positive (negative), it implies that foreign patenting has a positive (negative) spillover effect on domestic patenting.

The estimation results are shown in Table 2.3. In column (1) I estimate the effect of the foreign patent on domestic patent using the foreign patent as the only control variable. The coefficient on the foreign patent is positive and significant at 1 per cent level. This result remains consistent after I add controls for real GDP per capita, R&D stocks and research intensity and control for host and foreign countries fixed effect instead of country-pair fixed effect. In column (6) it can be seen that when foreign patents rise by 10 per cent point, the domestic patent will increase by 6.17 per cent (10·0.617=6.17). This result shows a significant impact of the foreign patent on domestic patenting and implies that the foreign patent has a positive effect on the domestic patent. With our previous findings, when foreign patents rise under the higher tariff, the domestic patents will increase by the technology spillover effect between foreign patent and domestic patent.

2.4.1.3 Robustness checks

In this section, I conduct several robustness checks. To check whether our findings of the positive effect of the tariff on the foreign patent are robust in different periods, I separate the sample into two groups, the year 1870 to the year 1950 and year 1951 to the year 2010. I perform the robustness check for all the estimations in the previous chapters. The regression results in sample period 1870 to 1950 and 1951 to 2010 of (15) are presented in column (1) and (2) in Table 2.4, respectively. Our results are robust to the different periods. The coefficient on tariff is positive and significant in 1 per cent level in both sample periods. Note that the coefficients on tariff in the first sample periods are generally larger than the coefficients in the second sample periods. This suggests that tariff has a larger impact on the foreign patent in the later 60 years. This is consistent with the rapid rise in FDI and technology growth in the recent half-century. One other important note is that the coefficient on real GDP per capita and research intensity in the host country is positive in the first sample periods but negative in the second sample periods. This implies that there is more

technology inflow to the country with better development and stronger research abilities in the first half century, while the technology inflow turned to the country with less development and research abilities in the recent half-century.

The results of the robustness check on (16) are presented in column (1) and (2) in Table 2.5. Column (1) shows the results of the sample period 1870 to 1950 and column (2) shows the results of the sample period 1951 to 2010. Again, the results change little relative to the previous full sample periods estimation. Foreign patents continually have a positive effect on domestic patents in both periods and the effect is larger in the first period than the second sample period.

One potential concern is that tariff may affect domestic innovations directly. To check this possibility, I investigate the effect of entry of WTO (World Trade Organisation) or ATT (the former organisation of WTO). To find out whether joining WTO has an impact on the foreign patent from that country, I generate a dummy variable that equals to zero before the year of joining WTO and equals to one after that year. The estimation specification is as follows:

$$\ln\left(Pat_{ijt}^{f}\right) = \beta_1\tau_{it} + \beta_2 im.WTO.dummy + \beta_3 RD_{it} + \beta_4 RD_{jt} + \beta_5 GDP_{it} + \beta_6 GDP_{jt} + \beta_7 RI_{it} + \beta_8 RI_{jt} + \varepsilon_{3,ijt} \quad (17)$$

As the results shown in Table 2.4 column (3), the coefficients of tariff remain positive and statistically significant. This suggests that tariff still has a positive effect on a foreign patent when entry of WTO is taken into account. Meanwhile, the coefficients on WTO dummy variables are insignificant. This suggets that there might exist differences in tariff cut and WTO accession. The insignificant coefficient on WTO dummy implies that joining WTO has little impact on the number of patent applied by foreigners. There are might be two possible reasons. First, WTO accession takes time to impact on trade and capital flows. Second, countries (especially developing countries) may be required to conduct different reforms prior to WTO which may also affect innovation activities. Hence, WTO accessions are more complicated (and more endogenous) than tariff changes. However, WTO in the regressions is included as a control variable but does not focus on the impact of WTO accession.

As I discussed in the background section, the PCT simplifies the application procedure from multiple applications into a single application and, it may have an impact on the foreign patent application. I then generate another dummy variable that equals to zero before the year of PCT applies to a country and equals to one after that year. The estimation specification is as follows:

$$\ln\left(Pat_{ijt}^{f}\right) = \beta_1\tau_{it} + \beta_2 PCT.dummy + \beta_3 RD_{it} + \beta_4 RD_{jt} + \beta_5 GDP_{it} + \beta_6 GDP_{jt} + \beta_7 RI_{it} + \beta_8 RI_{jt} + \varepsilon_{4,ijt} \quad (18)$$

The results are represented in Table 2.4 column (4), the elasticity of tariff with foreign patent continues to be highly significant when PCT was taken into account. Note that the coefficient on the PCT dummy is positive, which suggests that the PCT stimulates the foreign patent.

Since the foreign patent may not have an impact on the domestic patent immediately and usually it takes time for the domestic firms to learn and adopt foreign technology, there is a concern with time delay. Hence, I replace the foreign patent in (16) by one year and two years lagged foreign patent, respectively to check whether the foreign patent affect the domestic patent after a certain periods. The estimation specification is as follows:

$$\ln\left(Pat_{it}^{d}\right) = \gamma_1 \ln\left(Pat_{it}^{f}\right) + \gamma_2 RD_{it} + \gamma_3 GDP_{it} + \gamma_4 RI_{it} + \varepsilon_{ijt} \quad (19)$$

The one year lag results are shown in Table 2.5 column (3) and the two-year lag results are shown in Table 2.5 column (4). I can see that the coefficients on one year and two years lagged foreign patent are both positive and statistically significant at 1 per cent level. This implies that the positive technology spillover effect from a foreign patent on domestic patent still holds.

2.4.2 Endogeneity

One potential concern with our baseline equation (16) is that this equation may be biased using OLS if the foreign patent is endogenous. To be more specific, countries adopt different tariffs due to their difference in fundamentals. Observing countries' fundamentals, foreign firms may then differ in their parenting decisions. To deal with the endogeneity problem of the foreign patent, I conduct a two-stage least square (2SLS) regression, in which foreign patent is instrumented.

2.4.2.1 Constructing the instrument

Since the improvement of information technology (IT) has made the international transmission of knowledge faster and more efficient, it provides an important channel for international technology spillovers. Therefore, I use the number of the telephone line as a proxy for international communication. Though the bilateral telephone traffic should be used to calculate the weights for IT, the data are only available after the mid-1990s. In other words, the bilateral telephone traffic should

be proportional to the combined telephone line of the two countries. The source of the teledensity data is described in Appendix A. It covers the telephone line of 21 from 1876 to 2010.

The instrument for foreign patent is constructed following Frankel and Romer (1999). I start by estimating a variant of the gravity equations where the bilateral foreign patent applied by foreign country *j*'s residents in domestic country *i*, is determined by the telephone line is used in both countries. The estimation specification is:

$$\ln\left(Pat_{ijt}^{f}\right) = \beta_1 \ln(tel)_{it} + \beta_2 \ln(tel)_{jt} + \beta_3 RD_{it} + \beta_4 RD_{jt} + \beta_5 GDP_{it} + \beta_6 GDP_{jt} + \beta_7 RI_{it} + \beta_8 RI_{jt} + \beta_9 Pat_{it} + \beta_{10} Pat_{jt} + \varepsilon_{6,ijt} \quad (20)$$

where tel_{it} and tel_{jt} are the telephone line in domestic country *i* and foreign country *j*, respectively. I report the estimated coefficients in Table 2.6 columns (1) to (3) .The both coefficients on domestic and foreign countries' telephones are positive and significant. In column (3), I show that the telephone line in both countries are highly significant determinants of the bilateral foreign patent, even after controlling for all other control variables. This result implies that the countries with more advanced IT are granted and attracted more patents aboard.

Since international trade has long been considered a channel of technology transfer, I considered the imports-related technology transfer as another possible idea to construct the instrument variable for a foreign patent. According to Helpman (1999), the technology is embodied in the imported goods has indirect benefits to domestic producers. And Eaton and Kortum (1995) indicate that the probability that invention from country *i* will be adopted in country *j* depends on country *j*'s imports from *i*. Therefore I consider country *i*'s imports from country *j* to construct the instrument for the bilateral patents. The source of imports data is described in Appendix A, it covers the imports of 21 countries from the other 20 countries from 1870 to 2010.

Following Frankel and Romer (1999), I firstly estimate a gravity equation where the foreign patent applied by country *j*'s residents in country *i* is determined by country *i*'s imports from the country. The estimation specification is as follows:

$$\ln\left(Pat_{ijt}\right) = \beta_1 \ln\left(IM_{ijt}\right) + \beta_2 RD_{it} + \beta_3 RD_{jt} + \beta_4 GDP_{it} + \beta_5 GDP_{jt} + \beta_6 RI_{it} + \beta_7 RI_{jt} + \beta_8 Pat_{it} + \beta_9 Pat_{jt} + \varepsilon_{7,ijt} \quad (21)$$

where IM_{ijt} is the imports of domestic country *i* from the foreign country *j*.The results are shown in Table 2.6 columns (4) to (6). In column (4), when I only control for the imports of country

i from country j and GDPs, the coefficient on the imports is positive and significant at 1% level. The positive effect of imports on the bilateral foreign patent remains basically unchanged when I include R&D stocks, domestic patent and research intensity controls. These results imply that imports are highla y significant determinant of the bilateral foreign patent.

Then I follow Frankel and Romer 1990 to construct the instruments for the foreign patent. Using the two set of estimated coefficients from the above two estimation equations, I obtain the two predicted bilateral patent values, $\widehat{ptel_{ij}}$ from (20) and $\widehat{pim_{ij}}$ from (21). Next, for each country *i*, I aggregate the fitted bilateral shares across the patent partner (if the foreign patent in country *i* is granted to country *j*, *i* and *j* are considered as one patent partners) and obtain our teledensity-based instrument for foreign patent, $\widehat{PT_i}$, and imports-based instrument for foreign patent, $\widehat{PI_i}$, }. Note that the telephone-based instrument increases with the telephone line and the imports-based instrument increases with imports. Therefore, the specification of first-stage regression of teledensity-based instrument is as following:

$$\log(Pat_{it}^{f}) = \gamma_1 \log(\widehat{PT}_i) + \gamma_2 RD_{it} + \gamma_3 GDP_{it} + \gamma_4 RI_{it} + \varepsilon_{8,ijt} \quad (22)$$

And the specification of first stage regression of imports-based instrument is as following:

$$\log(Pat_{it}^{f}) = \gamma_1 \log(\widehat{PI}_i) + \gamma_2 RD_{it} + \gamma_3 GDP_{it} + \gamma_4 RI_{it} + \varepsilon_{9,ijt} \quad (23)$$

The results of these two estimations are reported in Table 2.7. Columns (1) to (3) report the results on the telephone-based instrument. The coefficients on the telephone-based instrument are all positive and significant at 1% level. This suggests that the teledensity-based instrument is correlated with foreign patent. Columns (4) to (6) show the results on the imports-based instrument. Again, the coefficients on the imports are all positive and statistically significant at 1 per cent. This suggests that the import-based instrument is also correlated with foreign patent.

2.4.2.2 Results

Then I use the telephone-based and import-based instruments as the instruments for foreign patent respectively in the second stage regression to check whether the foreign patent is a significant determinant of the domestic patent. Since the predicted value used to construct the instrument is generated from the bilateral foreign patent equation, it will be inconsistent if it is used as the instrument for the total foreign patent which including the foreign patents granted to non-OECD countries. Therefore, the foreign patent, $Pat^{f.oecd}$, in the second stage regression is the

foreign patents granted to OECD countries instead of the world countries. The estimation specification is as followings:

$$\log\left(Pat_{it}^{d}\right) = \gamma_1 \log\left(Pat^{f,oecd}\right)_{it} + \gamma_2 RD_{it} + \gamma_3 GDP_{it} + \gamma_4 RI_{it} + \varepsilon_{10,ijt} \quad (24)$$

The results are reported in Table 2.8. Columns (1) to (3) represent the results using the telephone-based instrument for the foreign patent. In column (1), the coefficient on the foreign patent is positive and significant at 1% level. In columns (2) to (3), I add R&D stock and research intensity control variables. Again, the results change little relative to the previous column. I continue to estimate the equation (24) using the import-based instrument for the foreign patent. The results are shown in column (4) to (6). In column (4), the coefficient on the foreign patent is positive and significant when I foreign patent and GDPs are control variables. Columns (5) and (6) add two more controls, the effect of the foreign patent on domestic patent changes very little compared with the previous column. These results implied the positive effect of the foreign patent on domestic patent and this result is consistent using either the teledensity-based instrument or imports-based instrument for the foreign patent.

I also tested equation (24) for endogeneity between foreign patent and domestic patent using the Durbin-Wu-Hausman test. The results of this test showed a p-value of 0.000. Hence, I can reject the null hypothesis and there is evidence of endogeneity between foreign patent and domestic patent.

To check whether our instruments are a weak instrument, I performed the weak instrument variable F test. The first stage regression shows that both telephone-based instrument and imports-based instrument are good indicators for a foreign patent. The weak instrumental variable test, which stems in testing the instrument significant in the equation (24), indicating a rejection with F-statistic being 123.80 for the telephone-based instrument in column (3) and 433.77 for the imports-based instrument in column (6), means that both teledensity-based instrument and imports-based instrument are appropriately selected.

2.5 Conclusion

Our analysis of the effect of the tariff on innovation across countries emphasizes the positive impact of trade barrier on economic growth. Firstly I provide a model that explains the relationship between exports and multinational production under different tariff rate. I find that high tariff lowers the exporter's profits and induce them to undertake multinational production. I also show that increasing multinational firms have a positive impact on the innovation capability of the domestic producer.

Our empirical work shows that the tariff has a positive effect on innovation by using the foreign patent as the indicator of innovation capability. By using the bilateral patent data, I find a positive and statistically significant relationship between tariff and the foreign patent. I also test the spillover effect of the foreign patent on domestic patent and find a statistically and quantitatively important positive spillover effects. I also address the endogeneity issue with the foreign patent and domestic patent by using information technology and imports as the instrument variable. The results are consistent with our previous findings.

One of the important issues that remain to be investigated is in which subsection tariff is effective in raising the innovation. This requires extending the empirical analysis by using industry-level data in addition to the country level data in this paper.

