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The Effects of East Asian Free Trade Agreements on Foreign Direct Investment

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Abstract

The proliferation of Free Trade Agreements (FTAs) in East Asia has triggered extensive studies about the economic effects of FTAs. With trade and welfare effects as the focuses of many studies, the Foreign Direct Investment (FDI) effect has attracted relatively less attention. Given that attracting FDI is a common goal of FTAs, it is important to fill this gap. This thesis fills the gap by assessing the FDI effects of ASEAN-China Free Trade Agreement (ACFTA) through econometric models and by simulating the FDI effect of Regional Comprehensive Economic Partnership (RCEP) through a Computable General Equilibrium (CGE) model.

I summarized three effects of Free Trade Agreements (FTAs) on FDI from the literature regarding theoretical links between trade liberalization and FDI. First is the vertical fragmentation effect. Reduction in trade costs of intermediate goods increases the incentive for multinationals to split production processes into different countries to take advantage of favorable conditions in each. Thus, vertical FDI would increase after FTA. Second is the market expansion effect. The preferential access to partner countries expands the domestic market to partners', increasing the attractiveness of member countries to market-seeking FDI. Third is the plant rationalization effect. Reduction in trade costs encourages firms to choose trade rather than FDI to supply partners' markets. Thus, trade substitution may decrease FDI.

ACFTA is the first important free trade agreement for China and a significant development in East Asian integration. The study of ACFTA has two steps. First, I adopted an econometric model to examine the overall FDI effect of ACFTA. The model is based on the knowledge-capital theory of FDI and captures third country effects, which enables it to explain not only horizontal and vertical FDI, but also complex FDI such as export platform and complex vertical FDI. The model has been found to suit FDI study in East Asia. ACFTA shows a positive and significant FDI-promoting impact, indicating that the market expansion and vertical fragmentation effects dominate the FDI-decreasing effect of plant rationalization.

I then conducted a more detailed study about ACFTA, aiming to explore the mechanism of how the agreement positively affected FDI. The target of this study is to detect the two FDI-promoting effects (the market expansion and vertical fragmentation effects) of ACFTA. This is the first time to examine these individual effects of an FTA and there is no existing methodology. Innovatively, I adopted an FDI industry model to test different effects of ACFTA on various industry sectors. The approach is adopted based on the two effects' definitions. The definition of vertical fragmentation effect suggests that it would mainly affect pro-fragmentation sectors, while the definition of market expansion effect indicates that it would mainly affect export-increasing sectors. The FDI effects of ACFTA on these sectors reflect the two corresponding effects. These sectors are identified through analyses of total trade, and trade in intermediate goods. The FDI industry model shows that both the market expansion and vertical fragmentation effects exist in ACFTA, with the latter a little stronger on China.

The effects of ACFTA mainly come from trade liberalization in goods but not services. Given the big share of services in FDI, it is important to include services liberalization in assessing the effects of FTAs on FDI. With this target, I developed a CGE model to simulate the potential effect of RCEP, which is expected to include liberalization of services trade. The CGE model utilizes the firm heterogeneity framework in analyzing FDI effects. The model incorporates FDI by sourcing capital to home region and differentiating firms by ownership. Given the importance of services to FDI, the model carefully deals with services barriers. Based on empirical evidence, the services barriers are modeled as tax equivalents that raise costs to imports and generate rents to incumbent firms. Simulation results show that RCEP can promote FDI to China, and services dominate the FDI increase. Specifically, comprehensive liberalization on trade in goods and services with a more than 50% reduction in services barriers in China can promote FDI flow to China by US$2.8 billion and increase its welfare by US96 billion. If RCEP can help member countries to improve their business environments so as to reduce fixed trading costs, the gains of China in FDI and welfare would be even bigger.

In summary, this thesis examines the FDI effects of ACFTA through econometric studies and experiments with RCEP through a CGE model. Both ACFTA and RCEP are found to

promote FDI to member countries. While the econometric finding of ACFTA suggests a significant FDI effect of goods trade liberalization, the CGE simulation results of RCEP show that the effect of services liberalization is much stronger.

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Chapter 1 Introduction

The proliferation of free trade agreements (FTAs) in East Asia has triggered intense research interests in assessing the economic effects of FTAs in this area. Within these studies, trade and welfare effects have attracted the most attention.[1] Very few studies focus on the foreign direct investment (FDI) effect. However, many FTAs aim not only to facilitate bilateral trade, but also to increase the attractiveness of member countries to FDI. Analyzing the FDI impact can help to assess the achievements of FTAs. In addition, the study is of significance for countries that are keen to attract FDI as its finding reveals whether FTAs in study are efficient tools to increase FDI. To enrich the FDI studies, this thesis analyzes the FDI impacts of two FTAs involving China and Association of East Asian Nations (ASEAN), with a particular interest in China.

One FTA is the ASEAN-China Free Trade Agreement (ACFTA), which took effect in 2005.[2] The data period after ACFTA is long enough to support econometric analyses. In this thesis, I adopt two econometric models to study the overall effect and industry effects of ACFTA respectively. Another research target is the Regional Comprehensive Economic Partnership (RCEP), the negotiation of which started in 2013 with planned conclusions in 2015. This study adopts a Computable General Equilibrium (CGE) model to simulate the potential FDI impacts of RCEP on China.

1.1. The FDI Study of ACFTA

ACFTA has been chosen as one of the research targets in this thesis because it is the first important FTA for China and a significant development in East Asian economic integration (Cai, 2003). ACFTA forms the third-largest economic group in the world, after the EU and North American FTA (NAFTA). The free trade area has 1.85 billion people and covers an area of 14 million square kilometers. In 2012, the total GDP of China and ASEAN was US$10.71 trillion, accounting for 15% of the world economy.

[1] See, for example, Aitken (1973), Clausing (2001), Soloaga and Alan Wintersb (2001), Baier and Bergstrand (2007), Baier and Bergstrand (2009), Kitwiwattanachai (2008) and Jeong-Soo and Kyophilavong (2013). These studies have examined the effects of various formats of economic integration such as FTA and Preferential Trade Agreement (PTA).

[2] ACFTA in this thesis represents the abbreviation of both the ASEAN-China Free Trade Agreement and the ASEAN-China Free Trade Area.

Between 2002 and 2012, the annual growth rate of China was 10.78%, and 5.34% for ASEAN. With these rapid growth rates, ACFTA becomes increasingly important in the world economy.

ACFTA is a South-South FTA, which distinguishes itself from the EU and NAFTA. As developing countries, the members of ACFTA are keen to attract FDI. The rapid growth of these economies generates great demand for capital. In this regard, foreign capital is an important complement to the relatively scarce domestic capital. In addition, FDI usually brings advanced technology, management skills and other positive spill-overs that the developing countries are generally short of and eager to acquire. These factors should explain that one of ACFTA's targets is to increase the attractiveness of its member countries to foreign investment. The importance of FDI to the economies of ACFTA members makes this study of great significance.

Theoretical analyses about the correlations between FTA and FDI point out three effects of FTA, namely, the vertical fragmentation, market expansion and plant rationalization effect.[3] The vertical fragmentation effect is a response to tariff cuts on intermediate goods. The establishment of FTA enables multinationals (MNCs) to reduce production costs by splitting their production process into several member countries according to the comparative advantages of each. The market expansion effect strengthens the attractiveness of member countries to FDI, which aims for big markets. The plant rationalization effect means that MNCs rationalize production plants in fewer locations as the source of output, and supply other markets by exporting, thereby gaining economies of scale. The definitions indicate that the first two effects are FDI-promoting, while the last one is FDI-decreasing. Each of the three effects is addressed in this thesis.

In the study of ACFTA, I first examine its overall effect on FDI flow to China and ASEAN6 and then explore the individual effects of ACFTA on China. The overall effect of ACFTA is investigated through an econometric model developed by Baltagi, Egger, and Pfaffermayr (2007) and extended by Dee (2006). The model is grounded in the knowledge-capital model of Markusen (2002) and captures third country effects.

[3] The three effects are summarized from the literature, and the terms for these effects are created by the author.

The knowledge-capital model explains horizontal and vertical FDI, while the capture of third country effects aims to explain more complex FDI that involves third countries, including export platform and complex vertical FDI. The model has been found to suit FDI study, particularly for East Asia because third country effects can explain the effect of East Asian advanced production networks.