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The data and data appendixes are provided by Professor Jakob Madsen at University of Western Australia.

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Table 2.1: Variable description

Variable	Description
Tariff in Domestic	Tariff rate in the domestic country
Domestic Real GDP	Real GDP in domestic country
Foreign Real GDP	Real GDP in the foreign country
Domestic R&D Stock	Research and development in domestic country
Log Foreign R&D Stock	Research and development in foreign country
Log Domestic Research Intensity	Research intensity in domestic country
Log Foreign Research Intensity	Research intensity in foreign country
WTO Dummy	A dummy variable equals to 1 if the country joined WTO, equals to 0 otherwise.
PCT Dummy	A dummy variable equals to 1 if the PCT applied, equals to 0 otherwise.
Foreign Patent	Number of patent applied by foreigners
Real GDP Per Capita	Real GDP per capita
Tel Domestic	Number of telephone line in domestic country
Tel Foreign	Number of telephone line in foreign country
Imports	Imports from foreign country
OECD Foreign Patent	Instrument generated from the patents applied by OECD countries.

Table 2.2.1: Bilateral Foreign Patents vs Tariff, gravity regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Tariff in Domestic	1.024***	1.177***	0.601***	1.113***	0.537***	0.540***
	(0.084)	(0.083)	(0.082)	(0.083)	(0.082)	(0.103)
Log(Domestic Real GDP)		0.426***	0.086***	0.465***	0.125***	0.131***
		(0.023)	(0.023)	(0.023)	(0.023)	(0.029)
Log(Foreign Real GDP)		0.787***	0.577***	0.811***	0.602***	0.597***
		(0.023)	(0.023)	(0.022)	(0.023)	(0.029)
Log(Domestic R&D Stock)			0.343***		0.343***	0.344***
			(0.007)		(0.007)	(0.009)
Log(Foreign R&D Stock)			0.220***		0.217***	0.218***
			(0.007)		(0.007)	(0.009)
Log(Domestic Research				11.897***	10.672***	10.874***
Intensity)				(0.911)	(0.885)	(1.118)
Log(Foreign Research				15.686***	15.626***	15.610***
Intensity)				(0.895)	(0.869)	(1.098)
Observations	55,464	55,464	55,464	55,464	55,464	55,464
Pair fixed effect	Y	Y	Y	Y	Y	N
Year fixed effect	Y	Y	Y	Y	Y	Y
Destination country fixed effect	N	N	N	N	N	Y
Source country fixed effect	N	N	N	N	N	Y
R-squared	0.866	0.869	0.877	0.870	0.878	0.804

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.2.2: Bilateral Foreign Patents vs Tariff, clustered gravity regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Tariff in Domestic	1.024***	1.177***	0.601*	1.113***	0.537	1.190***
	(0.373)	(0.357)	(0.332)	(0.358)	(0.327)	(0.346)
Log(Domestic Real GDP)		0.426***	0.086	0.465***	0.125	0.429***
		(0.139)	(0.113)	(0.140)	(0.114)	(0.137)
Log(Foreign Real GDP)		0.787***	0.577***	0.811***	0.602***	0.615***
		(0.186)	(0.159)	(0.184)	(0.157)	(0.164)
Log(Domestic R&D Stock)			0.343***		0.343***	
			(0.044)		(0.042)	
Log(Foreign R&D Stock)			0.220***		0.217***	0.199***
			(0.052)		(0.050)	(0.054)
Log(Domestic Research				11.897**	10.672**	10.263**
Intensity)				(4.763)	(4.749)	(5.001)
Log(Foreign Research				15.686***	15.626***	
Intensity)				(3.591)	(3.896)	
Observations	55,464	55,464	55,464	55,464	55,464	55,464
Pair fixed effect	Y	Y	Y	Y	Y	N
Year fixed effect	Y	Y	Y	Y	Y	Y
Destination country fixed effect	N	N	N	N	N	Y
Source country fixed effect	N	N	N	N	N	Y
R-squared	0.866	0.869	0.877	0.870	0.878	0.797

Table 2.3: Foreign Patents vs Domestic Patent, OLS regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Log(Foreign Patent)	0.672***	0.624***	0.671***	0.666***	0.626***	0.617***
	(0.021)	(0.020)	(0.021)	(0.021)	(0.020)	(0.020)
Log(Real GDP Per Capita)		1.216***			1.295***	1.345***
		(0.074)			(0.077)	(0.077)
Log(R&D Stock)			0.019		-0.141***	-0.158***
			(0.037)		(0.036)	(0.036)
Research Intensity				12.477***		18.189***
				(3.170)		(3.027)
Observations	2,833	2,833	2,833	2,833	2,833	2,833
Year fixed effect	Y	Y	Y	Y	Y	Y
Country fixed effect	Y	Y	Y	Y	Y	Y
R-squared	0.864	0.877	0.864	0.865	0.877	0.879

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.4: Bilateral Non-resident Patents vs Tariff, gravity regression

	(1)	(2)	(3)	(4)
Tariff in Domestic	1.201***	1.584***	0.487***	0.433***
	(0.091)	(0.245)	(0.103)	(0.103)
Log(Domestic Real GDP)	0.800***	-0.498***		
	(0.033)	(0.049)		
Log(Foreign Real GDP)	0.184***	0.471***		
	(0.033)	(0.044)		
Log(Domestic R&D Stock)	0.176***	0.218***	0.355***	0.359***
	(0.009)	(0.027)	(0.008)	(0.008)
Log(Foreign R&D Stock)	0.074***	0.355***	0.269***	0.269***
	(0.009)	(0.026)	(0.008)	(0.008)
Log(Domestic Research	8.910***	-10.937***	8.790***	8.798***
Intensity)	(1.485)	(1.157)	(1.118)	(1.118)
Log(Foreign Research	7.577***	1.301	15.111***	14.211***
Intensity)	(1.440)	(1.142)	(1.099)	(1.108)
WTO Dummy			0.001	
			(0.042)	
PCT Dummy				0.250***
				(0.041)
Observations	32,018	23,446	55,464	55,464
Pair fixed effect	Y	Y	N	N
Year fixed effect	Y	Y	Y	Y
Destination country fixed effect	N	N	Y	Y
Source country fixed effect	N	N	Y	Y
R-squared	0.899	0.889	0.802	0.802

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.5: Foreign Patents vs Domestic Patent, OLS regression

	(1)	(2)	(3)	(4)
Log(Foreign Patent)	0.539***	0.274***	0.550***	0.509***
	(0.023)	(0.031)	(0.020)	(0.020)
Log(Real GDP Per Capita)	-0.647***	3.320***	1.406***	1.451***
	(0.117)	(0.174)	(0.078)	(0.079)
Log(R&D Stock)	0.667***	-1.245***	-0.177***	-0.195***
	(0.068)	(0.078)	(0.037)	(0.037)
Research Intensity	38.996***	61.320***	19.272***	19.743***
	(4.865)	(5.424)	(3.074)	(3.069)
Observations	1,699	1,134	2,833	2,833
Year fixed effect	Y	Y	Y	Y
Country fixed effect	Y	Y	Y	Y
R-squared	0.917	0.926	0.872	0.868

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.6: Bilateral Patent vs Teledensity, Gravity regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Log(Tel Domestic)	0.124***	0.037***	0.068***			
	(0.012)	(0.012)	(0.012)			
Log(Tel Foreign)	0.204***	0.077***	0.099***			
	(0.012)	(0.012)	(0.012)			
Log(Imports)				0.102***	0.069***	0.071***
				(0.008)	(0.008)	(0.008)
Log(Domestic Real GDP)	0.734***	0.453***	0.295***	0.691***	0.573***	0.587***
	(0.031)	(0.031)	(0.031)	(0.044)	(0.045)	(0.042)
Log(Foreign Real GDP)	0.057*	-0.131***	-0.516***	0.580***	0.416***	0.127***
	(0.031)	(0.031)	(0.031)	(0.040)	(0.042)	(0.040)
Log(Domestic R&D Stock)		0.535***	0.344***		0.280***	0.064***
		(0.014)	(0.016)		(0.016)	(0.019)
Log(Foreign R&D Stock)		0.359***	-0.042***		0.225***	-0.291***
		(0.014)	(0.016)		(0.013)	(0.017)
Log(Domestic Research Intensity)			3.876***			10.334***
			(0.959)			(1.490)
Log(Foreign Research Intensity)			0.223			1.242
			(0.957)			(1.298)
Log(Patent in Foreign)			0.191***			0.214***
			(0.009)			(0.011)
Log(Patent in Domestic)			0.415***			0.528***
			(0.009)			(0.011)
Observations	37,577	37,577	37,577	16,112	16,112	16,104
Pair fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y
R-squared	0.855	0.862	0.872	0.864	0.868	0.887

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.7: First Stage Least Square, Gravity Regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Log(sum of telephone predict value)	0.724*** (0.052)	0.656*** (0.058)	0.647*** (0.058)			
Log(sum of imports predict value)				0.921*** (0.038)	0.875*** (0.041)	0.861*** (0.041)
Log(Real GDP per capita)	0.231*** (0.085)	0.153* (0.090)	0.174* (0.092)	-0.148* (0.082)	-0.193** (0.083)	-0.168** (0.084)
Log(R&D Stock)		0.113*** (0.042)	0.114*** (0.042)		0.080*** (0.025)	0.079*** (0.025)
Research Intensity			3.476 (3.083)			5.531* (2.845)
Observations	2,161	2,161	2,161	2,535	2,535	2,535
Pair fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y
R-squared	0.801	0.802	0.802	0.871	0.872	0.872

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 2.8 : Second Stage Least Square, OLS Regression, 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Log(OECD Foreign Patent)	2.560***	2.428***	2.462***	2.265***	2.002***	2.044***
	(0.174)	(0.202)	(0.210)	(0.091)	(0.089)	(0.094)
Log(Real GDP per capita)	0.539**	0.459**	0.403*	0.091	-0.184	-0.236
	(0.218)	(0.210)	(0.219)	(0.174)	(0.154)	(0.159)
Log(R&D Stock)		0.160	0.155		0.425***	0.424***
		(0.108)	(0.110)		(0.052)	(0.053)
Research Intensity			-8.511			-13.881**
			(7.345)			(5.709)
Observations	2,161	2,161	2,161	2,535	2,535	2,535
Pair fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y
Hausman chi^2 test P value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Weak IV F test	193.824	129.776	123.798	584.302	463.468	433.767
R-squared	0.087	0.179	0.157	0.471	0.595	0.579

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Chapter 3

Long-term demographic determinants of current accounts: Evidence for 21 OECD countries, 1870-2015

Abstract

This paper provides an empirical analysis of the long-term demographic determinants of current accounts. Using data for 21 OECD countries from 1870 to 2015, I find that i) a rise in old dependency ratio and/or life expectancy will lead to an increase in current account; ii) an increase in total dependency ratio, youth dependency ratio, fertility rate and population will yield a decline in current account.

3.1 Introduction

During the past two decades, many countries, including both advanced economies and developing countries, have experienced a persistent current account deficit. For instance, the U.S current account deficit as a percentage of GDP has been increasing since the early 1990s and reached to 6.21 per cent in the fourth quarter of 2005, which was the highest level from 1990. Turkey has an experienced persistent current account deficit from 2000 and reached close to 10 per cent in 2011. Policymakers, especially in emerging markets, usually concern much about the large current account deficits which are likely to be followed by potential sudden stops. To make optimal capital account or trade policies, a complete understanding of the determinants of the current account is important. Unfortunately, to my knowledge, the understanding of the current account in the existing literature is rather incomplete.

At the same time, many countries have experienced big changes in their demographic patterns. For instance, countries such as Germany and Japan are now facing serious population aging problems. The standard life-cycle theory suggests that such changes in demographics may have large impact on domestic savings as well as investment incentives. Note that, in definition, the current account of one country is the difference between national savings and national investment. Hence, a country's demographic pattern is quite likely to have a significant impact on its current account. In this paper, I aim at providing an empirical analysis to study the role of demographics in determining current account.

There exist several theories on savings and current account. First, the life-cycle theory suggests that individuals at a different stage in the life cycle can save differently. Therefore, a change in the demographic factors, such as the aged dependency ratio and life expectancy, will result in different weights of individuals at certain ages. Hence, aggregate savings and current account will change. (Modigliani and Cao, 2004; Park and Shin, 2009; Henriksen, 2002). Second, the precautionary savings motive theory predicts that a rise in future uncertainty will lead individuals to spend less on consumption and save more (Campell and Cochrane, 1999). As a result, the current account may improve. Third, financial market development is considered to be one crucial determinant of the current account. In theory, financial market development is associated with lower current account since i) it reduces individual savings since agents can borrow more freely when they receive low income, and ii), it also induces higher investment by reducing the cost of capital and transaction and improving corporate governance (King and Levine, 1993; Rajan and Zingales, 1998; Wurgler, 2000). However, there is no strong empirical support for the theoretical prediction (Loayza et al., 2000; Horioka and Yin, 2010). The last theory is habit persistence. Carroll and Weil (1994) find

that periods of high-income growth rate are usually the periods of high aggregate savings. When the economy starts growing faster, there will be an increasing gap between output and consumption. That is, savings will rise which in turn yield a current account surplus.

How demographics affect, current account is mainly predicted by the life-cycle theory. As in the standard international finance literature, current account of a country is the difference between domestic savings and domestic investment. One can simply extend a closed economy to an open economy model and consider how demographics affect capital flows. However, empirical studies mostly focused on the current account fluctuation over the past decades, leading to a wide variation and low efficiency of estimates. Therefore, in this paper, I use a historical data which covers 21 OECD countries from 1870 to 2015. Choosing the data for OECD instead of developing countries provides a substantially better quality of the data, given the longer available data span and the higher standard of data quality for OECD than for developing countries. The long data enables the exploitation of the historical variation in the international capital evolution, especially, the collapse of capital mobility during war-period and the increasing capital integration in the post-war period. The long data of multiple countries also provides an opportunity to analyze the countries at different stages of economic development.

Except allowing large variation of variables, there are many other benefits of using historical dataset. First of all, a rich historical dataset contains much more information than the recent dataset. This allows me to observe the changes in the transition periods and understand the evolution patterns, especially the effects of financial system transitions. Secondly, estimating with historical data improves the statistical accuracy by correcting observational errors and provides a robust estimation.

I also add the foreign part of demographic variables into regressions. For instance, when considering the impact of the life-expectancy variable on the current account. I have a pair of variables: domestic life-expectancy and foreign life-expectancy. The variable foreign expectancy is constructed by weighted averaging the life-expectancies in each trading partner of the home country. The weight is simply the bilateral trade in my baseline regressions. I include the foreign part of demographics because, if I study a two-country model, changes in domestic demographic variables and foreign domestic variables will affect home current account in opposite ways. Ignoring foreign part of those variables may potentially lead to biased estimates statistically and miss some important interpretations of current account movement in one country. As showing in the empirical session, foreign parts of demographic variables affect current account significantly both statistically and economically.

The structure of the paper is as follows. Section 3.2 lists the main theories behind the current account. Section 3.3 describes the dataset, measurements and related econometric issues. The empirical methodology and results are represented in section 3.3. In section 3.4, a variety of robustness checks are performed. And section 3.5 provides concluding remarks.

3.2 Review of theoretical literature

In definition, a country's current account is the difference between national saving and national investment. Hence, factors that change national savings will also affect current account. Among all theories on savings and current account, life-cycle theory (Modigliani 1970; Modigliani and Cao 2004) provides an important link between demographics and savings. The theory suggests that people make consumption choices based on the resources available over their lives. Agents in an economy will save less (or dis-save) when they receive low income, while the agent saves more in periods when they receive high income. As a result, one can obtain a well-known inverse U shape of savings pattern over the life cycle, since young people and old people; in general, receive lower income than mid-age people. A simplified life-time saving equation can be written as:

$$S = (\omega_A S_A) + (\omega_B S_B) + (\omega_A S_C) \quad (1)$$

where *S* is the aggregate savings. *A*, *B* and *C* represent young, working-aged and old individuals, respectively. $\varpi_i(\mathrm{i} = \mathrm{A}, \mathrm{B}, \mathrm{C})$ is the corresponding weight of age *A* people in the whole economy. If $S_A < 0$ and $S_C < 0$ as predicted by life-cycle hypothesis, (1) shows that, an increase in the weight of young or old leads to a decline in national savings, while an increase in the weight of working-aged has a positive impact on national savings. In the rest of this section, I present several demographic variables which have been widely discussed in the literature and focus on their impact on lifetime saving and the role of determining a country's current account.

3.2.1Dependency ratio

The Dependency ratio is one well-known index of a country's age structure. In (1) if the weight of young people ω_A or old people weight ω_C rises, the national savings will fall. This potentially leads to a lower current account as the investment is relatively insensitive to demographic changes. Such theoretical prediction is empirically supported. Calderon et al. (2002) find that a 1 percentage point rise in dependency ratio leads to a reduction in the current account (as a percentage of GDP) by 0.06 percentage points in developing countries. Unger (2017) uses the data of Euro-area

countries to show that the current account declines by 0.55 percentage point when the dependency ratio increases by 1 percentage point.

One concern of dependency ratio is that it contains both youth and dependency ratio and old dependency ratio. In theory, young people and old people may have completely different saving habits and hence, the effects of youth dependency ratio and old dependency ratio ($\omega_A$and ω_C) on the current account can be asymmetric. Several studies have considered two dependency ratios separately. Gruber and Kamin (2007) find that a 1 percentage point increase in old dependency ratio reduces the current account by 0.14 percentage points, while 1 percentage point increase in youth dependency ratio has a much weaker impact which only reduces the current account by 0.03 percentage points. One should note that their results, however, are not robust when controlling for U.S. and major developing Asian countries separately. Chinn and Prasad (2003) also study two dependency ratios separately for industrial countries, and find that a 1 percentage point increase in youth dependency ratio leads to about 0.06 percentage points reduction in the current account, while a 1 per cent increase in old dependency ratio yields 0.20 percentage points rise in the current account. In a later work, by dividing the data into two groups--industrial and less developed countries, Chinn and Ito (2007) find that a 1 percentage point increase in youth dependency ratio leads current account to rise by 0.02 percentage point in industrial countries but to reduce by 0.07 percentage points in less developed countries. A 1 percentage point increase in old dependency ratio leads current account to rise by 0.001 percentage points in industrial countries but to reduce by 0.31 percentage points in less developed countries. Lane and Ferretti (2012) also find that changes in the old dependency ratio have different impacts on current account in emerging market and advanced economies. Their results indicate that 1 percentage point increase in the old dependency ratio reduces the current account by 0.3 percentage points in the emerging market while the effect on advanced economies is insignificant.

3.2.2 Life expectancy

The second variable I focus on is life expectancy. Life expectancy has two different impacts on savings. On the one hand, when life expectancy increases, the length of post-retirement periods goes up which may raise the weight of old people (ω_C) rises). Hence, aggregate savings falls and current account declines. On the other hand, when agents fully anticipate the longer life, they will save more when they are mid-aged, which implies a higher S_B) in (1) Then aggregate savings go up and current account increases. In general, the net effect is ambiguous and the data could indicate which channel is the dominant one.

Empirically, Henriksen (2002) estimates how life expectancy affects current account using data on Japan and the U.S., and find that the country with higher life expectancy is indeed associated with a higher current account. Samwick (2000) finds that an increase in life expectancy by 1 year leads to a 0.17 percentage points rise in private savings. Li et al. (2007) also find that an increase in life expectancy by 1 year raises national savings by 0.2 percentage points by in a sample which covers more than 200 countries.

3.2.3 Fertility rate

Another variable I am interested in is the fertility rate. In theory, changes in fertility rate also have an ambiguous effect on savings and current account. First, the lower fertility rate reduces the burden of raising a child, which in turn leads to higher consumption and lower savings (lower S_B in (1). Current account declines in this case. Second, with a smaller number of children, people get lower support when they are old. Hence, they may save more in working ages. Current account then may rise Third, lower fertility rates yield fewer young workers in the labor market. As a result, demand for capital may decline which yields a lower investment and hence, current account rises. Lastly, fertility rates may affect current account through the composition in the total population. Lower fertility rates will lead to a larger share of old people ω_C in the economy in the long run. Since old people are quite likely to be dis-savers implied by life-cycle theory, the aggregate savings, as well as current account may fall. Overall, the effect of changing fertility rates on current account is ambiguous. Empirically, Li et al (2007) find that 1 percentage point increase in fertility rate is associated with 0.02 percentage point reduction in savings and there is no discussion on how fertility rate affects current account.

3.2.4 Population growth

Population growth is the last factor I am interested in. In general, the sign of its impact on the current account is ambiguous. Deaton and Paxson (2000) find that an increase in population growth can either increase or decrease the aggregate saving rate depends on economic growth. On the one hand, when population growth increases, there is a larger share of young people (ω_A), which results in a heavier burden of child raising which then lowers private savings. On the other hand, an increasing population growth implies a smaller fraction of old people (ω_C) among the total population. By the well-known life-cycle hypothesis, old people are most likely to dis-save. Hence a lower ω_C implies to a higher aggregate savings. The net effect of population growth on current account is then ambiguous.

3.3 Empirical evidence

3.3.1 Data

As I discussed previously, there are a large number of papers on demographic determinants of the current account. However, their empirical findings are mainly based on data from the recent five decades. The long-term effects of demographic variables on the current account have not been studied. Given the relatively slow pace of demographic change, analysis on short-term data does not capture the complete effects on the current account. A focus on the long-term data, which allows more variety of variables, is essential to understand the overall impact of demographic variables. This chapter uses current account and demographic data over more than a century for 21 OECD countries. A detail data source is listed in Appendix A. The long historical data not only capture the long-term effects of demographic variables on the current account but also to analyse the difference between short-term effects. Another advantage of using long historical dataset is that it improves the statistical accuracy by correcting observational errors and provides a robust estimation.

The 21 OECD countries included in the data set during the period 1870 to 2015 are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, German, Greece, Ireland, Italy, Japan, Netherland, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the UK and the US. Although the estimation would be strengthened by including the non-OECD countries, long historical data are not available for many non-OECD countries. In contrast, the data of OECD countries has been collected on a regular base and in a long timeframe, which ensures the accuracy and reliability of the data. Moreover, the OECD countries that are included in my dataset are the main driving forces in the world economy. Therefore, estimating the OECD data is adequate to represent the major effect of demographic variables on the current account.

Another contribution of this paper is that I generate a foreign country variable for each demographic factor. In a two-country model as in Devereux and Shi (1991), the more 'patient' country, the country with lower productivity and larger government sectors, has relatively higher interest rate than world interest rate and hence, higher savings. The theory predicts that the current account can be caused by the relative variables within a two-country setup. To capture this effect, I generate a foreign variable by computing the trade-weighted foreign counterpart variable. For instance, I compute the foreign dependency ratio as follows

$$FDEP_{it} = \sum \left(\frac{Trade_{ijt}}{Trade_{it}} DEP_{it} \right) \quad (2)$$

where $FDEP_{it}$ is the foreign dependency ratio. $Trade_{ijt}$ is the total import of country i from country j at time t, and $Trade_{it}$ is the sum of $Trade_{ijt}$ over index j. Table 1 provides a detailed description of the variables in dataset.

3.3.2 Baseline estimation

My estimation strategy is based on my previous review of theory in Section 3.2. I test how demographic variables affect current account. The baseline estimation equation is as follows

$$CAGDP_{it} = \beta_1 \ln(GDPPC_{it}) + \beta_2 DEP_{it} + \beta_3 \ln(LEXP_{it}) + \beta_4 FER_{it} + \beta_5 \Delta \ln(POP)_{it} + \varepsilon_{it} \quad (3)$$

where $CAGDP_{it}$ is the current account (% of GDP) in country i at time t. $GDPPC_{it}$ is the real GDP per capita. DEP_{it}, $LEXP_{it}$, and FER_{it} represent three demographic variables: dependency ratio, life expectancy and fertility rate, respectively. $\Delta \ln(POP)_{it}$ is population growth. Scatter plots show that there exists one outlier country Greece. Hence, I exclude Greece in the estimation of (3). Table 2 reports the estimation results. In the following subsections, I will discuss each demographic determinants of current account separately.

3.3.2.1 Dependency ratio

The theoretical analysis shows that a higher dependency ratio is associated with a lower national savings and hence, a lower current account. Column (1) in Table 3.2 shows that the coefficient on dependency ratio is negative and statistically significant, which is consistent with theory as well as the existing empirical findings in the literature. Consider that dependency ratio rises by 1 percentage point, the current account to GDP ratio will decrease by 0.3 percentage point. The quantitative effect of dependency ratio suggested by my data is much stronger than that in Calderon et al. (2002), who find 0.06 percentage points change in the current account. In Column (8), I include all three demographic variables. The coefficient on dependency ratio remains negative and statistically significant.

As I discussed in the theoretical section, young people and old people may have completely different saving motives, I separate youth and old dependency ratio in empirical estimations. In Columns (2) and (3), I find that the old dependency ratio has a positive on current account, while

young dependency ratio has a negative effect. Both effects are statistically significant. Interestingly, when pooling youth dependency ratio and old dependency ratio together in Column (9), I can see that youth dependency ratio has a much stronger negative effect than old dependency ratio (insignificant coefficient) in determining the current account. In other words, how total dependency ratio affects the current account is mainly via the youth dependency ratio. This result is in line with what Chinn and Prasad (2003) find.

3.3.2.2 Life Expectancy

Theory predicts an ambiguous effect of life expectancy on the current account. Empirically, Column (4) in Table 3.2 shows that life expectancy is positively correlated with the current account. Such an effect is statistically significant (at 1 per cent level). This result is in line with empirical findings in Henriksen (2002) and Samwick (2000). When pooling all factors together, Columns (8) and (9) show that the positive effect of life expectancy on the current account now become statistically insignificant. This could be due to the collinearity among the variables. This issue will be discussed in the following robustness check section.

3.3.2.3 Fertility Rate

As in the theoretical section, the effect of fertility rate on the current account is ambiguous. Empirically, Column (5) in Table 3.2 shows the coefficient on fertility rate is negative and statistically significant. However, after adding other demographic variables to the regression in Columns (8) and (9), although the coefficients on fertility rate remain negative, they are not significant statistically. Interestingly, when removing the dependency ratio from control variables in Column (7), the coefficient on fertility rate becomes significant again. This suggests that there may exist collinearity between the dependency ratio and fertility rate. I will further discuss this issue in the robustness check section.

3.3.2.4 Population growth

Implied by the life-cycle theory, the sigh of the effect of population growth on savings is ambiguous. In Column (6), I find that population growth is strongly negatively associated with the current account and the effect is statistically significant. However, this result becomes insignificant again when including other demographic variables in the estimation.

3.3.3 Robustness checks

In this section, I conduct several robustness checks to examine the role of demographic variables in determining a country's current account position.

3.3.3.1 Long-run regressions

One concern on annual frequency regressions is that the estimated effects may largely reflect the short-run business cycle movements. To exclude the effect of business cycles, I can take five- or ten-year averages of all variables in regressions.

Table 3.3 reports the regression results when I consider five years as one period. In other words, I take a five-year average for all variables in the sample and re-estimate (3). My baseline results hold in this experiment. The coefficient on dependency ratio remains negative and statistically significant. When including other demographic variables in Column (8), the coefficient on dependency ratio remains significantly negative, with slightly higher value. Old and young dependency ratios are estimated separately in Columns (2) and (3). Both coefficients on the youth dependency ratio and old dependency ratio remain the same as in my baseline regression. Again, when pooling two ratios together in the last column, I can see that the main effect of dependency ratio on current account is coming from the youth dependency ratio part. The coefficient on life expectancy, fertility rate and population growth remain significant and have the same signs as in (3).

I also experiment by considering ten years as one period. The results are represented in Table 3.4. Overall, all coefficients remain the same signs as in the baseline regression; however, due to a substantial reduction in sample size, some of them now lose the significance.