The model finds that ACFTA has a significantly positive effect on FDI flow to China and ASEAN6 since 2005, the year of the first agreement's (the agreement on trade in goods) entry into force. When the second agreement (the agreement on trade in services) took effect in 2007, the joint effect of the two agreements has not shown significant difference from that of the 2005 agreement. That finding corresponds to a review result of Cornish and Findlay (2011) that the services liberalization under ACFTA is very limited. Thus, I draw a conclusion that the positive FDI effect of ACFTA mainly come from the liberalization on trade in goods.

The positive correlation between ACFTA and FDI suggests that forming FTA might be an efficient way to attract FDI. Given that East Asian countries are keen to attract FDI, it is worthwhile to explore the mechanism of how ACFTA promotes FDI. Do both of the two FDI-promoting effects (the market expansion and vertical fragmentation effects) exist or only one of them? And what is the magnitude of each effect? These questions are answered through a detailed study of the two effects. The FDI-decreasing plant rationalization effect is left out since the finding of a positive correlation between ACFTA and FDI indicates this effect is not significant. This is the first time to study the individual effects of FTA on FDI.

I investigate the two FDI-promoting effects through an FDI industry model. The FDI industry model can detect the two effects through examining the industry impacts of ACFTA. This relies on a reasoning that the trade agreement impacts on different sectors through different effects. Specifically, the vertical fragmentation effect would mainly affect the pro-fragmentation sectors, that is, sectors where it is easy to split production processes among different countries. The market expansion effect would mainly affect export-increasing sectors, that is, sectors which have expand exports to partners' markets after trade liberalization. Due to the availability of sectoral FDI data in China that are sufficient to conduct analyses, this study focuses on China only.

In this study, I first examine trade data to find the pro-fragmentation and export-increasing sectors. Trade in intermediate goods is an indicator of production fragmentation, and thus can be used to find the pro-fragmentation sectors (Ando & Kimura, 2005). A study of trade in intermediate goods between China and ASEAN suggests that the pro-fragmentation sectors concentrate in machinery and electrical goods. A close examination of trade in intermediate goods shows a switch in the bilateral trade from goods that used to be traded freely to goods that used to be blocked. That should be a clear reflection of the trade effect of ACFTA. A study of total trade finds that textile, metal products, furniture and toys show significant export increases, which is disproportionately larger than the increases in other sectors. They are the most significant export-increasing sectors. Results from trade studies display a clear-cut separation between export-increasing and pro-fragmentation sectors, which makes it easy to isolate the market expansion and vertical fragmentation effects.

The FDI industry model finds both of the market expansion and vertical fragmentation effects of ACFTA, suggesting that the positive FDI effect on China comes from the preferential access to the ASEAN market and the facilitation of production fragmentation. A policy implication from this result is that countries could attract FDI through building FTAs with big markets or markets in the same production value chain. Another inference from the econometric result is that the market expansion effect is less strong than the vertical fragmentation effect, which reflects the relatively small market size of ASEAN. Apart from the finding of the two effects, a further contribution of this study is to show how the FDI industry model based on Caves (1974) can be applied to the analysis of industrial FDI in China.

1.2. The FDI study of RCEP

The positive effect of ACFTA mainly comes from the liberalization on trade in goods. However, services liberalization should have a much more straightforward effect on FDI due to the overlap of services trade and FDI. According to Stephenson (2014), FDI in services sectors constitutes fully two-thirds of the inward stock of FDI. Since FDI is a principal modality of services liberalizing, services liberalization could almost be equivalent to FDI liberalization. The importance of services liberalization to FDI,

together with increasing interests in reducing services barriers, motivates the FDI study of RCEP.

RCEP is region-wide trade liberalization initiative being negotiated among ASEAN and its 6 dialogue partners (China, Japan, Korea, India, Australia and New Zealand). China is the country of interest in this study. The guiding principles and objectives for negotiating RCEP state that it will be a high-quality FTA covering trade in goods, services and other issues. The coverage and possible deep liberalization of services trade make RCEP an ideal research target.

I develop a CGE model (FHFDI) to simulate the possible FDI changes in China after RCEP. The FHFDI model is built on Zhai (2008) and follows its assumptions of no sunk costs, no free entry and exit of firms, as well as the calibration of fixed trading costs. The fact that the model is based on assumptions about, and abstractions from, the real economy highlights the importance of interpreting simulation results as experimental results than predictions.

The main contribution of the FHFDI model is to incorporate FDI into a firm heterogeneity framework. In theory, FDI has already been introduced into the firm heterogeneity model (Helpman, Melitz, & Yeaple, 2004). The introduction of FDI extends the Melitz model from a selection of exporters and non-exporters to a further selection of exporters and MNCs among firms supplying foreign markets. MNCs are more productive than exporters because they face extra costs apart from those faced by exporters. In the FHFDI model, I treat MNCs as the most productive firms in both home and host regions. In the host region, the foreign affiliates of MNCs are more productive than domestic firms as a result of high costs faced by MNCs in operating away from their home region.

Thus, separating FDI from domestic capital and separating foreign firms from domestic firms are the main extensions of the FHFDI model to the Zhai model. The FHFDI model captures export platform FDI by allowing foreign firms to export. Foreign firms could export to third markets and the home market, but the fixed costs to enter export markets (including home market) are higher than those to enter the local market. More productive foreign firms can enter export markets and less productive ones can only supply the local market, the same as for domestic firms. Reduction in trade costs would

promote exports of foreign firms to the partner regions, driving up FDI demand of exporters. That corresponds to the market expansion effect. On the other hand, trade liberalization intensifies competition from imports and brings in trade as a substitute for FDI, and thus weeds out the least productive foreign firms and reduces FDI demand of non-exporters. That corresponds to the plant rationalization effect.

Another extension of the FHFDI model from the Zhai model is to include Non-Tariff Barriers (NTBs), including services barriers. NTBs in goods and transportation sectors are modelled as tax equivalents that raise costs to imports, while NTBs in other services sectors, or services barriers, are modelled as tax equivalents that not only raise costs to imports, but also generate rents to incumbent firms due to the monopoly power associated with trade protection. The rent-creating effect is specific to services barriers, which is based on empirical measurements about the price impacts of trade restraints in banking and telecommunication (Dee & Hanslow, 2000; Konan & Maskus, 2006).

In addition, the FHFDI model has added a capital allocation block. The capital endowment is allocated among sectors, regions and firms according to a hierarchal structure. Last but not least, I construct a Social Accounting Matrix (SAM) based on the GTAP 8 Database and two FDI databases. A global FDI stock database helps to separate FDI from total capital and a global foreign affiliate sales database helps to separate the outputs of foreign firms from total outputs.

The CGE model, together with data, is run in GAMS (General Algebraic Modelling System) by using a CONOPT Solver. Simulation results show that China can gain FDI and welfare from RCEP. Comprehensive liberalization on trade in goods and services with a more than 50% reduction in services barriers in China can promote FDI flow to China by US$2.8 billion and increase its welfare by US96 billion. If RCEP can help member countries to improve their business environments so as to reduce fixed trading costs, then the gains of China in FDI and welfare would be even bigger. Services are found to dominate the total FDI increase, corresponding to the importance of services liberalization to FDI. In addition, the FHFDI model finds market expansion and plant rationalization effects for RCEP.

Overall, the study of RCEP complements the studies of ACFTA in several ways. First, the CGE analysis corresponds to the third market effect in the econometric model of

Baltagi et al. (2007). According to Baltagi et al. (2007), third markets affect bilateral FDI due to their weight in world-wide demand or supply, and their general equilibrium effects on product and factor prices. It is hard for an econometric model to control all third country effects, but the CGE study can fully capture third market effects through a general equilibrium model. Second, the RCEP study covers the effect of services liberalization that has not been a main achievement of ACFTA. It turns out that services liberalization affects FDI in a dramatic way. The studies of RCEP and ACFTA together provide a comprehensive analysis about the effects of FTA on FDI. Finally, the study of RCEP finds the plant rationalization effect, which has been left out in the ACFTA study. Thus, the empirical studies have demonstrated the existence of all three FDI effects of FTA.