3.3.3.2 Financial Variables

Another concern with the estimation in (3) is that the estimation may miss important non-demographic factors. Hence, I add financial sector variables to the regressor list. Financial market development is one of the most debated factors influencing the saving and investment decision in the literature. As Chinn and Ito (2006) suggest, financial market development raises returns and lowers the cost of capital and the risk of investment. Therefore, further financial deepening could induce more saving through more depth financial system. Gruber et al. (2009) find that the lower interest rates are more common in more financially developed economies, as a result of lower risk. This then boosts investment and discourages savings. Loayza et al. (2000) and Horioka and Yin (2010) also find that financial sector development hurts the saving rate.

In my estimation, I choose to credit to private sector to GDP ratio and broad Money to GDP ratio as the measures of financial development in (3). As suggested in Debelle and Faruqee (1996),

the long-term variation in the stock price might affect the saving through their implications for precautionary saving. I also include the stock price in (3). Then the estimation equation becomes:

$$CAGDP_{it} = \beta_1 \ln(GDPPC_{it}) + \beta_2 DEP_{it} + \beta_3 \ln(LEXP_{it}) + \beta_4 FER_{\mathrm{it}} + \beta_5 \Delta \ln(POP)_{it} + \beta_6 Z_{it} + \varepsilon_{it} \quad (4)$$

where Z_{it} is a set of financial variables in country i at time t, which includes stock price over CPI, credit to private sector as a percentage of nominal GDP and broad money as a percentage of nominal GDP.

The results of (4) are presented in Table 3.5. Both financial sector variables play significant roles in determining the current account fluctuations. The coefficients on stock price are negative and statistically significant in Columns (1), (4), (5) and (8), which indicates that lower stock price leads to a higher current account balance. This can be explained as lower stock price causes higher precautionary savings, therefore current account increases. In Columns (2), (4), (6) and (8), credit to private sector (% of GDP) has a negative impact on current account balance, suggesting that the relaxation of credit constraints reduce private savings. The broad money is found negatively correlated with a current account balance in Columns (4) and (8).

With financial sector variables being controlled, I still find similar patterns of demographic variables. Interestingly, when I pool all demographic variables into one regression, all coefficients not only remain the same signs as in the baseline estimation, those coefficients on life expectancy and fertility rate also become more statistically significant, which suggest that a complete set of regressors is important to understand the most relevant determinants of current account.

3.3.3.3 Foreign variable

In this section, I re-estimate (3) by adding the foreign variable part for each domestic demographic variable. Then the estimation equation becomes:

$$CAGDP = \beta_1 DEP_{it} + \beta_{11} DEP_{jt} + \beta_2 LEXP_{it} + \beta_{22} LEXP_{jt} + \beta_3 FER_{it} + \beta_{33} FER_{jt} + \beta_4 POP_{it} + \beta_{44} POP_{jt} + \varepsilon_{it} \quad (4)$$

For the same reason in (3), I remove Greek data which are outliers to avoid the influence of unreliable and unusual data. The results are presented in Table 3.6. Columns (1) to (6) present evidence when estimating the effect of each demographic variable on the current account. For all those domestic variables, they remain the same signs as in my baseline regression and are statistically significant. my interest in this experiment falls more on the foreign variable counterpart. Column (1) shows that foreign dependency ratio is also negatively although statistically insignificant associated with home current account position. In Column (8), when pooling all demographic variables into one regression, the coefficient of the foreign part of dependency ratio now becomes statistically significant, which is striking since it is opposite to standard theory. When separating the youth dependency ratio and old dependency ratio, I again find very interesting results that, the foreign counterpart always have the same signs as the home dependency ratios, which are also statistically significant.

For the life expectancy, I can see that the foreign counterpart now has the opposite sign as the home life expectancy, implying that the two-country analysis can be empirically supported. In Columns (8) and (9), I find that the coefficients on the home life expectancy remain positive and statistically significant while the coefficients on the foreign counterpart now become statistically insignificant, suggesting that life expectancy affects current account mainly via the domestic channel.

When examining the role of fertility rate, Column (5) shows the coefficient on the home fertility rate is negative and statistically significant while the coefficient on the foreign counterpart is positive and statistically significant. However, when adding more control variables in Columns (8) and (9), the coefficients on home fertility rate are not significant. This implies home current account position is mainly affected by foreign fertility rate.

For population growth, the coefficient of the home part remains negative, while the coefficient of the foreign counterpart is positive and statistically significant; this is consistent with a two-country model result.

I also perform one robustness check to (5) by considering five years as one period (five-year average to all variables). The results are reported in Table 3.7. Overall, results are very similar to the ones in Table 3.6. It is quite puzzling that coefficients on dependency ratios are the same in the home and foreign variables which is inconsistent with a two-country theoretical framework. For other demographic variables, I do find opposite signs of the coefficients on home and foreign counterparts. In Table 3.8, I also control for financial sector variables. Similar to previous analysis,

with financial sector variables in the regressor list, demographic variables have more significant coefficients in those estimations with their signs same as what Table 6 reports.

3.4 Conclusion

The determinant of the current account has always been a heated discussion topic in macroeconomics. Most empirical works are mainly based on the evidence from the last five decades. Therefore, this chapter uses a historical dataset and finds that the demographic variables, including dependency ratio, life expectancy, fertility rate and population growth, have significant long-term effects on the current account. This paper finds that countries with lower dependency ratio, higher life expectancy, lower fertility rate and lower population growth should have a more current account surplus. In addition, this paper finds that world demographic changes, especially old age dependency, life expectancy and fertility rate have a significant impact on the country's current account.

A difficult but meaningful extension of this paper would be to identify the channels through which different components of the current account being affected by the demographic determinants. This would allow for an explicit understanding of the demographic variables' impact on saving and investment, which oppositely affect the current account.

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Appendices: Data source

The data and data appendixes are provided by Professor Jakob Madsen at University of Western Australia.

Current account

Canada

1870-1996 CAB: Mitchell, B.R. (2013), International Historical Statistics, 1750-2010, online database, Palgrave Macmillan: New York; 1997-2014 from OECD Economic Outlook No 96 - November 2014 - OECD Annual Projections, http://stats.oecd.org/ accessed February 2014, henceforth the OECD Economic Outlook No 96 database.

USA
1874-1996 CAB from Mitchell B.R. 2013 *op. cit*; 1997-2014, OECD Economic Outlook No 96 database.

Japan
1859-1867 CAB computed using the net exports to GDP ratio; 1867-2006 from Mitchell B.R. 2013 *op. cit*; 1997-2014, OECD Economic Outlook No 96 database.

Australia
1861-1996 CAB from Mitchell B.R. 2013 *op. cit*; 1997-2014, OECD Economic Outlook No 96 database.

New Zealand
1870-1939 CAB is from Madsen and Greasley, (2007), Scandanevian Journal of Economic History; 1940-1949 interpolated; 1950-1996 from Mitchell B.R. 2013 *op. cit*; 1997-2014 from the OECD Economic Outlook No 96 database.

Austria
1820-1872 CAB backdated using the net exports to GDP ratio; 1873-1947 CA/Nominal GDP = Net Export/Nominal GDP - Debt GDP ratio* UK Interest Rate. Debt GDP ratio and net export obtained from Mitchell B.R. 2013 *op. cit*; 1948-1996 current account balance was obtained from Mitchell B.R. 2013 *op. cit*; 1997-2014 from the OECD Economic Outlook No 96 database. The CAB to GDP ratio is computed for the entire series and then subsequently converted into overall CAB.

Belgium
1831-1895 CAB was computed using the net exports to GDP ratio; 1896 to 1947 computed as CAB = NFA + Interest payments, with interest rate assumed to be 4% throughout the period and data obtained from R. W. Goldsmith (1974), A Note on the National Balance Sheet of Belgium 1850-1971, Discussion Paper, Workshop on quantitative Economic History (no. 7403), Leuven; 1948-1996 from Mitchell B.R. 2013 *op. cit*; 1997-2014 from the OECD Economic Outlook No 96 database.

Denmark
1844-1874 CAB computed using the net exports to GDP ratio; 1874-1914 and 1921-1996 from Mitchell B.R. 2013 *op. cit*; 1997-2014 from the OECD Economic Outlook No 96 database.

Finland
1860-1985 from Hjerppe, R. 1989, The Finish Economy 1860-1985, Helsinki: Bank of Finland, Government Printing Centre. Data used to compute CA to GDP ratio; 1986-1996 current account balance obtained from the World Bank database, http:// databank.worldbank.org and used to compute CA to GDP ratio. The ratios are subsequently used to compute overall CAB in euros; 1997-2014 from the OECD Economic Outlook No 96 database.

France
1800-1819 computed using the net exports to GDP ratio; 1820-1913 and 1920-1996 nominal GDP and current account data from Mitchell B.R. 2013 *op. cit* used to compute the CAB to GDP ratio, subsequently converted to overall CAB in Euros using nominal GDP; 1997-2014 from the OECD Economic Outlook No 96 database.

Germany
1850-1959 CAB from Hoffmann, W. G., Grumbach, F., and Hesse, H. 1965, Das Wachstum der Deutschen Wirtschaft seit der mitte des 19. Jahrhunderts, Berlin: springer- verlag; 1960-1987 from Liesner, T. 1989, One Hundred Years of Economic Statistics, Oxford, The Economist; 1988-1996 CAB from the World Bank database, http:// databank.worldbank.org.

Greece
1833-1997 CAB computed using the net exports to GDP ratio and spliced to the level of the actual CAB using 1997 as base year; 1997-2014 from the OECD Economic Outlook No 96 database.

Ireland
1870-1923 CAB to Nominal GDP ratio is based on UK spliced with Ireland in 1931; CA balance from 1931-1996 is obtained from Mitchell B.R. 2013 *op. cit*: 1997-2014 from the OECD Economic Outlook No 96 database.

Italy
1861-1997 CAB from Mitchell B.R. 2013 *op. cit*; 1997-2014, OECD Economic Outlook No 96 database.

Netherlands
1806-1996 from Central Bureau voor de Statistiek 1800-1999; 1997-2014, OECD Economic Outlook No 96 database.

Norway
1865-1900, 1910, 1920, 1930, 1939, 1946, 1950, 1955, 1960 CAB from the General Bureau of Statistics of Norway, 1966, Trends in Norwegian Economy 1865-1960, Oslo; CAB for 1901-1909, 1911-1919, 1921-1929, 1931-1938, 1945-1949, 1956-1951 and 1961-1996 is from Mitchell B.R. 2013 *op. cit*; 1997-2014 is from the OECD Economic Outlook No 96 database.

Portugal
1851-1948 CAB = Net Export + External debt* UK Interest rate: Net export obtained from Paula, F., and Nuno, V. (2000), Foreign Economic Relations and Economic Growth in Portugal, A Long Term View, Économies et Sociétés, 3/2000: External debt from Mata Maria Eugénia (1993), As Finanças Públicas Portuguesas da Regeneração à Primeira Guerra Mundial, Lisboa: Banco de Portugal, 1993 and Nuno, V., (1997), As Finanças Públicas Portuguesas Entre as Duas Guerras Mundiais, Lisboa, Cosmos; 1948-1996 CAB from Paula and Nuno (2000) *op. cit*; 1997-2014 from the OECD Economic Outlook No 96 database.

Spain

1851-1969 consumption as a percentage of nominal GDP and Government purchase as a percentage of nominal were obtained from Carreras, A. and Tafunell, X. (2005). Estadisticas Históricas de España Siglos XIX-XX, (1). Segunda Edicion Revisada Y Ampliada. Fundacion BBVA; 1970-2014 private and government consumption are both from the OECD National accounts.

Sweden
1800-1860 CAB backdated using the net exports to GDP ratio; 1861-1996 CA from Mitchell B.R. 2013 *op. cit* and 1997-2014 is from the OECD Economic Outlook No 96 database.

Switzerland
1885-1948 CA/Nominal GDP = (Net Export + Cumulative net export* 0.04)/Nominal GDP): all variables obtained from Mitchell B.R. 2013 *op. cit*. The computed ratio is spliced to the level of CA to GDP obtained using actual CAB data from Mitchell B.R. 2013 *op. cit*; 1948-1996 CAB is from Mitchell B.R. 2013 *op. cit*; 1997-2014 is from the OECD Economic Outlook No 96 database.

UK
1710, 1715, 1725, 1735, 1745, 1755, 1765, 1785 and 1795 CAB balance from Brezis, Elise S., (1995), Foreign capital flows in the Century of Britain's Industrial Revolution: New Estimates, controlled conjectures, Economic History Review, XLViii, 1, pp 46-67; 1830-1996; 1816-1996 is obtained from Mitchell B.R. 2013 *op. cit*: 1997-2014 from the OECD Economic Outlook No 96 database.

Stock prices

See data appendix of Madsen and Davis (2004) for data sources.