1.3. Thesis Outline

The thesis is divided into 6 chapters. Chapter 1 provides an overview about the study. Chapter 2 reviews the literature on East Asian regionalism, as well as theoretical and empirical studies about FTA and FDI. Within the literature review of empirical studies, this chapter reviews econometric and CGE researches separately. Chapter 3 introduces ACFTA and FDI trends in this area, and then examines the overall effect of ACFTA on FDI flow to China and ASEAN6. The individual effects of ACFTA are detected in Chapter 4, with a focus on the market expansion and vertical fragmentation effects. Chapter 5 develops a CGE model to simulate the possible effects of RCEP on FDI in China. Chapter 6 concludes and provides policy implications. The earlier versions of Chapters 4 & 5 were included in published works by the author (Li, 2013, 2014).

Chapter 2 Literature Review

In this chapter, I begin with a selective review of East Asian regionalism, to provide contextual background for the dissertation. This is followed by a review of the literature on impacts of economic integration on FDI. Studies of the correlations between economic integration and FDI can be classified into three groups, theoretical studies, econometric studies and CGE studies. The review is divided into three subsections accordingly. A brief review of FDI theories is included in the subsection on theoretical studies.

2.1. Evolution of East Asian Regionalism

This dissertation focuses on two agreements that fit within the broader process of regional economic integration that has been described as East Asian regionalism. The evolution of East Asian regionalism over the past fifteen years can be divided into three partly overlapping stages. The first stage consists of a proliferation of bilateral agreements. The second stage involves the creation of a series of five ASEAN-centred ASEAN+1 FTAs. Implementation of the two most economically important ASEAN+1 FTAs — ACFTA and the ASEAN-Japan Comprehensive Economic Partnership (AJCEP) — began in earnest in 2006. The third stage, now under way, involves negotiation to establish a region-wide agreement, the Regional Comprehensive Economic Partnership (RCEP). The RCEP can be regarded as the successor to earlier proposals to establish a region-wide agreement based on the ASEAN+3 group (the East Asia Free Trade Agreement) or the ASEAN+6 group (the Comprehensive Economic Partnership in East Asia (CEPEA)).

Parallel to these developments, ASEAN has been pursuing its own integration. This began much earlier with the ASEAN Free Trade Agreement (AFTA), which entered into force in 1993, and has since been substantially widened and deepened, and more recently re-named as the ASEAN Trade in Goods Agreement (ATIGA). ASEAN is now engaged in an initiative to create an ASEAN Economic Community (AEC), an integrated market within ASEAN, by 2015.

The two agreements that are the subjects of this dissertation are the ACFTA and the RCEP. A selection of the empirical literature relevant to these two agreements is briefly reviewed here.

The effects of ACFTA have been examined through both econometric and CGE models. Yang and Martinez-Zarzoso (2014) assess the trade effect of ACFTA by using a gravity model. The results indicate that ACFTA leads to substantial and significant trade creation. The trade creation effect is significant in both agriculture and manufacturing goods, as well as chemical products and machinery and transport equipment. Lakatos and Walmsley (2012) assess the investment effects and resulting welfare impacts of ACFTA through a CGE model. This paper adapts the dynamic GTAP model to take account of bilateral ownership of investment. Two versions of the model are considered. The first version is an example of applied models of investment demand, while the second is a model of investment supply. The CGE model shows that ACFTA would boost the economies of the liberalizing regions and increase rates of return. As a result, total investment in both ASEAN countries and China would increase. In particular, all countries increase ownership of capital stocks in Viet Nam, Thailand, Philippines and Indonesia. The paper finds clear evidence of investment diversion effects in regions not signatory to ACFTA. Finally, the world as a whole gains welfare from ACFTA and the main beneficiaries are EU27, North America, Malaysia and China.

Two projects conducted by Economic Research Institute for ASEAN and East Asia (ERIA) have considered the ASEAN+1 FTAs as possible building blocks for a region-wide East Asian agreement, which is now being pursued in the form of RCEP. One is reported in Findlay (2011) and the other in Lee and Okabe (2011). The two projects comparatively assess the extent of liberalization achieved by ASEAN+1 FTAs in terms of tariff reduction, services liberalization, trade facilitation, Rules of Origin (ROOs) and investment.

In Chapter 2 of Lee and Okabe (2011), Kuno (2011) constructs a preferential tariff dataset covering 70 signatory-level tariff schedules bound under the five ASEAN+1 FTAs and seven bilateral FTAs concluded by Japan. Based on the conventional liberalization indices by FTA and by country calculated by using this dataset, it was found that the most liberalized ASEAN+1 FTA is the AANZFTA. On average, 94.6%

of tariff lines are liberalized by ASEAN-Australia-New Zealand FTA (AANZFTA). It is followed by ACFTA (92%), ASEAN-Korea FTA (AKFTA) (91.6%) and AJCEP (89.2%). The least liberalized ASEAN+1 FTA is the ASEAN-India FTA (AIFTA) (76.5%).

The average level of liberalization by country indicates that the ASEAN 6 countries except for Indonesia achieved much higher levels of liberalization (more than 90%) under the ASEAN+1 FTA than the CLMV countries.[4]. Among ASEAN's partners, the highest level of liberalization vis-à-vis ASEAN countries has been achieved by Australia and New Zealand (100%), followed by China (94.6%), Korea (92.2%), Japan (86.3%), and India (74.3%). As the agreement of interest, ACFTA has achieved a relatively high level of tariff liberalization among ASEAN+1 FTAs, which is partly attributed to China's liberalization effort.

Services liberalization under ASEAN+1 FTAs is at a lower level than tariff liberalization. Significant barriers to trade and investment in services remain in member countries. Commitments of member countries often appear to be less liberal than actual policy and contain considerable 'water' (Findlay, 2011).

Pellan and Wong (2011) examine trade facilitation provisions in the ASEAN+1 FTAs, which cover a number of behind-the-border issues affecting the free flow of goods, including non-tariff measures such as sanitary and phytosanitary (SPS) measures, standards, technical regulations and conformity assessment procedures. AANZFTA is the one that includes the most comprehensive and substantive set of provisions on trade facilitation among the five ASEAN+1 FTAs. With the exception of AANZFTA, ASEAN+1 FTA provisions on trade facilitation often lack specificity. The provisions are broad and aspirational and do not commit parties to undertake concrete action or to achieve specific targets or goals. All of the ASEAN+1 FTAs call for economic cooperation in the area of customs with the objective of simplifying customs procedures and, to the extent possible, harmonizing such procedures to international standards. Another important area of trade facilitation addressed to varying degrees in a number

[4] The CLMV countries are Cambodia, Laos, Myammar and Viet Nam, which are latecomers to the ASEAN group, with much lower levels of development than the ASEAN-6 (Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand).

of ASEAN+1 FTAs (including ACFTA) is non-tariff barriers (NTBs), including SPS and technical barriers to trade (TBT) measures such as standards, technical regulations and conformity assessment procedures.

E. Medalla and Rosellon (2011) discuss the nature of the Rules of Origin (ROOs) in the ASEAN+1 FTAs. In the various ASEAN+1 FTAs, there are four basic rules used to determine origin: (1) wholly obtained, (2) regional value content (RVC), (3) change in tariff classification (CTC) and (4) specific process rule. For ACFTA, the general rule is RVC (40), that is, at least 40% of value added is obtained from the free trade area. For AIFTA, the general rule is the dual rule, RVC (35) + CTSH (change in tariff sub-heading), which is considered the most restrictive as both rules need to be complied with. The AANZFTA, AJCEP and AKFTA adopt the co-equal rule, RVC (40) or change in tariff heading (CTH). A quantitative assessment of the ROO restrictiveness in ASEAN+1 FTAs shows that AANZFTA has a relatively liberal ROO regime (E. Medalla, 2011).

Investment liberalization is relatively under-developed in the arrangements of the ASEAN+1 FTAs. Thangavelu and Lim (2011) shed light on the challenges of FDI liberalization under ACFTA and AKFTA in their analyses of the restrictiveness of FDI policies in ASEAN countries. By creating the FDI Restrictiveness Index, they find that the FDI commitments listed by the ASEAN countries in both AKFTA and ACFTA reflect relatively high levels of FDI restriction remaining under the agreements. However the levels of FDI restrictions in the indices for AKFTA and ACFTA are still as expected lower than in the base level index, pointing to the observation that the commitments of ASEAN countries in these FTAs do involve some modest liberalization of FDI. The sectoral analysis also reveals that manufacturing tends to have more liberal treatment of FDI as compared to services in both ACFTA and AKFTA. In ACFTA, Cambodia, Malaysia, Singapore and Viet Nam tend to have more liberal FDI provisions as compared to other ASEAN countries. In comparison, China tends to have less FDI restrictiveness as compared to the ASEAN countries.

Negotiations have now been launched to create a larger region-wide agreement based on these ASEAN+1 FTAs. The goal is to achieve wider and deeper integration with lower costs to business. In November 2012, the leaders of the ASEAN+6 countries

agreed to launch negotiations for a new region-wide FTA called RCEP, and negotiations began in May 2013. Fukunaga and Isono (2013) study ASEAN's own FTA and the ASEAN+1 FTAs, and finds that the ASEAN+1 FTAs provide an insufficient level of liberalization, both in tariffs and services trade. The coexistence of five FTAs with different ROOs creates a potential 'noodle-bowl' situation which impedes the effective use of the FTAs. The challenge to 'ASEAN centrality' from the proposed China-Japan-Korea FTA and the Trans-Pacific Partnership (TPP) also motivates ASEAN to promote the RCEP. RCEP negotiations should address those challenges by (a) concluding a comprehensive and high-level RCEP by 2015; (b) setting the target of 95% tariff elimination with a "common concession" approach; (c) introducing the "core non-tariff measures (NTMs)" concept and removing them; (d) allowing coequal rules in the ROOs, setting a general rule of "RVC(40) or CTH" and developing consolidated operational certification procedures: (e) introducing concrete and tangible trade facilitation programs and addressing FTA utilization issues; and (f) liberalizing trade in services at a high level.

In relation to RCEP, a CGE model is applied by Petri, Plummer, and Zhai (2012) to comprehensively assess the potential benefits from RCEP, in comparison to TPP. Their simulation shows that the initial benefits from RCEP are small but over time the benefits rise substantially to US$215 billion. The trade effect of RCEP would again start small, but by 2025 RCEP generates US$574 billion in additional trade. China, Japan and Korea are major beneficiaries.

The results of Petri et al. (2012) are typical of CGE studies about region-wide FTAs in East Asia and the Asia-Pacific in showing that bigger free trade areas deliver more benefits. For instance, China can gain more from economic integration with Japan and Korea than with ASEAN. Among plausible regional trade agreements, region-wide integration, such as the ASEAN+3 FTA (the East Asian FTA) or the ASEAN+6 FTA (CEPEA) that were proposed earlier, or the RCEP now under negotiation, would yield larger gains to East Asia, meanwhile mitigating the harmful noodle bowl effects of different tariffs, ROOs and standards (Martin, Petri, & Yanagishima, 1994; Park, 2008).

2.2. Theoretical Studies about the Impact of FTA on FDI

Theoretical studies about the impact of FTA on FDI cannot bypass the links between trade and FDI. Horizontal FDI substitutes trade between home and host countries, but complements trade between host and third countries. The complex associations result in a mix of positive and negative impacts of FTA on horizontal FDI. On the other hand, vertical FDI only complements with trade, and thus, a positive correlation between FTA and vertical FDI is the common result. This subsection starts with a review of FDI theory and then goes to the theoretical studies about the correlations between FTA and FDI.

2.2.1. FDI Theory

Early stages of FDI theory distinguish between two modes of MNCs. Vertical MNCs are initially proposed by Helpman (1984). In this study, the author points out that vertical MNCs split production process across different countries (including parent) according to their relative factor endowments with an aim to minimize production costs. The split of production process brings about intra-firm trade in intermediate goods. Horizontal MNCs are proposed and systematically analyzed by Markusen (1984) and Markusen and Venables (1998). These papers note that horizontal MNCs often involve a 'public good' that can be incorporated into any number of additional plants without reducing the marginal production of that goods in existing plants. The existence of this 'public good' generates firm-level scale economies. When firm-level scale economies and transport costs are large relative to plant-level scale economies, horizontal FDI tends to substitute trade.

The two FDI modes have been integrated in the 'knowledge capital' model of FDI by Markusen (2002). The 'knowledge capital' refers to the 'public good' above, the existence of which motivates FDI. In the knowledge capital model, horizontal MNCs seek to save on trade costs by serving markets locally rather than trading. This results in higher fixed investment costs than those incurred by exporting national firms. Accordingly, these firms are more likely to come into existence if markets are large (enabling exploitation of economies of scale at the firm level), plant set-up costs are low, and trade costs are high. Thus, horizontal FDI and goods trade are substitutes. In contrast, vertical MNCs engage in trade in intermediate goods between foreign

affiliates and trade in final goods between affiliates and home country. They are more likely to come into existence if the home-to-host country skilled-to-unskilled labor (capital-to-unskilled labor) endowment ratio is high, and both trade costs and foreign fixed plant set-up costs are low (Helpman, 1984; Helpman & Krugman, 1985).

Later studies have extended the knowledge capital model to allow for more 'complex' patterns of trade and investment (Baltagi et al., 2007; Egger, Larch, & Pfaffermayr, 2004; Ekholm, Forslid, & Markusen, 2007; Grossman, Helpman, & Szeidl, 2006; Yeaple, 2003). Of these specifications, the model of Baltagi et al. (2007) is the most promising, because it allows for two-stage production in a three-country framework (Dee, 2006).[5] In this model, four types of 'complex' FDI are possible, depending on the combinations of relative factor endowments, transport costs, and economies of scale. Taking d as the home country, i as the host country and j as the third country, the investment pattern of the home country can be

- Horizontal — Plants in d and i, with exports from d to j
- Export platform (complex horizontal) — plants in d and i, with exports from i to j
- Vertical — plants in i and j, with exports from i to d
- Complex vertical — plants in i and j, with exports from j to d.

Complex vertical FDI differs from vertical FDI in terms of the exporting country of final goods; nonetheless, they could both be explained by the same FDI theory (Helpman, 1984; Helpman & Krugman, 1985). The newly emerging FDI is the export platform FDI. Export platform MNCs aims to take advantage of local resources in i and supply third markets through export (Ekholm et al., 2007). Therefore, export platform FDI complement trade between host and third countries, but substitute trade between home and host countries. Export platform MNCs are more likely come into existence when the host country is an ideal production base due to advantages in production costs or trade costs with third countries.

[5] The working paper of Baltagi et al. (2007) came out earlier than Dee (2006).

2.2.2. The Impact of FTA on FDI

Based on the correlations between trade and FDI, the effects of FTA on different types of FDI have been explained in many different ways in the literature. Horizontal FDI, including export platform FDI, complements as well as substitutes trade. The complex relations with trade indicate that the impact of FTA on horizontal FDI is not clear-cut. In general, there exist a positive impact and a negative impact. The positive impact comes from market enlargement and the negative impact comes from trade substitution. The explanation for the market enlargement impact given by Ethier (1998a) is that the inflows of FDI from non-member countries into the FTA region are likely to go up as they establish a beachhead position in an FTA member country in order to serve the market of other members. The explanation given for the trade substitution impact is that if multinationals are initially operating in member countries to serve the protected local market, then these multinationals may rationalize their network of affiliates after the formation of FTA and as a result, some member countries could lose investment (Adams, Dee, Gali, & McGuire, 2003).

The positive and negative effects of FTA on horizontal FDI have been explored in many studies. In an analysis of the effects of economic integration on oligopolistic multinationals, Motta and Norman (1996) show that by improving market accessibility, economic integration encourages outside firms to invest in the integrated regional bloc. Since economic integration does not change members' country size, the Regional Integration Agreement (RIA) is more likely to generate intra-regional export platform FDI from the external country, leading to increased trade volumes between the integrating countries. [6] Neary (2002) studies the effects of internal tariff reduction inside a single market on inward FDI in a partial equilibrium model, with firms making strategic decisions in choosing between export and FDI to serve their target market.[7] Neary finds that the reduction in internal tariffs and the presence of high external tariffs make tariff-jumping FDI from non-member countries more attractive than exports. But

[6] FTA is a special type of RIA. But in Motta and Norman (1996), RIA performs the same as FTA when FTA could not change members' country sizes but could improve market accessibility.