Dependency ratio, fertility rate, credit to private sector and broad money

See data appendix of 2018 Memoranda University of Western Australia

Table 3.1: Variable description

Variable	Description
GDP PC	Current account to nominal GDP ratio
Dependency Ratio	Dependency ratio (Population under 15 and over 65 / Population between 15 and 65)
Old Dependency	Old dependency ratio (Population over 65 / Population between 15 and 65)
Youth Dependency	Youth dependency ratio (Population under 15/ Population between 15 and 65)
Life expectancy	Life expectancy at birth in total years
Fertility rate	Total births per woman
Population Growth	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t
Stock Price	Stock price to CPI ratio
Credit to Private Sector	Domestic credit to private sector to nominal GDP ratio
Broad Money	Broad money to nominal GDP ratio
Growth	Real GDP growth rate

Table 3.2: OLS Regression on Current Account/GDP 1870-2015 (Outliers Dropped)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP PC	0.034***	0.050***	0.034***	0.047***	0.044***	0.052***	0.042***	0.033***	0.032***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Dependency Ratio	-0.003***							-0.002***	
	(0.000)							(0.000)	
Old Dependency		0.133**							-0.044
		(0.056)							(0.059)
Young Dependency			-0.281***						-0.276***
			(0.022)						(0.031)
Life expectancy				0.042***			0.021	0.025	0.017
				(0.016)			(0.016)	(0.016)	(0.016)
Fertility rate					-0.019***		-0.018***	-0.004	-0.001
					(0.002)		(0.002)	(0.003)	(0.003)
Population Growth						-0.457***	-0.166	-0.181	-0.085
						(0.126)	(0.130)	(0.129)	(0.130)
Observations	2,937	2,937	2,937	2,937	2,937	2,918	2,918	2,918	2,918
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.427	0.401	0.434	0.401	0.416	0.403	0.418	0.429	0.435

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.3: OLS Regression on Current Account/GDP 1870-2015 - 5 Years Average

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP PC	0.036**	0.056***	0.034**	0.047***	0.050***	0.061***	0.051***	0.035**	0.032*
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)
Dependency Ratio	-0.003***							-0.004***	
	(0.001)							(0.001)	
Old Dependency		0.285*							-0.079
		(0.149)							(0.160)
Young Dependency			-0.354***						-0.446***
			(0.058)						(0.082)
Life expectancy				0.104**			0.095**	0.105**	0.088*
				(0.044)			(0.046)	(0.045)	(0.045)
Fertility rate					-0.015***		-0.007	0.017**	0.019**
					(0.006)		(0.007)	(0.008)	(0.008)
Population Growth						-1.278**	-1.009*	-1.133**	-0.710
						(0.509)	(0.578)	(0.568)	(0.589)
Observations	605	605	605	605	605	605	605	605	605
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.498	0.478	0.508	0.480	0.481	0.481	0.487	0.506	0.515

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.4: OLS Regression on Current Account/GDP 1870-2015 - 10 Years Average

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP PC	0.020	0.033	0.019	0.026	0.030	0.033	0.025	0.013	0.011
	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.022)	(0.021)	(0.021)
Dependency Ratio	-0.002***							-0.004***	
	(0.001)							(0.001)	
Old Dependency		-0.041							-0.212
		(0.216)							(0.224)
Young Dependency			-0.270***						-0.437***
			(0.088)						(0.123)
Life expectancy				0.085			0.070	0.091	0.080
				(0.066)			(0.076)	(0.074)	(0.075)
Fertility rate					-0.009		-0.005	0.026*	0.026*
					(0.009)		(0.012)	(0.015)	(0.015)
Population Growth						0.025	0.187	0.440	0.728
						(1.217)	(1.401)	(1.365)	(1.390)
Observations	203	203	203	203	203	203	203	203	203
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.621	0.603	0.624	0.607	0.605	0.603	0.607	0.631	0.636

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.5: OLS Regression on Current Account/GDP 1870-2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP PC	0.006	0.034***	0.028***	0.010	-0.000	0.032***	0.026***	0.006
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)
Dependency Ratio	-0.002***	-0.004***	-0.004***	-0.003***				
	(0.000)	(0.000)	(0.000)	(0.000)				
Old Dependency					0.035	-0.099	-0.004	0.009
					(0.074)	(0.078)	(0.086)	(0.086)
Young Dependency					-0.288***	-0.416***	-0.442***	-0.348***
					(0.045)	(0.039)	(0.041)	(0.048)
Life expectancy	0.110***	0.133***	0.104***	0.187***	0.096***	0.116***	0.089***	0.171***
	(0.027)	(0.022)	(0.022)	(0.030)	(0.027)	(0.022)	(0.022)	(0.031)
Fertility rate	0.007	0.011***	0.011***	0.007	0.011**	0.014***	0.014***	0.011**
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
Population Growth	-0.557***	-0.398**	-0.333*	-0.491***	-0.420**	-0.269	-0.164	-0.355**
	(0.168)	(0.163)	(0.172)	(0.176)	(0.170)	(0.165)	(0.173)	(0.178)
Stock Price	-0.011***			-0.014***	-0.013***			-0.015***
	(0.002)			(0.002)	(0.002)			(0.003)
Credit to Private Sector		-0.000***		-0.001***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)		(0.000)
Broad Money		-0.001		-0.004**		-0.001		-0.006***
		(0.001)		(0.002)		(0.001)		(0.002)
Growth			-0.056*	-0.057*			-0.053*	-0.054*
			(0.029)	(0.029)			(0.029)	(0.029)
Observations	2,573	2,959	2,723	2,322	2,573	2,959	2,723	2,322
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.330	0.469	0.470	0.355	0.336	0.475	0.479	0.362

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.6: OLS Regression on Current Account/GDP 1870-2015 including foreign variables (Outliers Dropped)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP PC	0.029***	0.044***	0.028***	0.039***	0.038***	0.046***	0.037***	0.029***	0.024***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Dependency Ratio	-0.003***							-0.002***	
	(0.000)							(0.000)	
Dependency Ratio (ROW)	-0.000							-0.004***	
	(0.001)							(0.001)	
Old Dependency		0.131**							-0.026
		(0.057)							(0.059)
Old Dependency (ROW)		0.321***							0.444***
		(0.121)							(0.129)
Young Dependency			-0.278***						-0.291***
			(0.022)						(0.032)
Young Dependency (ROW)			-0.042						-0.487***
			(0.051)						(0.089)
Life expectancy				0.069***			0.042**	0.053***	0.044**
				(0.017)			(0.017)	(0.017)	(0.017)
Life expectancy (ROW)				-0.250***			-0.161***	-0.049	0.012
				(0.039)			(0.042)	(0.046)	(0.046)
Fertility rate					-0.018***		-0.015***	-0.000	0.002
					(0.002)		(0.002)	(0.003)	(0.003)
Fertility rate(ROW)					0.020***		0.013**	0.048***	0.074***
					(0.006)		(0.006)	(0.009)	(0.009)
Population Growth						-0.443***	-0.226*	-0.219*	-0.138
						(0.127)	(0.131)	(0.130)	(0.129)
Population Growth (ROW)						0.004**	0.003*	0.002	0.004**
						(0.002)	(0.002)	(0.002)	(0.002)
Observations	2,887	2,887	2,887	2,887	2,887	2,869	2,869	2,869	2,869
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.426	0.402	0.433	0.410	0.417	0.403	0.423	0.438	0.455

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.7: OLS Regression on Current Account/GDP 1870-2015 including Foreign variables - 5 Years Average

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP PC	0.032*	0.049***	0.030*	0.038**	0.045***	0.056***	0.045***	0.031*	0.025
	(0.017)	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Dependency Ratio	-0.003***							-0.004***	
	(0.001)							(0.001)	
Dependency Ratio (ROW)	-0.001							-0.004*	
	(0.002)							(0.003)	
Old Dependency		0.278*							-0.047
		(0.151)							(0.160)
Old Dependency (ROW)		0.432							0.530
		(0.324)							(0.347)
Young Dependency			-0.346***						-0.453***
			(0.060)						(0.084)
Young Dependency (ROW)			-0.124						-0.644**
			(0.139)						(0.256)
Life expectancy				0.139***			0.140***	0.155***	0.133***
				(0.046)			(0.048)	(0.047)	(0.047)
Life expectancy (ROW)				-0.353***			-0.325***	-0.149	-0.031
				(0.111)			(0.119)	(0.135)	(0.136)
Fertility rate					-0.014**		0.001	0.024***	0.025***
					(0.006)		(0.007)	(0.009)	(0.009)
Fertility rate(ROW)					0.014		0.006	0.054**	0.093***
					(0.016)		(0.017)	(0.027)	(0.028)
Population Growth						-1.340**	-1.399**	-1.447**	-1.107*
						(0.519)	(0.598)	(0.588)	(0.599)
Population Growth (ROW)						0.016*	0.014	0.012	0.019**
						(0.008)	(0.008)	(0.008)	(0.008)
Observations	595	595	595	595	595	595	595	595	595
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.497	0.480	0.508	0.489	0.481	0.483	0.497	0.518	0.537

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 3.8: OLS Regression on Current Account/GDP 1870-2015 including Foreign variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP PC	-0.000	0.007	0.021**	-0.019*	-0.009	0.005	0.015*	-0.025**
	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)
Dependency Ratio	-0.002***	-0.003***	-0.004***	-0.002***				
	(0.000)	(0.000)	(0.000)	(0.000)				
Dependency Ratio (ROW)	-0.001	-0.006***	-0.005***	-0.002				
	(0.001)	(0.001)	(0.001)	(0.001)				
Old Dependency					0.005	-0.044	0.019	0.023
					(0.075)	(0.080)	(0.087)	(0.091)
Old Dependency (ROW)					0.488***	0.167	0.615***	0.508**
					(0.163)	(0.184)	(0.190)	(0.216)
Young Dependency					-0.265***	-0.384***	-0.453***	-0.320***
					(0.046)	(0.040)	(0.043)	(0.049)
Young Dependency (ROW)					-0.298**	-0.659***	-0.566***	-0.260*
					(0.131)	(0.114)	(0.120)	(0.139)
Life expectancy	0.119***	0.154***	0.144***	0.210***	0.109***	0.139***	0.122***	0.195***
	(0.028)	(0.022)	(0.023)	(0.032)	(0.028)	(0.023)	(0.023)	(0.032)
Life expectancy (ROW)	-0.153**	0.054	-0.116*	0.062	-0.070	0.046	-0.051	0.055
	(0.073)	(0.061)	(0.062)	(0.083)	(0.073)	(0.061)	(0.062)	(0.082)
Fertility rate	0.007	0.012***	0.014***	0.005	0.009*	0.013***	0.016***	0.007
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
Fertility rate(ROW)	-0.014	0.072***	0.049***	-0.015	0.014	0.080***	0.081***	-0.004
	(0.013)	(0.012)	(0.013)	(0.015)	(0.014)	(0.012)	(0.013)	(0.015)
Population Growth	-0.525***	-0.449***	-0.352**	-0.451**	-0.412**	-0.348**	-0.197	-0.360**
	(0.169)	(0.163)	(0.174)	(0.176)	(0.170)	(0.164)	(0.173)	(0.177)
Population Growth (ROW)	0.000	0.005**	0.002	0.001	0.002	0.005**	0.005**	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Stock Price	-0.012***			-0.011***	-0.011***			-0.012***
	(0.002)			(0.003)	(0.002)			(0.003)
Stock Price (ROW)	-0.004			0.001	-0.004			0.000
	(0.003)			(0.003)	(0.003)			(0.003)
Credit to Private Sector		-0.000***		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)		(0.000)
Credit to Private Sector (ROW)		-0.000**		-0.000		0.000		0.000*
		(0.000)		(0.000)		(0.000)		(0.000)
Broad Money		-0.002*		-0.004*		-0.001		-0.005**
		(0.001)		(0.002)		(0.001)		(0.002)
Broad Money (ROW)		-0.009***		-0.008***		-0.009***		-0.007***
		(0.001)		(0.001)		(0.001)		(0.001)
Growth			-0.050*	-0.035			-0.046	-0.036
			(0.030)	(0.030)			(0.029)	(0.030)
Growth (ROW)			0.193**	0.168**			0.203***	0.175**
			(0.080)	(0.079)			(0.078)	(0.079)
Observations	2,549	2,910	2,674	2,298	2,549	2,910	2,674	2,298
Country fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.334	0.492	0.480	0.371	0.345	0.500	0.498	0.379

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Chapter 4

Financial Market Development and International Capital Flows

Abstract

Capital flows especially long-run capital inflows are usually considered very important to economic growth, especially in emerging economies. This chapter provides a detailed analysis of two different types of capital inflow and outflow: foreign direct investment and portfolio equity. Using a dataset of capital flows and financial market development including 217 countries from 1980 to 2015, I find that a country with more developed financial market has more FDI and equity capital outflows. However, financial development has little impact on capital inflows.

4.1 Introduction

Capital flows especially long-run capital inflows such as foreign direct investment (FDI henceforth) are usually considered very important to economic growth, especially in emerging economies. For instance, the period that East Asian countries such as China grow rapidly is also the one that there were surges in their cross-border capital flows. Given the important role of capital flows in determining economic growth, many studies estimate how capital flows are affected by domestic macro factors such as real interest rate, inflation and financial market development.

However, most of the existing works focus only on the net aggregate capital flows. There are two potential weaknesses of this type of approach. First, capital inflows and outflows may typically be influenced by domestic macro conditions in different ways. In the case where the estimation of aggregated capital flows is not statistically but the capital inflows or outflows have significant effects, only estimating the aggregate capital flows may mistakenly understand the accurate effects of capital flows. Second, there exist a number of different types of capital flows; for instance, long-term capital flows and short-term capital flows. A change in domestic fundamental may cause various impacts on different capital flows although the aggregate capital flow may not change much.

In this chapter, I aim at providing a more detailed analysis of how domestic macro variables affect different types of capital inflows, outflows and net flows separately. To be more specific, I focus on the role of domestic financial market development in determining two types of capital flows: FDI and portfolio equity. As in the standard literature, a country's financial market development degree is often measured as the ratio of credit ratio to GDP (credit ratio). I also adopt another widely used measure such as broad money (M2/GDP) as the second proxy for financial market development As Chinn and Prasad (2003), this measure indicates the depth and sophistication of a country's financial system.

My work is related to a large body of studies in the literature. Giovanni (2005) finds that a more advanced financial market leads to a larger amount of FDI outflow. Chinn and Ito (2006) suggest that financial market development raises the availability of credit as it alleviates information asymmetry and decreases adverse selection and moral hazard. As a result, a more advanced financial market is associated with a higher investment which then may attract more foreign capital inflows. Alfaro (2000) argues that better financial markets are associated with more efficient knowledge spillovers and hence, help to attract FDI. Forbes (2010) finds that countries with less efficient financial markets usually hold a larger share of equity investment abroad which implies that, a less developed financial market can lead equity outflow.

Empirically, I run a panel data regression in a dataset covers 217 countries from 1980 to 2015. The results show that a country with a more developed financial market leads more investment to flow outside the country and has an insignificant effect on attracting foreign FDI into the country. Also, more developed financial market causes more equity outflow rather than inflow. When decomposing the sample by periods and country development stage, interestingly, the role of financial market development seems to be more critical when I restrict the sample to high-income countries or years after 2000.

The rest of the paper is structured as follows. Section 4.2 discusses the current literature on financial market development and capital flows. The empirical methodology and results are presented in section 4.3. In section 4.4, a variety of robustness checks are performed. Endogeneity issue is addressed in section 4.5. And section 4.6 provides concluding remarks.