[7] Although single market is at a higher level of integration than FTA, it is treated as reducing internal tariffs and remaining high tariffs to external firms in Neary (2002), which is similar to the definition of FTA. The additional integration measures of single market beyond FTA have not been captured by this paper. Thus, the results from this paper could be applied to the case of FTA.

the reductions in internal tariffs also reduce the tariff-jumping incentive of internal MNCs establishing more than one plant. Internal MNCs tend to supply the union market through export platform FDI. Neary (2002) also considers the effects of competition from internal firms. Increased imports intensify competition in each member country, which may result in FDI withdrawal.

Buckley, Clegg, Forsans, and Reilly (2001) explore specific FDI motivations in face of regional integration, including import-substituting investment and rationalization investment. The import-substituting investment is similar to tariff-jumping FDI, which would increase after FTA as a response of external firms to the trade diversion effect of FTA. The rationalization investment decreases since it is a response of inside firms to the trade-creating effect of FTA. Heinrich and Denise Eby (2000) examine the impact of preferential trade agreements (PTA) on horizontal FDI from external sources through an industrial organization approach. [8] Their study shows that, at a higher level of initial trade distortion, pre-existing investments may be rationalized, as firms concentrate production in a single plant in the PTA. At a lower level of initial trade distortion, the market expansion effect will bring in FDI. As a result, the degree to which integration spurs additional FDI depends on the level of the initial trade distortion.

Raff (2004) examines the effect of FTA on the location of FDI by considering that governments may adjust their tax policy to compete for FDI. It finds that a free trade agreement may lead to FDI creation or consolidation, but not FDI destruction. For FDI creation to occur, the production costs in home and host countries must be in an intermediate range relative to the production cost in the rest of the world. In particular, they must be sufficiently large so that in the absence of free internal trade, countries individually prefer to rely on imports from the rest of the world, but with FTA, the expanding market effect could justify the relatively high production cost of FDI. Also, the production cost must be low enough that, when markets are integrated, no FDI would be withdrawn. However, if a firm invests in both countries of the potential FTA, then integration will lead to FDI consolidation.

[8] PTA is a trading bloc which gives preferential access to certain products from the member countries by reducing tariffs. PTA is the first stage of economic integration. Because almost any PTA has a goal of becoming an FTA, the line between a PTA and an FTA may be blurred.

In a study of industrial location, Puga and Venables (1997) find that a move towards a free trade area means that imperfectly competitive firms in the integrating countries selling their output to (and importing intermediates from) other member countries face lower trade barriers, as compared to firms outside the free trade area. This raises the profitability of firms located in the liberalising nations, and shifts industry to them. In a hub-and-spoke arrangement, industrial production will shift to the hub, because hub firms can access spoke consumers and intermediate goods producers at a lower cost.

In comparison with horizontal FDI, vertical FDI has a rather clear positive correlation with FTA. Yeyati, Stein, and Daude (2002) state that trade liberalization enables multinationals to operate vertically in an FTA area, stimulating vertical FDI among the relevant partners. Y. Kim (2007) demonstrates that PTA increases intra-bloc vertical FDI flows when the integrating countries show large differences in factor costs. Moreover, when the technology gap is relatively large between the integrating countries, inter-bloc horizontal FDI tends to flow to a country with a higher technology level even though its factor cost is higher.

In sum, different types of FDI relate to FTA in different ways. For vertical FDI, theoretical studies generally agree that it positively correlates with FTA. For horizontal FDI, studies find two opposite impacts. Thus, the overall effect of FTA is an empirical question.

2.3. Econometric Studies about the Impact of FTA on FDI

The empirical literature summarized in Table 1 explores the relationship between preferential trade agreements and FDI through both multi-FTA studies and case studies. Multi-FTA studies take more than one FTA into consideration and try to find a relationship between FTA and FDI. The case studies usually focus on one specific FTA or a few FTAs. In general, both multi-FTA studies and case studies find more positive than negative results.

2.3.1. Multi-FTA Studies

Although it is not easy to draw a definite conclusion from the multi-FTA studies, in general, they come up with more positive than negative results. Adams et al. (2003) develop a Member Liberalization Index from provisions to indicate degree of trade

Table 1 Summary of empirical studies on the impacts of preferential liberalization on FDI

Methodology	Paper	Finding
Multi-FTA studies	Yeyati et al. (2002)	Joining a PTA increases bilateral FDI stocks between members by 27%, while a larger common market affects host's FDI with an elasticity of 0.1.
	Adams et al. (2003)	Six of the nine sample PTAs (including the EU) are investment creating, one investment diverting, and two have no observable impact.
	Lederman, Maloney, and Serven (2005)	The expectation of joining a PTA can increase FDI flows by more than one third, while joining a common market twice as large as the host country can raise FDI flows by 20% or more.
	Jaumotte (2004)	Significant positive effect of the beginning-of-period extended market size on end-of-period FDI stocks.
	Moon (2009)	Vertical FDI is increased by trade liberalization, while horizontal FDI would be substituted with export.
	Park and Park (2008)	Member countries attract more FDI by going through reforms of internal economies after joining FTAs.
Case studies	Lim (2001)	FDI-to-GDP more than doubled in the four-year post-PTA period for Portugal and Spain (EU accession), Brazil (MERCOSUR), and Mexico (NAFTA), and increased by 70% for Argentina (MERCOSUR).
	Lederman et al. (2005)	Similar to Lim (2001) for Spain and Portugal, but no change in FDI inflows for Greece following EU accession. FDI into Mexico increased in the first two years following NAFTA, but leveled off soon afterwards, similar to a stock adjustment experienced by the new EU entrants.
	Pain (1997)	Sharp increase in intra-EU FDI following the implementation of the Single Market Program in 1985.
	Pain and Lansbury (1997)	Similar to Pain (1997) for German investment into the rest of the European Union.
	Dunning (1997)	Both intra- and extra-European Community FDI have been stimulated after the Single Market Program in Europe in 1985.
	Blomström and Kokko (1997)	Intra-bloc FDI into Canada declined following the Canada–USA FTA (CUSFTA), but extra-bloc FDI increased just enough to offset the decrease. In the US, net FDI rose as a result of CUSFTA, but this was achieved through a large increase in FDI from outside CUSFTA. Extra-bloc FDI responded more strongly to the macroeconomic stabilization programs than the early stages of MERCOSUR, but subsequent deeper integration with the establishment of the customs union resulted in significant increases in the US investment position.
	Globerman (2002)	Following CUSFTA and subsequently NAFTA, European FDI to Canada increased much more than FDI from the US.
	Buckley et al. (2001)	FDI from EU to member countries was increased by NAFTA.
	Monge-Naranjo (2002)	Positive effect of NAFTA on US-sourced FDI in Mexico only during the first two to three years of the agreement.
	Waldkirch (2003)	NAFTA has impacted positively on inward FDI in Mexico, which has been large with respect to the partner countries in the agreement – the US and Canada – while investment from elsewhere has been largely unaffected.
	Feils and Rahman (2008)	The establishment of NAFTA increases intra-regional FDI flows. The US increases the most, Canada the second and Mexico does not show significant FDI increase.
	Ismail, Smith, and Kugler (2009)	The EU increased investment in AFTA (ASEAN FTA), more than in other region, from 1995 to 2003.

Source: Medvedev (2012) and authors' summarization.

liberalization of PTAs. By doing so, they identify the separate effects of trade provisions and non-trade provisions. The latter include investment, competition and intellectual property. Results show that non-trade provisions have more significant impact on FDI. In particular, six PTAs have a net investment creation effect, one PTA (AFTA) has a net investment diversion effect and two PTAs have no impact.

The doctoral dissertation of Moon (2009) examines the responses of vertical and horizontal FDI to FTA. Due to the difficulty of obtaining disaggregated FDI data, the author differentiates vertical and horizontal FDI by the characteristics of each type. For instance, vertical FDI usually happens between countries with big differences in factor endowment, while horizontal FDI tends to occur between countries with big market size. By incorporating indicators of these features to different regression functions, this paper finds that vertical FDI increases between countries within the same FTA under the condition that host countries are more open to goods trade and the difference in factor endowments is large. Horizontal FDI sourced from FTA partners decreases after economic integration but FDI from non-FTA members increases. The results are consistent with theoretical expectation. However, without disaggregated data, the method adopted to differentiate vertical and horizontal FDI may be open to question.

Using a gravity model, Yeyati et al. (2002) regress bilateral outward FDI stocks from 20 OECD countries to 60 host countries. It finds that common membership in an FTA with a source country nearly doubles the bilateral stocks of FDI. The increase in market size associated with the formation of RIAs implies important gains for member countries. Balasubramanyam, Sapsford, and Griffiths (2002) also adopt a gravity model to analyze the effect of RIAs on FDI but finds that once one extends the conventional gravity model to encompass not only the 'economic size' of the host country but also that of the investing country, no RIA effects exist.

From another point of view, Park and Park (2008) demonstrate that member countries attract more FDI by going through reforms of internal economies that are triggered by FTA. Ethier (1998c) argues that small "outside" countries need to show multinationals signs of credible commitment to reform in order to compete with similar countries for

inward FDI.[9] Usually, building FTAs with large and 'inside' countries is a signal of reform, which may increase the attractiveness of small countries to multinationals.

2.3.2. Case Studies

In case studies within the literature on regional integration and FDI, EU and NAFTA have drawn the most attention. The EU is at a higher level of economic integration than FTAs, so the studies of its FDI effect may contain more effects. In general, case studies of individual agreements find an increase in FDI following preferential liberalization, as in Spain and Portugal after EU accession, Mexico after NAFTA and Canada after CUSFTA (Canada-US FTA) and NAFTA, and Brazil and Argentina after MERCOSUR.[10] The following session first reviews studies about EU and then NAFTA and ends with a brief review of AFTA.

Dunning (1997) extensively analyses the 1985 European Internal Market Programme (IMP) and inbound FDI, and provides rich observations.[11] Of these findings, the most interesting results suggest that the main dynamic impact of the IMP on FDI flows is through its effects on other variables affecting FDI – and most noticeably market size, income levels, the structure of economic activity and agglomeration economies. IMP has stimulated both extra and intra EC FDI, but the former more than the latter – but not as significantly as have other variables. In addition, the effects of IMP seem to be industry specific and there are some evidence that extra-EC FDI has increased more in sensitive than in non-sensitive sectors since the early 1980s – and equally important – more in these sectors than elsewhere in the developed world. The underlying reason for more FDI increase in sensitive sectors is that these sectors tend to be protected by high trade barriers before IMP, which enable them to retain high rents. The high rents constitute great attractiveness to MNCs.

Pain (1997) and Pain and Lansbury (1997) examine the effects of IMP on intra-EU FDI from UK and Germany respectively. With industry level data, these papers investigate the overall effects and industry effects of IMP. Findings from the two papers are very

[9] The "outside" countries indicate countries that are not WTO members.
[10] MERCOSUR is an economic and political agreement among Argentina, Brazil, Paraguay and Uruguay.
[11] The Internal Market Program seeks to guarantee the free movement of goods, capital, services, and people – the EU's four freedoms – within the European Community (EC) member states. As explained by Dunning (1997), EU now is called European Union (EU). However, as most of the analysis in this article predates the formation of the EU, we shall use the expression EC throughout.

similar. IMP has had a significant, positive impact on the aggregate level of intra-EU investment by German and UK corporations in both industrial and services sectors as a whole. The combined results of these two papers suggest that the IMP raised the intra-EU FDI stock from UK and German firms by some US$27 billion as of 1992, equivalent to 0.5% of EU GDP. The financial services sectors accounts for half of this additional investment. They also find that investment in Europe has been reduced in the chemicals and mechanical engineering sectors, consistent with the hypothesis that the removal of internal barriers to trade could result in production becoming more concentrated. These two papers have inspired my study about the industry impacts of ACFTA on FDI. Their methodology of capturing industry effects has been adopted to investigate the different industry effects of ACFTA in Chapter 4 of this thesis.

Egger and Pfaffermayr (2004) assess the impact of three different events in the EU integration process during the 1990s on bilateral European FDI relations: the Single Market Programme, the 1995 enlargement and the Europe Agreements between the EU and the Central and Eastern European Countries (CEEC). They find positive anticipation effects are common to all three integration steps. The anticipation effects on FDI typically take place between the announcement and the formal establishment of an integration event.

NAFTA is a North-South FTA that was formed in 1992, essentially extending the 1989 CUSFTA. The US is a globally important FDI investor and receiver, so intra-NAFTA investment is as dynamic as the investment from outside sources. Blomström and Kokko (1997) find that North-North agreements like CUSFTA do not cause any radical change in the inward FDI to Canada. However, the North-South NAFTA has created new opportunities for domestic and foreign investors in Mexico as well as in Canada. With respect to the size-of-country hypothesis, Buckley et al. (2001) find some evidence that investment from European countries has been greater than it would otherwise have been, as a result of North American integration. MNCs from UK and Switzerland appear to have upgraded the importance of the US as an investment location as a result of integration.

Waldkirch (2003) investigates whether a developing country can use economic integration with a large developed country as a mean of attracting more FDI, using Mexico as a case study. This paper reveals that NAFTA has impacted positively on

inward FDI in Mexico, which has been large with respect to the partner countries in the agreement – the US and Canada – while investment from elsewhere has been largely unaffected. But for all countries, investors' sensitivity to the determinants of FDI has been changed by NAFTA, which probably explains the FDI increase to Mexico from non-member countries after NAFTA. Feils and Rahman (2008) also demonstrate that the formation of NAFTA increases intra-regional FDI flows, but with a reverse order; that is, the US increases the most, Canada the second, and Mexico does not show significant FDI increase.

The FDI increase in AFTA in the early 1990 has triggered some studies about the FDI impact of AFTA. Using a gravity model, Ismail et al. (2009) demonstrate that the EU increased investment in AFTA, more than in other regions, from 1995 to 2003. Bende-Nabende, Ford, and Slater (2001) find that AFTA has a delayed influence on FDI inflows, which is to the advantage of the more-developed member countries, and to the disadvantage of the less-developed member countries.

The review of econometric studies shows that there has no paper that investigates the impact of ACFTA on FDI. ACFTA is chosen as a case study because ACFTA is distinctly different from other FTAs and is an important regional integration initiative which might be a precursor of more FTAs in East Asia. This gives a distinct motivation for studying its impact on FDI. By studying the effects of ACFTA on FDI, this thesis enriches the empirical literature on the impact of FTAs on FDI, supplementing the existing case studies. In addition, given that empirical studies find more positive impact than negative impact of FTAs, I hypothesis that ACFTA positively correlates with FDI to member countries.

2.4. CGE Studies about FTA and FDI

Apart from econometric models, CGE models are another widely used tool to assess the impacts of economic integration (Kitwiwattanachai, 2008). One difference between CGE models and econometric analysis is that CGE models are usually used to analyse potential or newly-established FTAs while econometric models tend to assess well-established FTAs. Data requirement is one factor that causes the difference between CGE and econometric models. CGE models require a base year dataset that covers all economic sectors, while econometric models usually require time-series data that range

from pre-FTA to post-FTA. Thus, in the analysis of an under-negotiating FTA, RCEP, Chapter 5 adopts a CGE model.

Among the CGE models assessing trade liberalization, there are few models incorporating FDI. But along with the increasing interests in services liberalization, more and more studies pay attention to FDI given that it is an important mode of services trade. This section reviews CGE models that incorporate FDI, which pave the way for building my CGE model.

In a pioneering contribution to the applied CGE literature, Petri (1997) develops a model that includes FDI as well as cross-border trade in services. FDI in the Petri model gives rise to affiliates (foreign-owned plants) that differ from domestic firms in the same sector by using inputs 'imported' from the parent company as well as domestic factors of production. By assuming that consumer demand is differentiated both by place of production (along Armington lines) and nationality of ownership of plants it becomes possible to model the effects of policies that decrease the costs of foreign firms that are established in a given market. Capital allocation is modelled in an optimizing framework that allocates capital to the highest return activities, but also takes into account investor preferences for a particular mix of investment instruments. In turn, the return to capital relates to profits in different production locations. Petri applied the FDI-CGE model to analyze the economic effects of APEC's 'Bogor Declaration'. Barriers to FDI are represented in the model as a 'tax' on FDI profits. It is estimated to be one half as high as tariff-equivalents in the tradable primary and manufacturing sectors. Barriers to FDI in services are higher than other sectors, which are based on the estimates by Hoekman as reported and applied in simulations by Brown, Deardorff, Fox, and Stern (1995). Simulation suggests that global welfare gains from achieving the Bogor targets are estimated at around US$260 billion annually.