4.2 Literature

Cross country capital flows have always been a central topic in the international finance literature. In this section, I review the existing literature on financial market development and capital flows including FDI and portfolio equity.

4.2.1 FDI

FDI flows to developing countries have increased dramatically in the past decades. Many empirical works of literature in FDI flows find a significant impact of financial market development. Afraro (2004) shows that better financial markets allow agents in the economy to take advantage of knowledge spillovers from FDI and hence, help to attract FDI. Giovanni (2005) uses the credit ratio as a measure of financial deepening and finds that a more advanced financial market leads to a more substantial amount of FDI outflow. Chinn and Ito (2006) estimate a panel data which covers 108 counties and twenty years. They suggest that a higher level of financial market development creates more available credit, alleviates information asymmetry and reduce adverse selection and moral hazard, which fosters the development of the equity market. Loungani and Razin (2001) argue that FDI has been proved to be resilient during financial crises, and this resilience could lead many developing countries to favour FDI over other forms of capital flows.

4.2.2 Portfolio equity

For portfolio equity flows, Portes and Rey (1999) use a new panel data set on bilateral gross cross-border equity flows to find gross asset flows depend on market size in both source and

destination country. Forbes (2010) uses foreign financial capital inflow of the United States and finds that a country with less developed financial markets tends to generate a greater equity outflow. Stultz (1999) shows that financial globalization reduces the cost of equity due to lower compensate risk and agency costs. La Porta et al. (1997, 1998) find a negative correlation between shareholder rights and equity market development.

Though some of the literature focuses on the capital inflows and outflow, there are not many studies that examine the capital inflow and outflows of FDI and portfolio equity together. Therefore, this chapter aims to fill this shortage in literature.

4.3 Empirical methodology

4.3.1 Data

To explore the relationship between financial development and capital flow, I using a panel dataset by collecting data on financial development measurements and different types of capital flow. The dataset spans from 1980 to 2015 and includes 217 countries. In this section, I will describe the data used in the empirical analysis and provide a first glance at the capital flow patterns around financial development indicators.

Most of the existing works focus on the net aggregate capital flows. There are two potential weaknesses of this type of approach. First, capital inflows and outflows may typically be influenced by domestic macro conditions in different ways. Without separating inflows and outflows, the effects of macro variables on capital flows may be misleading if the estimation results are not statistically significant. Second, there exist a number of different types of capital flows, such as long-term capital flows and short-term capital flows. A change in the domestic fundamental may cause significant impacts on individual capital flows although the aggregate capital flow may not change much.

Hence, I conduct empirical analysis by focusing on the role of financial market development in determining two different types of capital flows: FDI and portfolio equity. The cross country capital flow data are from Alfaro et al. (2014), which contains various types of capital flow and separates the capital inflow and outflow. A capital inflow is defined as an increase in the country's foreign liability position which is resulted from borrowing from abroad, such as selling an asset. Capital outflow is defined as an increase of foreign asset position when a country lends abroad by purchasing a foreign asset or claim against the foreign country.

In the standard literature, a country's financial market development degree is often measured as the credit ratio (King and Levine, 1993). The credit ratio estimates the financial resources provided to the private sector, such as loans, purchases of non-equity securities and trade credits. I also include another widely used measurement, broad money (M2), in my analysis. Broad money indicates the depth and sophistication of a country's financial system (Chinn and Prasad, 2003), which can be used as a proxy for financial market development. The data on credit ratio and broad money are collected from the World Bank Development Indicators.

4.3.2 Baseline Estimation

$$y_{it} = \beta_1 \cdot \frac{Money_{it}}{GDP_{it}} + \beta_2 \cdot \frac{Credit_{it}}{GDP_{it}} + \beta_3 \cdot Z_{it} + f_i + f_t + \varepsilon_{it} \quad (1)$$

where y_{it} represents FDI and equity flows as a percentage of GDP (t). The two main regressors in this paper are $\frac{Money_{it}}{GDP_{it}}$ and $\frac{Credit_{it}}{GDP_{it}}$. Z_{it} is a set of control variable which includes real interest rate, GDP growth rate, trade openness and capital account openness. As higher interest rates will attract more capital flows into a country, interest rate should be includethe d in the control variables. Trade openness should also be included in the control variables as higher trade openness reduces the opportunities of capital account restriction through trade transaction. Capital restrictions can reduce the profits from capital investment, therefore I include capital account openness in the control variables. f_i and f_t are country and year fixed effects, respectively.

Though the financial market is the main reason for capital flows, there may exist a causal relationship between capital flows and financial market development. Some literature has tested this possibility. Sahin and Ege (2015) use data of FDI inflow and financial development in Turkey, Macedonia, Greece and Bulgaria, and find a two-way causality in Turkey, but not in Bulgaria and Greece. Abzari et al. (2011) also examines the causality between financial development and FDI inflow, and find a one-way causality. To check the causality, I use an instrumental variable for financial market development to address this causality issue.

4.3.2.1 FDI

Table 4.1 summarizes the results when I focus on FDI flows. Columns (1) to (3) show the results when using FDI inflow as the dependent variable. In Columns (1) and (2), when broad money and credit ratio are controlled independently, neither of them is found to be significantly related to FDI inflow. In Column (3), when both of them are controlled at the same time, the coefficient of credit ratio becomes positive and statistically significant at the ten per cent level. This

indicates that financial market development may not have a significant impact on FDI inflow. Among the other potential determinants of FDI inflow, GDP growth and trade openness have a positive and significant effect on FDI inflow which is consistent with what literature finds. There seems to be no significant relationship between FDI inflow and real interest rate or capital account openness.

Columns (4) to (6) in Table 1 show the regression results when using FDI outflow as the dependent variable. In Column (4), the coefficient on credit ratio is statistically significant at the one per cent level. A one percentage point increase in credit ratio is associated with an increase in FDI outflow by 4%. The coefficient on credit ratio remains positive and significant after controlling for broad money. Although the coefficient for broad money is not statistically significant in Column (5), it becomes statistically significant at the 10 per cent level when adding credit ratio to the regression. This suggests that FDI outflows are affected by financial market development while FDI inflows seem not to be. Capital account now becomes positively and significantly related to FDI outflow in Column (4), but it becomes insignificant when controlling for credit ratio. Both real interest rate and GDP growth are not found to be significantly related to FDI outflow.

The results of equation (1) when using FDI net inflow as capital flow variable are shown in Column (7) to (9). In Column (8), the coefficient on credit ratio is negative and statistically significant at 5% level. A one percentage point increase in credit ratio reduces the FDI net inflow by about two per cent. And this result carries over to Columns (9) when adding broad money in the regressors. This is not surprising given the significant and positive effect of credit ratio on FDI outflow and insignificant effect on FDI inflow. In Columns (7) and (9), whether controlling broad money alone or with credit ratio, the coefficients on broad money are not significant. This is consistent with broad money's insignificant effect on FDI inflow and the weak effect on FDI outflow. Among the other potential determinants of FDI net inflow controlled in the regression, trade openness and GDP growth have a significant and positive impact on FDI net flow. The coefficient on the real interest rate is negative and significant only at 10% in Column (8).

These estimates suggest that credit ratio and broad money has a stronger impact on FDI outflow than FDI inflow and its effects on net inflow is mainly due to FDI outflow. In other words, a country's financial market development could lead to more substantial FDI outflow rather than FDI inflow.

4.3.2.2 Equity portfolio

The results on equity portfolio are presented in Table 3.2. Columns (1) to (3) show that none of the coefficients on broad money or the credit ratio is statistically significant. This implies that financial market development has little effect on equity inflow. However, the GDP growth rate and trade openness indicate strong correlations with equity inflow. In all three columns, the GDP growth rate shows a strong and positive effect on equity inflow. In column (3), when the GDP growth rate increases by 1 per cent, equity inflow is likely to increase by 5.07 per cent, which is economically significant. Trade openness indicates a significant and negative effect on equity flow in all three columns. In column (3), a 1 per cent increase in trade openness is associated with a 0.013 per cent decrease in equity inflow. There is no strong correlation found between capital openness and equity inflow.

In column (4) and (6), the estimation analyses the effect of financial development on equity outflow. Credit ratio is found to have a significant and positive impact on equity outflow in column (5). When credit ratio increases by 1 per cent, equity outflow is likely to grow by 1.3 per cent. In column (6), when both broad money and credit ratio are controlled, broad money indicates a statistically significant and negative effect on equity outflow. A 1 per cent increase in broad money leads to a 2.9 per cent decrease in equity outflow. In the rest controlled variables, only capital openness is found to have a positive and statistically significant effect on equity outflow.

The results are represented in column (7) to (9) when estimating the equity net flows. Similar to the estimation results of equity outflow, both proxies for financial market development are found to be significantly correlated with equity net flow. The coefficient on broad money is negative but insignificant in column (4). While, in column (9), when broad money is controlled with credit ratio, the coefficient on broad money becomes statistically significant. When broad money rises by 1 per cent, the equity net flow is likely to increase by 2.4 per cent. In column (8), credit ratio indicates a strong and negative effect on equity net flow. This negative effect remains statistically significant when including broad money in the estimation. In column (9), a 1 per cent increase in the credit ratio is associated with a 2.7 per cent decrease in equity net flow. Most of the other controlled variables are not found to have a significant effect on the equity net flow. Only the capital to openness shows a negative and statistically significant impact on equity net flow.

The estimation results of imply that credit ratio and broad money has a larger and stronger effect on equity outflow than equity inflow. And the effects on equity net flow are likely to be dominated by the impact of equity outflow. Therefore, a more developed financial market leads to more equity flowing out instead of flowing into the country.

4.3.3 Robustness checks

In addition to previous preliminary findings, it is important to check the consistency of findings. Therefore, in this section, I perform several robustness checks to examine whether previous results are affected by capital resources, early 2000s recession and short-run business cycle movements.

4.3.3.1 Income group

To address the possible influence of capital resources, I differentiate the impact of resources in high- and low-income countries. I define the high-income country as its income per capita is greater than or equal to the world median income. Accordingly, the low-income country is defined as its income per capita is less than the world median income. Thus, the sample is divided into two subsamples, high-income group, and low-income group. Then I re-estimate the effect of financial market development in two groups.

4.3.3.1.1 FDI

I first re-estimate Equation 1 in the high- and low-income subsamples. The results of estimating FDI inflows are represented in Table 4.3. In high-income subsamples, neither of broad money or credit ratio shows a significant effect on FDI inflow, which is similar to the findings in baseline estimation. This implies that financial market development has little impact on FDI inflow in high-income countries. In low-income subsamples, there is no significant effect found in broad money or credit ratio. This suggests that, in low-income countries, financial market development is unlikely to attract FDI capital inboard.

The results of re-estimating Equation 1 on FDI outflows are represented in Table 4.3 Columns (3) and (4). Comparing with the baseline results, broad money becomes significantly and negatively correlated with FDI outflow in the high-income subsample. However, the statistically significant level is relatively low at 10 per cent level. Credit ratio remains significantly correlating with FDI outflow. In the low-income subsample, both broad money and credit ratio become insignificant with FDI outflow. These results suggest that, in high-income countries, financial market development may cause more FDI capital flowing outbound. While in low-income countries, financial market development has little impact on FDI outflow.

Table 4.3 Columns (5) and (6) represents the results of re-estimating equation 1 on FDI net flow. Different from the coefficient in baseline results, the coefficient on broad money becomes positive and statistically significant at the 5 per cent level in the high-income subsample. The significance of coefficient on credit ratio also rises from 10 per cent to 1 per cent. In the low-

income subsample, the coefficients on broad money and credit ratio become insignificant. This implies that financial development has strong effects on FDI net flow in high-income countries rather than in low-income countries.

4.3.3.1.2 Equity portfolio

For the equity portfolio, the results are shown in Table 4.4. In the high-income subsample, both broad money and credit ratio have no significant effects on equity inflow, which is in line with the baseline results. In the low-income subsample, the results are the same as the baseline result, which neither of broad money or credit ratio has a significant correlation with equity inflow. This suggests that financial development has little impact on equity inflow, regardless of the level of capital resources.

The results of re-estimating on equity outflow are shown in Table 4.4 Columns (3) and (4). In the high-income subsample, Both broad money and credit ratio remain their sign and significance level in baseline results. When broad money rises by 1 per cent, equity outflows in high-income countries are likely to decline by 3.1 per cent, which is slightly larger than the effects in baseline results. A 1 per cent increase in credit ratio is associated with a 2.6 increase in high-income countries' equity outflow, which is also slightly larger than the effects in baseline results. In low-income countries, the impact of broad money is relatively larger than it is in high-income countries. The coefficient on credit ratio in low-income subsample is slightly lower than in high-income subsample. Thus, in both low- and high-income countries, financial market development plays a significant role in causing equity outflow. The effects are relatively larger in low-income countries than in high-income countries.

Table 4.4 Columns (5) and (6) show the results of re-estimating Equation 2 on equity net flow. In the high-income subsample, broad money has a positive and significant effect on equity net flow. However, the significance level is relatively low at 10 per cent. Credit ratio remains negatively and significantly correlated with equity net flows. In the low-income subsample, both the value and significant level of the coefficient on broad money increases from the baseline results. The significant level rise from 5 per cent to 1 per cent and the coefficient increases to 0.037. Credit ratio remains the same significance level as in baseline results. This implies that financial development has a significant effect on the equity net flow in both high- and low-income countries. The low-income countries' financial development has a stronger influence on equity net flow.

4.3.3.2 Different periods

I also divide the sample into two subsamples, the year 1980 to 2000 and year 2001 to 2015 and re-estimate the effect of financial market development on capital flows.

4.3.3.2.1 FDI

Table 4.5 shows the FDI flow results. In Column (1), broad money has no significant effect on FDI inflow before 2000. While credit ratio indicates a strong and negative impact on FDI inflow before 2000. A 1 per cent increase in credit ratio is associated with a 5.8 per cent decrease in FDI inflow. In the after-2000 subsample, broad money remains insignificantly correlating with FDI inflow. Credit ratio is also significantly related to FDI inflow; however, its effects become positive. Thus, when the credit ratio increases by 1 per cent, FDI inflow is expected to increase by 3.9 per cent. This implies that financial market development harms FDI inflow before 2000. After 2000, the impact of financial market development becomes positive.