Building on the initial Petri (1997) paper, working with the ORANI and GTAP family of models, Hanslow (2000) and Dee and Hanslow (2000) integrated FDI into an FTAP model. The main feature of the FTAP model is incorporating increasing returns to scale (IRS) and large-group monopolistic competition in all sectors. The treatment of FDI follows closely Petri (1997). But the FTAP model is different from Petri in terms of commodity substitutions. Petri assumes commodities produced by the same firm from

different locations are closer substitutes than those produced in the same location by firms with different nationality. In contrast, the FTAP model treats that products produced in the same market as closer substitute. In dealing with capital allocation, the FTAP model assumes that capital moves less readily between sectors in a given region, but more readily across regions in a given sector, which captures the idea that knowledge capital will often be sector-specific (Markusen, 2002).

The FTAP model contains four types of trade barriers. It distinguishes barriers to commercial presence (primarily through FDI) from barriers to other modes of service delivery; and additionally, it distinguishes non-discriminatory barriers to market access from discriminatory restriction on national treatment. These barriers have been modeled as different taxes. The rents generated from barriers are retained by different parties. A key result of their simulation is that the rents associated with services barriers are substantial.

The FTAP model has been used to compare estimates of the gains from eliminating barriers to trade in services with those from eliminating post-Uruguay barriers remaining in the traditional areas of agriculture and manufacturing in Dee and Hanslow (2000). They find the gains in services liberalization are as big as those related to the combined liberalization of the remaining barriers to trade in agriculture and manufactured goods.

Brown and Stern (2001) adapt the Michigan Model to incorporate cross-border services trade and FDI. Firms are taken to be monopolistically competitive. They set a price for the output of each plant with an optimal mark-up of price over marginal cost. Its demand structure follows Dee and Hanslow (2000). The capital installed in each host country is derived from the multinational's determination of the profit-maximizing output from each plant. In essence, capital allocation is decided by rate of return. They assume capital is perfectly mobile between countries. Barriers to FDI are modelled as a tax on variable capital and labor, that is, increasing variable costs.

The early papers have not considered different productivity levels between domestic firms and MNCs, which has been picked up in later studies. Jensen, Rutherford and Tarr (2004, 2007) develop a small open economy CGE model of Russia to assess the impact of FDI liberalization as part of its WTO accession. In their model, they use the

basic concept of Markusen's knowledge-capital model. When MNCs produce in Russia, they import technology or management expertise, which makes them more productive. The barriers to FDI affect MNCs' profitability and entry. Reduction in the constraints will induce foreign entry that will typically lead to productivity gains. When more varieties are available, buyers can obtain varieties that more closely fit their demands and needs (the Dixit-Stiglitz variety effect). This model has also been used in some other studies (Lakatos & Fukui, 2013; Latorre, Bajo-Rubio, & Gómez-Plana, 2009).

Lejour, Rojas-Romagosa, and Verweij (2008) also incorporate productivity difference, rather than between national firms and foreign affiliates, but between domestic and foreign capital in a CGE model — WorldScan. WorldScan assumes a hybrid firm using both domestic and foreign capital. It adopts one production function for this hybrid firm because of data limitation which restricts the authors to discriminate production functions for domestic and foreign capital. With one production function, the productivity effect of foreign capital has been modeled in a form of externalities. This model has been applied to the Services Directive of the European Commission which aims to open up services markets within the EU. Result shows that the economic gains of liberalizing FDI in other commercial services are modest and only countries with large FDI inflows benefit significantly.

These studies have shown how to incorporate FDI to a CGE framework. Learned from their way of dealing with FDI, I introduce FDI to a firm heterogeneity CGE framework. The firm heterogeneity framework not only can model the high productivity of MNCs in a straightforward way, but also provides a solid theoretical background for the heterogeneous productivities among firms. This advantage, together with the good performance of the firm heterogeneity model in explaining trade, gives me the initial motivation to adopt it in Chapter 5 (Helpman, 2006). Chapter 5 provides a detailed review on the firm heterogeneity model and its application in CGE models.

2.5. Summary

This chapter reviews the recent development of East Asian regionalism, with an aim to clarify the positions of ACFTA and RCEP. ACFTA is the first ASEAN+1 FTA. ASEAN+1 FTAs have reduced trade restrictions between ASEAN and its dialogue partners, while the main achievement of these FTAs is to remove tariff barriers, leaving

services barriers barely touched. The establishment of ASEAN+1 FTAs has paved the way for regional FTAs. In 2013, ASEAN and its dialogue partners launched the negotiation for RCEP. The target of RCEP is to liberalize trade in goods and services to a high level, facilitating trade and investment among member countries. By the time of signing RCEP, East Asian regionalism would move to a new period. Overall, ACFTA and RCEP are two important FTAs that mark two different stages of regionalism in East Asia. Their FDI implications may be able to extend to other FTAs in the similar stages.

This chapter also reviews the impacts of FTAs on FDI from three perspectives. First, the review of theoretical studies shows that FTA positively correlates with vertical FDI, but exerts a mixed effect on horizontal FDI. Second, the review of econometric studies finds more positive than negative effects, which provides me an initial hypothesis that ACFTA relates to FDI in a positive way. Third, the review of CGE models demonstrates how to incorporate FDI into a CGE framework. The less straightforward way of modelling the high productivity of MNCs in the literature motivates me to adopt the firm heterogeneity CGE framework.

Chapter 3 The Overall Impact of ACFTA on FDI

3.1. Introduction

China and ASEAN states have actively participated in economic integration movements, but how would they benefit from the various trade liberalization initiatives? This chapter aims to answer this question by examining ACFTA and its particular effects on FDI. According to Cai (2003), ACFTA is the first important FTA for China; it also represents a significant development in East Asian integration. It consists of three agreements: the 2005 agreement on trade in goods, the 2007 agreement on trade in services, and the 2010 agreement on investment. Because the investment agreement is relatively new, there are insufficient data for empirical analysis; this paper focuses on the first two trade agreements. [12]

ACFTA integrates the big market of China and an integrating market of 10 smaller economies of ASEAN. As a South-South FTA, it is rich in low-cost labor, but it also has a fast growing market, both of which distinguish ACFTA from the EU, NAFTA and other FTAs. Another distinctive characteristic of ACFTA is that its members have participated in East Asian advanced production network. China is the center of the network, and imports intermediate goods from its Asian neighbors and the rest of the world. The advanced ASEAN members, including Viet Nam, are key players in the network.[13] China and ASEAN together constitute the main part of "Factory of the World" (WTO, 2011).

The emergence of China and some ASEAN members has been accompanied by large amounts of FDI inflow. According to UNCTAD statistics, FDI stock in ACFTA member countries reached US$2.15 trillion in 2012, accounting for 9.4% of the world total FDI. To a great extent, in the first instance, foreign capital is attracted to this area by the abundant low-cost labor. The labor advantage helps to foster production

[12] The investment agreement regulates national treatment, most-favored-nation treatment, fair and equitable treatment and full protection and security to the investors from partner countries, in order to promote investment flows and to create a liberal, facilitative, transparent and competitive investment regime in China and ASEAN.

[13] The advanced ASEAN members include Singapore, Malaysia, Thailand, Indonesia and Philippines.

networks. Along with the development of production networks, the markets of member countries expand, thus creating new attraction to MNCs.

With tariff reduction on trade in goods as the main achievement, ACFTA could affect FDI through three effects, vertical fragmentation, market expansion and plant rationalization. This chapter does not test the individual effects, but, rather, the overall effect of ACFTA. The overall effect on FDI is tested through an econometric model developed by Baltagi et al. (2007) and extended by Dee (2006). The model is grounded in the knowledge-capital model of Markusen (2002) and captures third country effects. The knowledge-capital model explains horizontal and vertical FDI, while the capture of third country effects aims to explain more complex FDI that involves third countries, including export platform and complex vertical FDI. I adopt this model because the capture of third country effects enables to take account of the effect of East Asian production networks. East Asia, as a "world factory", has extensive production networks, especially for electrical and machinery products (WTO, 2011). In addition, the East Aisan advanced production networks closely link to FDI, as the networks are mainly driven and used by MNCs (Cheng, Qiu, & Tan, 2001). Therefore, the production networks should have non-negligible effect on FDI in East Asia, which necessities the capture of third country effects.