Columns (3) and (4) in Table 4.5 show the results on FDI outflow. In the before-2000 subsample, both broad money and credit ratio have an insignificant effect on FDI outflow. In the post-2000 subsample, broad money indicates a strong and negative impact on FDI outflow. When broad money rises by 1 per cent, the FDI outflow is expected to decline by 4.5 per cent. Credit ratio also has a significant impact on FDI outflow after 2000. A 1 per cent increase in credit ratio is associated with a 9.8 per cent increase in FDI outflow. Therefore, financial market development has a significant effect on FDI outflow after 2000 rather than before 2000.

The results on FDI net flow are presented in Columns (5) and (6). In the before-2000 subsample, both broad money and credit ratio are found significantly and negatively correlating with FDI net flow. In the after-2000 subsample, the coefficient on broad money becomes positive. When broad money increases by 1 per cent, FDI net flow is expected to increase by 4.6 per cent. The coefficient on credit ratio remains negative and statistically significant. Thus, financial market development has a strong impact on FDI net flow in both subsamples. However, the effect of broad money on FDI net flow reverses after 2000.

4.3.3.2.2 Equity

For equity, results are presented in Table 4.6. In Column (1), broad money is positively related to equity inflow, and the coefficient is statistically significant at 1 per cent level. While credit to private sector has no significant impact on equity inflow. In the after-2000 subsample, neither of broad money or credit ratio is significantly correlated with equity inflow. Therefore, financial

market development has a significant effect on equity inflow before 2000. After 2000, equity inflow is unlikely affected by financial market development.

The results on equity outflow are shown in Columns (3) and (4). In the before-2000 subsample, broad money indicates a positive effect on equity outflow and the coefficient is statistically significant at 10 per cent level. Credit ratio has no significant impact on equity outflow before 2000. In the after-2000 subsample, both broad money and credit ratio are significantly correlated with equity outflow. When broad money increases by 1 per cent, equity outflow is expected to decrease by 4.4 per cent. And when the credit ratio rises by 1 per cent, equity outflow will increase by 3.2 per cent. Thus, financial market development has a strong effect on equity outflow after 2000 than before 2000.

Columns (5) and (6) represent the results on equity net flow. In the before-2000 subsample, broad money is positively and significantly correlated with equity net flow. And credit ratio is negatively related to equity net flow at 10 per cent significance level. In the after-2000 subsample, broad money remains its positive and significant effects on equity net flow. Credit ratio continues to have negative effects on equity net flow and the significance level increases to 1 per cent. Thus, financial market development has a significant impact on equity net flow regardless before- or post-2000.

4.3.3.3 Long-run regression

In this section, I take five-year averages of all variables and re-estimate the baseline equations. This method can exclude the effect of short-run business cycle movements, which is one of the concerns on annual frequency regressions.

4.3.3.3.1 FDI

The results of FDI flows are reported in Table 4.7. In Columns (1) to (3), both broad money and credit ratio are insignificantly correlated with FDI inflows. In Columns (4) to (6), broad money has a positive and significant impact on FDI outflow when excluding credit ratio in the regression. Credit to private sector indicates positive effects on FDI outflow at 5 per cent significance level. In column (6), when the credit ratio increases by 1 per cent, the FDI outflow will increase by 3.5 per cent. In Columns (7) to (9), there is no strong correlation found between financial market development proxies and equity net flow. Thus, the financial market development has a strong impact on FDI outflow when excluding the effects of the short-run business cycle.

4.3.3.3.2 Equity

For equity, the results are shown in Table 4.8. In column (1) to (3), both broad money and credit ratio have a significant effect on equity inflow. Broad money has a significant and negative impact. Credit ratio has a slightly negative effect, but it becomes more significant and positive when controlling with broad money. In Columns (4) to (6), broad money dose does not have a significant effect on equity outflow alone. The coefficient becomes significant and negative when controlling with credit ratio in Column (6). In Columns (7) to (8), both broad money and credit ratio have a significant and negative effect on equity net flow. However, in Column (9) when broad money and credit ratio are controlled at the same time, their coefficients become insignificant.

4.4 Endogeneity

One potential concern of the baseline OLS estimation is the possible endogeneity between the financial market variable and the capital flows. Instrumental variable estimations are the most common way to overcome the endogeneity issue. Therefore, in this section, I generate two instrumental variables for broad money and credit ratio to address the possible endogeneity issue.

The instrumental variable is generated as the mean of the previous three-year average of the endogenous variable. For instance, this means that the instrumental variable for broad money at time *t* is the mean of the broad money from period *t-3* to *t-1*. The logic behind this methodology is that the mean of the past three years financial market development degree is highly correlated with the current level. Using the two instrumental variables, I perform two-stage least square (2SLS) regression analysis on FDI capital flows and equity flows. The results are discussed in the following sections.

4.4.1 FDI

The results of 2SLS regression on FDI capital flows are represented in Table 4.9. In Columns (1) to (3), both broad money and credit ratio have found insignificantly correlated with FDI capital inflows. In Columns (4) to (6), again, there is no significant correlation found between the two financial market development proxies and the FDI capital outflow. In Column (7) to (9), neither of broad money or credit ratio is found to have a significant impact on FDI capital net flow.

4.4.2 Equity

Table 4.10 shows the results of equity flows. In Columns (1) to (3), broad money is found to have a significant and negative effect on equity inflow. In Column (3), when broad money rises by 1 per cent, the equity inflow is expected to decline by 2.2 per cent. Credit ratio has no significant correlation with equity inflow in Columns (1) to (3). In Column (4), the coefficient on broad money

is positive and significant at 5 per cent level. In Column (5), credit ratio is positively correlated with equity outflow at 10 per cent significance level. In Column (6), when broad money and credit ratio are controlled simultaneously, both coefficients on broad money and credit ratio become insignificant. In Column (7) to (9), broad money and credit ratio have no significant impact on equity net flow. Such a result is consistent with our baseline OLS estimation results.

4.5 Conclusion

Cross country capital flows have always been studied in current macroeconomic literature. Both economic theory and recent empirical evidence suggest that financial market development has a significant impact on capital flows. This paper examines how the financial market development influence two forms of capital flows: FDI flows and portfolio equity. Using a panel data set on capital inflow, outflow and a net inflow of those two forms of capital flow, I find that a country financial market development does not have a significant impact on capital inflows, while it is positively associated with FDI and equity outflows. A theoretical framework is needed to explain the mechanism, which I leave to future research.

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Appendix A: Data source

Capital inflows and outflows

See data appendix of Alfaro, Laura, Sebnem Kalemli-Ozcan and Vadym Volosovych (2014) for data sources.

Broad money ratio, credit ratio, real interest rate, GDP growth rate, trade openness ratio and capital openness ratio

The World Bank, World Development Indicators (2018)
http://datatopics.worldbank.org/world-development-indicators/

Table 4.1: OLS Regression on FDI Capital Flow/GDP 1980-2015

	Inflow			Outflow			Net flow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	0.012		-0.002	0.014		-0.022*	0.001		0.015
	(0.011)		(0.013)	(0.009)		(0.011)	(0.011)		(0.013)
Credit to Private Sector/GDP		0.015	0.020*		0.040***	0.051***		-0.018**	-0.021*
		(0.009)	(0.011)		(0.007)	(0.009)		(0.009)	(0.011)
Real Interest Rate/GDP	-0.007	-0.009	-0.008	0.005	-0.000	-0.002	-0.019	-0.021*	-0.018
	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)
GDP Growth Rate	15.145***	15.278***	15.613***	-0.337	-0.403	-0.647	13.305***	12.947***	13.265***
	(3.247)	(3.221)	(3.256)	(2.625)	(2.552)	(2.599)	(2.859)	(2.795)	(2.859)
Trade Openness/GDP	0.078***	0.078***	0.079***	0.025***	0.027***	0.030***	0.063***	0.061***	0.062***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Capital Openness/GDP	1.159	0.975	1.060	1.385**	1.044	1.106	1.020	0.959	1.102
	(0.719)	(0.712)	(0.724)	(0.678)	(0.660)	(0.673)	(0.730)	(0.719)	(0.736)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,385	2,495	2,383	1,598	1,709	1,597	2,231	2,341	2,229
No. of Country	135	152	135	113	130	113	133	150	133
R Squared	0.513	0.510	0.514	0.406	0.430	0.419	0.484	0.482	0.485

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.2: OLS Regression on Equity Capital Flow/GDP 1980-2015

	Inflow			Outflow			Net flow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	-0.007		-0.005	-0.009		-0.029***	0.002		0.024**
	(0.005)		(0.006)	(0.009)		(0.011)	(0.010)		(0.012)
Credit to Private Sector/GDP		-0.006	-0.001		0.013**	0.025***		-0.019***	-0.027***
		(0.004)	(0.005)		(0.006)	(0.008)		(0.007)	(0.009)
Real Interest Rate/GDP	-0.006	-0.008	-0.006	0.011	0.007	0.008	-0.019	-0.017	-0.016
	(0.008)	(0.009)	(0.008)	(0.012)	(0.012)	(0.012)	(0.015)	(0.015)	(0.015)
GDP Growth Rate	5.185***	4.928**	5.073***	3.481	4.839**	3.072	-1.436	-2.549	-1.075
	(1.835)	(1.962)	(1.843)	(2.284)	(2.132)	(2.280)	(2.616)	(2.532)	(2.611)
Trade Openness/GDP	-0.013***	-0.010**	-0.013***	0.002	-0.003	0.006	-0.011	-0.005	-0.016*
	(0.004)	(0.004)	(0.004)	(0.007)	(0.006)	(0.007)	(0.008)	(0.007)	(0.008)
Capital Openness/GDP	0.083	0.181	0.079	1.606**	1.354**	1.581**	-1.552**	-1.154*	-1.436**
	(0.375)	(0.395)	(0.377)	(0.629)	(0.586)	(0.627)	(0.700)	(0.679)	(0.699)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1,275	1,380	1,274	1,286	1,397	1,285	1,366	1,477	1,365
No. of Country	101	118	101	109	126	109	111	128	111
R Squared	0.309	0.756	0.310	0.381	0.456	0.387	0.209	0.344	0.215

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.3: OLS Regression on FDI Capital Flow/GDP in income subgroups 1980-2015

	Inflow		Outflow		Net flow	
	(1)	(2)	(3)	(4)	(5)	(6)
	High Income	Low Income	High Income	Low Income	High Income	Low Income
M2/GDP	0.013	-0.005	-0.027*	0.021	0.031**	-0.001
	(0.013)	(0.029)	(0.016)	(0.013)	(0.012)	(0.032)
Credit to Private Sector/GDP	0.017	0.002	0.061***	-0.004	-0.034***	0.008
	(0.011)	(0.026)	(0.013)	(0.010)	(0.010)	(0.028)
Real Interest Rate/GDP	0.031*	-0.034**	0.002	-0.011	0.024	-0.047**
	(0.018)	(0.017)	(0.026)	(0.010)	(0.016)	(0.019)
GDP Growth Rate	8.378*	16.607***	-2.376	0.820	7.228**	17.928***
	(4.618)	(4.599)	(4.037)	(2.124)	(3.096)	(4.988)
Trade Openness/GDP	0.039***	0.112***	0.043***	-0.012*	0.001	0.120***
	(0.009)	(0.010)	(0.011)	(0.007)	(0.008)	(0.011)
Capital Openness/GDP	2.085**	0.429	1.894*	0.111	0.900	1.116
	(0.842)	(1.276)	(1.021)	(0.672)	(0.754)	(1.433)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	1,128	1,245	881	711	1,099	1,120
No. of Country	70	83	63	62	70	81
R Squared	0.552	0.533	0.425	0.344	0.532	0.513

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.4: OLS Regression on Equity Capital Flow /GDP in income subgroups 1980-2015

	Inflow		Outflow		Net flow	
	(1)	(2)	(3)	(4)	(5)	(6)
	High Income	Low Income	High Income	Low Income	High Income	Low Income
M2/GDP	-0.003	-0.001	-0.031**	-0.038***	0.029*	0.037***
	(0.009)	(0.007)	(0.015)	(0.011)	(0.017)	(0.011)
Credit to Private Sector/GDP	-0.003	-0.003	0.026**	0.024***	-0.030**	-0.023***
	(0.007)	(0.006)	(0.011)	(0.008)	(0.012)	(0.009)
Real Interest Rate/GDP	-0.005	-0.001	0.012	0.005	-0.019	-0.010
	(0.013)	(0.006)	(0.022)	(0.006)	(0.025)	(0.008)
GDP Growth Rate	6.372**	1.723	2.467	3.532**	-0.927	-2.405
	(3.211)	(1.179)	(3.399)	(1.456)	(3.963)	(1.641)
Trade Openness/GDP	-0.017**	-0.004	0.010	-0.000	-0.025**	0.003
	(0.007)	(0.003)	(0.011)	(0.004)	(0.013)	(0.005)
Capital Openness/GDP	0.125	-0.151	2.370**	-0.015	-2.225**	0.010
	(0.566)	(0.306)	(0.943)	(0.404)	(1.067)	(0.429)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	719	550	738	545	774	586
No. of Country	53	55	57	61	57	62
R Squared	0.320	0.263	0.369	0.584	0.209	0.483

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.5: OLS Regression on FDI Flow/GDP before- and after-2000

	Inflow		Outflow		Net flow	
	(1)	(2)	(3)	(4)	(5)	(6)
	Before 2000	After 2000	Before 2000	After 2000	Before 2000	After 2000
M2/GDP	-0.030	0.001	0.007	-0.045**	-0.052**	0.046**
	(0.026)	(0.019)	(0.010)	(0.018)	(0.026)	(0.018)
Credit to Private Sector/GDP	-0.058**	0.039**	-0.011	0.098***	-0.048*	-0.050***
	(0.025)	(0.016)	(0.010)	(0.014)	(0.026)	(0.015)
Real Interest Rate/GDP	0.012	-0.022	-0.012	-0.007	0.016	-0.032*
	(0.015)	(0.019)	(0.009)	(0.021)	(0.015)	(0.019)
GDP Growth Rate	7.946*	11.345***	-0.148	-2.012	7.767*	10.112***
	(4.098)	(4.302)	(1.897)	(3.364)	(4.277)	(3.347)
Trade Openness/GDP	0.294***	0.017*	0.011	0.028***	0.301***	-0.004
	(0.011)	(0.009)	(0.009)	(0.010)	(0.012)	(0.009)
Capital Openness/GDP	1.739*	2.220*	-0.009	2.512**	3.000***	0.195
	(1.031)	(1.283)	(0.463)	(1.221)	(1.093)	(1.229)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	738	1,645	398	1,199	667	1,562
No. of Country	107	131	66	108	104	128
R Squared	0.787	0.508	0.709	0.437	0.799	0.493

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.6: OLS Regression on Equity Flow/GDP before- and after-2000

	Inflow		Outflow		Net flow	
	(1)	(2)	(3)	(4)	(5)	(6)
	Before 2000	After 2000	Before 2000	After 2000	Before 2000	After 2000
M2/GDP	0.091***	-0.005	0.038*	-0.044***	0.059***	0.039**
	(0.025)	(0.009)	(0.023)	(0.015)	(0.019)	(0.018)
Credit to Private Sector/GDP	-0.018	-0.006	-0.005	0.032***	-0.027*	-0.039***
	(0.019)	(0.006)	(0.023)	(0.011)	(0.016)	(0.013)
Real Interest Rate/GDP	0.011	-0.011	0.014	0.004	-0.012	-0.014
	(0.020)	(0.010)	(0.016)	(0.016)	(0.015)	(0.020)
GDP Growth Rate	16.161***	2.784	7.278	1.771	7.381**	-1.054
	(4.183)	(2.156)	(4.453)	(2.632)	(3.297)	(3.108)
Trade Openness/GDP	-0.034	-0.002	0.016	0.001	-0.039**	-0.001
	(0.024)	(0.005)	(0.023)	(0.009)	(0.019)	(0.010)
Capital Openness/GDP	-0.397	-0.043	0.313	2.205**	-0.801	-1.898*
	(0.995)	(0.570)	(0.885)	(0.990)	(0.732)	(1.137)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	282	992	240	1,045	277	1,088
No. of Country	52	97	46	107	55	107
R Squared	0.526	0.289	0.599	0.401	0.653	0.227

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.7 OLS Regression on FDI Capital Flow/GDP 1980-2015 - 5 Years Average

	Inflow			Outflow			Netflow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	-0.003		-0.011	0.030**		0.006	-0.025		-0.013
	(0.020)		(0.024)	(0.014)		(0.016)	(0.023)		(0.028)
Credit to Private		-0.001	0.011		0.035***	0.035***		-0.029	-0.017
Sector/GDP		(0.016)	(0.020)		(0.010)	(0.012)		(0.018)	(0.023)
Real Interest	-0.008	-0.008	-0.007	0.031	0.023	0.021	-0.044	-0.043	-0.043
Rate/GDP	(0.014)	(0.014)	(0.014)	(0.031)	(0.031)	(0.031)	(0.035)	(0.035)	(0.035)
GDP Growth Rate	25.460***	25.941***	25.287***	-1.462	-2.632	-1.962	32.106***	33.454***	32.332***
	(6.936)	(6.708)	(6.950)	(4.709)	(4.556)	(4.654)	(8.065)	(7.778)	(8.076)
Trade	0.112***	0.110***	0.113***	0.029***	0.036***	0.034***	0.085***	0.079***	0.083***
Openness/GDP	(0.013)	(0.012)	(0.013)	(0.010)	(0.009)	(0.010)	(0.015)	(0.014)	(0.015)
Capital	0.564	0.496	0.522	0.945	0.511	0.722	0.515	0.629	0.567
Openness/GDP									
	(1.353)	(1.319)	(1.357)	(1.003)	(0.962)	(0.994)	(1.586)	(1.535)	(1.589)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	543	572	543	391	420	391	529	558	529
No. of Counry	137	153	137	116	132	116	135	151	135
R Squred	0.721	0.722	0.721	0.672	0.716	0.682	0.668	0.671	0.668

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.8 OLS Regression on Equity Capital Flow/GDP 1980-2015 - 5 Years Average

	Inflow			Outflow			Netflow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	-0.017***		-0.029***	-0.012		-0.046***	-0.020**		-0.011
	(0.006)		(0.007)	(0.009)		(0.011)	(0.009)		(0.012)
Credit to Private		-0.011*	0.014**		0.013**	0.038***		-0.023***	-0.011
Sector/GDP		(0.006)	(0.005)		(0.006)	(0.008)		(0.007)	(0.008)
Real Interest	0.001	0.002	0.002	-0.003	-0.010	-0.013	-0.014	-0.009	-0.011
Rate/GDP	(0.003)	(0.005)	(0.003)	(0.018)	(0.019)	(0.017)	(0.021)	(0.022)	(0.021)
GDP Growth Rate	5.361	12.444**	6.261*	-0.942	1.670	-2.184	-0.452	1.491	-0.222
	(3.305)	(4.899)	(3.281)	(2.760)	(2.788)	(2.624)	(3.073)	(3.123)	(3.072)
Trade	-0.013***	-0.016**	-0.009*	-0.015*	-0.018**	-0.009	-0.012	-0.015**	-0.016*
Openness/GDP	(0.005)	(0.006)	(0.005)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
Capital	0.384	0.686	0.333	1.039*	1.252**	1.085*	-0.895	-0.726	-0.839
Openness/GDP									
	(0.449)	(0.645)	(0.444)	(0.630)	(0.629)	(0.596)	(0.689)	(0.690)	(0.689)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	316	344	316	326	355	326	351	380	351
No. of Counry	105	121	105	109	125	109	114	130	114
R Squred	0.734	0.920	0.742	0.704	0.783	0.736	0.599	0.809	0.602

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.9 2SLS Regression on FDI Capital Flow/GDP 1980-2015

	Inflow			Outflow			Net flow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	-0.002		-0.002	-0.002		-0.012	-0.011		-0.020
	(0.013)		(0.016)	(0.011)		(0.014)	(0.013)		(0.016)
Credit to Private		-0.005	-0.000		0.010	0.014		0.000	0.014
Sector/GDP		(0.011)	(0.014)		(0.009)	(0.012)		(0.011)	(0.014)
Real Interest	-0.009	-0.010	-0.009	-0.007	-0.011	-0.009	-0.021*	-0.024*	-0.022*
Rate/GDP	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)	(0.014)	(0.012)	(0.012)	(0.013)
GDP Growth Rate	14.163***	13.839***	14.241***	0.863	2.195	0.743	12.178***	13.223***	12.261***
	(3.178)	(3.173)	(3.198)	(2.562)	(2.535)	(2.588)	(2.796)	(2.727)	(2.805)
Trade Openness/GDP	0.082***	0.082***	0.082***	-0.027***	-0.030***	-0.025***	0.067***	0.063***	0.068***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Capital Openness/GDP	1.294*	1.187*	1.288*	-1.401**	-1.449**	-1.476**	1.196*	1.047	1.117
	(0.700)	(0.704)	(0.709)	(0.658)	(0.669)	(0.667)	(0.709)	(0.708)	(0.719)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,344	2,406	2,338	1,572	1,635	1,567	2,195	2,257	2,189
R Squred	0.515	0.516	0.515	0.409	0.413	0.401	0.486	0.491	0.484
Wald F Statistic	4268.818	3723.924	1430.447	2506.628	2334.253	955.802	3846.890	3525.816	1349.259

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Table 4.10 2SLS Regression on Equity Capital Flow/GDP 1980-2015

	Inflow			Outflow			Net flow		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
M2/GDP	-0.017***		-0.022***	0.023**		0.017	0.003		-0.007
	(0.006)		(0.008)	(0.011)		(0.014)	(0.012)		(0.016)
Credit to Private		-0.004	0.007		0.014*	0.007		0.009	0.013
Sector/GDP		(0.005)	(0.006)		(0.008)	(0.010)		(0.009)	(0.012)
Real Interest	-0.004	-0.007	-0.005	-0.012	-0.013	-0.013	-0.019	-0.021	-0.022
Rate/GDP	(0.008)	(0.008)	(0.008)	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)	(0.015)
GDP Growth Rate	4.709***	4.958***	4.754***	-2.585	-3.608*	-2.732	-1.465	-1.430	-1.777
	(1.793)	(1.803)	(1.810)	(2.226)	(2.086)	(2.248)	(2.550)	(2.415)	(2.575)
Trade Openness/GDP	-0.009**	-0.015***	-0.008*	-0.006	0.000	-0.005	-0.010	-0.010	-0.008
	(0.004)	(0.004)	(0.005)	(0.007)	(0.006)	(0.007)	(0.008)	(0.007)	(0.009)
Capital Openness/GDP	0.162	0.121	0.133	-1.623***	-1.631***	-1.640***	-1.522**	-1.578**	-1.577**
	(0.367)	(0.369)	(0.369)	(0.608)	(0.593)	(0.612)	(0.677)	(0.667)	(0.683)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1,249	1,307	1,245	1,265	1,328	1,261	1,343	1,407	1,339
R Squred	0.307	0.571	0.307	0.381	0.416	0.377	0.208	0.227	0.202
Wald F Statistic	1708.886	1592.391	589.221	1510.108	1719.724	625.393	1731.067	1909.157	662.846

Standard errors in parentheses,
***p<0.01, **p<0.05, *p<0.01

Chapter 5

Conclusion

Economic development has been in the centre of discussion in the literature for a long time. Sustained economic growth is critical for both developed and developing countries since it is one of the most critical factors of living standards. This thesis focuses on technology innovation, current account fluctuation and capital flows which have significant impacts on economic development.

This thesis makes several contributions to the current literature. Chapter 2 and 3 use historical datasets to explore long-term impacts on technology innovation and current account fluctuation. Chapter 4 uses short-term data on capital flows to test single effect from financial market development on capital inflows and outflows, which have not been well discussed in the literature.

5.1 Summary of findings

Chapter 2 explores the economic growth of the technology channel. Tariff is usually considered as a barrier for trade, therefore dampens economic growth. However, from a different point of view, tariff raises the trade costs and encourages foreign firms to avoid such trade cost by transferring their production to the exporting countries. Though the production, there is a very high chance for technology spillover by employee or supply chain. This would stimulate technology innovation and thus boost economic growth. The estimation of chapter 2 starts from a theoretical model which shows that the exporting firm has a greater incentive to establish a foreign subsidiary for production when the tariff of exporting country increases. The number of non-resident patent increases as the exporting firm would apply for a patent to protect their innovation. Then I use a historical dataset contains data on tariff and patent for 21 OECD countries. Using this historical dataset, I first estimate the relationship between tariff and non-resident patent. The estimation results indicated a strong correlation between tariff and non-resident patent. When tariff rises by 10 per cent, the non-resident patent will increase by 13.5 per cent. This suggests that tariff has a positive effect on economic growth through innovations. Secondly, I estimate how patents applied by foreigners will affect the patents applied by domestic residents. I find that the non-resident patent has a strong and positive effect on the resident patent. With 10 per cent increase on non-resident patent, the resident patent will increase by 5.5 per cent. This implies a possible spillover effect of international technology diffusion.

Chapter 3 focuses on the demographic determinants of current account fluctuation. In recent years, many countries have experienced a more extended period of current account deficit. While at

the same time, there were significant demographic changes in many countries. This raises the question of whether there is a relationship between demographic changes and current account fluctuation. Though the demographic determinants have been discussed in literature; there are few studies on the long-term effect. Therefore, in chapter 2, I use a long-term data on demographic variables and current account of 145 years and 21 OECD countries. As in the standard literature, the current account is defined as the difference between saving and investment. Therefore, the demographic variables I chose are dependency ration, life expectancy, fertility rate and population growth which are closely related to saving. The empirical estimation starts with testing the effect of dependency ration on the current account. The estimation results show that a higher dependency ratio is associated with a lower current account. When dependency ratio increases by 1 per cent, the current account to GDP ratio will decrease by 0.3 per cent. Additionally, I separate young and old dependency ratio and find that old dependency ratio has a positive effect on the current account, while young dependency ratio has a negative effect. Then I estimate the second demographic variable, life expectancy. The estimation results show that there is a strong and positive correlation between life expectancy and current account. The third demographic variable I estimate is the fertility rate. I find that the fertility rate has a significant and negative effect on the current account. The last demographic variable I estimate is population growth. The estimation results show that population growth is significantly and negatively associated with the current account.

Chapter 4 discusses the relationship between capital flows and financial market development. There are extensive studies on capital flows in the current literature. However, most of them focus on the aggregate capital flows and there are few studies study the capital inflows and outflows separately. Therefore, chapter 3 aims to fill this gap in the current literature. I focus on the role of financial market development in two types of capital inflows and outflows: FDI and portfolio equity. I use the most commonly used proxies for financial market development: the ratio of credit ratio to GDP and broad money as a percentage of GDP. The dataset I use including capital flows and financial data on 217 countries from 1980 to 2015. I first estimate how financial market development affects FDI. The estimation results show a significant and positive correlation between financial development and FDI outflows. While there is no strong relationship found between FDI inflow and financial market development. Then I estimate how financial market development affects portfolio equity flows. I find that financial market development has a significant impact on equity outflows rather than equity inflows. Together with the results on FDI, the financial market development is more likely to have a stronger impact on capital outflows rather than inflows. In other words, a country with a high level of financial market development is more likely to encourage more capital outflows and attracts fewer capital inflows.

5.2 Considerations for future research

This thesis has discussed the international and development economics from three different aspects. There are also some important issues that remain to be investigated. To further extend the chapter 2 on tariff and innovation, it is worth to consider using industry-level data. Such a method allows examining the different effects across various industries and a more detailed investigation of the technology spillovers. A meaningful extension to chapter 3 would be to identify how demographic determinants affect current account. This would provide an explicit understanding of the relationship between demographic variables and the current account. Chapter 3 provides empirical evidence on the effects of financial market development on capital inflows and outflows while it is worth to develop a theoretical framework to provide background support for the empirical evidence.