The model finds that ACFTA positively correlates with FDI flow to China and ASEAN6. The joint effect of the 2005 and 2007 agreements does not show any significant difference from the effect of the 2005 agreement. That suggests the 2007 agreement on trade in services may not have promoted more FDI to member countries, corresponding to the limited services liberalization under ACFTA. In addition, this model shows that a mix of FDI exists in the free trade area and has been affected by third countries.

This chapter is organized as follows: section 3.2 describes the 2005 and 2007 agreements and the degree of trade liberalization committed by members; the facts relating to FDI in China and the ASEAN countries for the past 10 years are also shown. Section 3.3 theoretically analyzes the effects of ACFTA on FDI and provides a hypothesis for the overall impact. Section 3.4 describes the bilateral FDI data and the model applied in the FDI study. The results are shown and discussed in section 3.5, and section 3.6 presents a summary.

3.2. ACFTA Agreements and FDI

This section first reviews the ACFTA agreement on trade in goods (TIG) and the agreement on trade in services (TIS), and then presents a general introduction concerning FDI activities in ACFTA member countries.

3.2.1. The ACFTA Agreements

In 2005, the agreement on trade in goods came into force. This agreement stipulates tariff reduction schedules, non-tariff barriers (NTBs), national treatment, Rules of Origin (ROO), etc. Two years later, the agreement on trade in services came into force and started to open services sectors to partner countries. Later, the 2005 and 2007 agreements were upgraded separately by adding new protocols. For the 2005 agreement, the most important upgrade should be the Protocol to Incorporate Technical Barriers to Trade and Sanitary and Phytosanitary Measures into the Agreement on Trade in Goods, which took effect in January 2013. In this protocol, members agree to regulate technical barriers to trade (TBT) and SPS measures to facilitate trade. Another upgrade of the 2005 agreement is the 2010 Second Protocol to Amend the Agreement on Trade in Goods, which revises ROOs to provide greater flexibility. In terms of the agreement on TIS, the specific commitments of member countries are expanded significantly in the 2011 Protocol to Implement the Second Package of Specific Commitments under the Agreement on Trade in Services. Although these upgrades are important components of ACFTA in terms of trade liberalization, they are not covered in the estimation of the impact of ACFTA on FDI in this chapter because the times they came into force are beyond the data period. The full effect of all agreements under ACFTA could be estimated later when more data are available.

3.2.1.1. The Agreement on Trade in Goods

The 2005 agreement consists of tariff reduction provisions and non-tariff reduction provisions. The tariff provisions stipulate tariff reduction schedules for member countries. The tariff reduction and elimination provisions classified tariff lines into Normal Track and Sensitive Track. For tariff lines in the Normal Track, applied tariffs were to have been gradually eliminated by 2010 for ASEAN-6 and China and by 2015

for CLMV.[14] Table 2 shows the tariff reduction schedule of ASEAN-6 and China. The applied tariff rates (X) are divided into five categories, $X \geq 20\%$, $15\% \leq X < 20\%$, $10\% \leq X < 15\%$, $5\% < X < 10\%$, $X \leq 5\%$. In July 2005, tariffs were reduced to the lower boundary of each category except for the group with the lowest barriers, "$X \leq 5\%$". In 2007, ACFTA further cut tariffs from 20% to 12% for the first group, and from 15% and 10% to 8% for the second and third group. The 2007 reduction was substantial, almost halving the two highest tariff rates. In 2009, the first three groups all reached 5%, while the two low-rate groups eliminated tariffs. As of January 1st, 2010 China and ASEAN-6 eliminate tariffs on 7000 product categories covering 90% of traded goods (Lakatos & Walmsley, 2012). The tariff elimination on such a high proportion of products is indicative of the level of economic integration being achieved between China and ASEAN.

Table 2 Tariff reduction covering 90% of traded goods between China and ASEAN-6

X=Applied MFN Tariff Rate	**ACFTA Preferential Tariff Rate (Not later than 1 January)**			
	2005	**2007**	**2009**	**2010**
$X \geq 20\%$	20	12	5	0
$15\% \leq X < 20\%$	15	8	5	0
$10\% \leq X < 15\%$	10	8	5	0
$5\% < X < 10\%$	5	5	0	0
$X \leq 5\%$	Standstill		0	0

Source: The 2005 agreement on TIG.

The number of tariff lines in the Sensitive Track is subject to a maximum ceiling of 10% of the total import value, based on 2001 trade statistics. Tariff lines in the Sensitive Track were further classified into a Sensitive List and Highly Sensitive List. The ceiling number of tariff lines in the Highly Sensitive List is no more than 40% of the total number of tariff lines in the Sensitive Track for all members. ASEAN-6 and China agreed to reduce the applied rates on tariff lines in Sensitive Lists to 20% by no later than January 1st, 2012 and further to 0-5%, by no later than January 1st, 2018. CLMV agreed to reduce the applied rates on tariff lines in the Sensitive Lists to 20% by no later

[14] ASEAN-6 consists of Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand. The ASEAN-6 in this section is different from ASEAN6 in the rest of this paper. In ASEAN6, Brunei is replaced by Viet Nam because this study focuses on the relatively large economies of ASEAN that receive significant foreign investment. CLMV consists of the four relatively new members of ASEAN: Cambodia, Laos, Myanmar and Viet Nam.

than January 1st, 2015 and further to 0-5% by no later than January 1st, 2020. The parties agreed to reduce the applied rates on tariff lines in the Highly Sensitive Lists to no more than 50% by no later than January 1st, 2015 for ASEAN-6 and China, and January 1st, 2018 for CLMV. The restriction of numbers and cuts in rates on tariff lines in the Sensitive Track coincide with the relatively high rank of ACFTA among ASEAN+1 FTAs in terms of tariff liberalization, as shown in section 2.1.

The non-tariff provisions of the 2005 agreement deal with national treatment, NTBs and ROOs. The national treatment provision accords the same treatment to products of all the other parties as domestic products. The NTBs are not identified in the 2005 agreement, but the protocol of TBT and SPS measures has regulated barriers in these two aspects. Members agree to use international standards as the basis of their own regulations, agree to enhance the acceptance of technical regulations and SPS measures of other parties and enhance information exchange on standards and technical cooperation. The agreement on TBT and SPS measures would promote trade further on top of tariff elimination, especially for agricultural goods.

ROO provisions regulate origin criteria for products that are eligible for the preferential tariff concession. Origin criteria differ between wholly obtained and non-wholly obtained products. Products that have not been wholly produced or obtained in the ACFTA area qualify for the preferential tariff when not less than 40% of their regional value content originates from any party, that is, RVC (40). With RVC (40) as the only rule in the majority of cases, ACFTA can be considered to be simpler relative to other ASEAN+1 FTAs, although the lack of alternative rule could be constraining (E. M. Medalla & Balboa, 2009). However, revisions of the ACFTA ROOs are being made to provide greater flexibility, with more alternative rules being developed. In the 2010 Protocol, ASEAN and China adopted RVC (40) cumulation rule, allowing for eligibility based on ACFTA cumulative content of no less than 40%, as well as Product Specific Rules (PSR).

The tariff and non-tariff provisions on trade in goods enable China and ASEAN to trade most goods freely and safely with each other. The 2005 agreement, the first main achievement of ACFTA, laid a foundation for the free trade area.

3.2.1.2. The Agreement on Trade in Services

The 2007 agreement on trade in services regulates market access, national treatment and mutual recognition. China provides GATS-plus market access to ASEAN countries in the area of construction, the environment, recreation, cultural and sporting activities, transportation, and business services. ASEAN members offer GATS-plus market access to China in various areas, for instance, in finance, telecommunication, education, tourism, construction and medical services. The national treatment provision states that in the sectors inscribed in its schedule, each party shall grant treatment, to services and service suppliers of any other party, that is no less favorable than that which it grants to its own services and service suppliers. Market access and national treatment are the two core categories of commitments on trade in services. By calculating the Hoekman index based on these two aspects of four ASEAN+1 FTAs (The ASEAN Framework Agreement on Services (AFAS), AANZFTA, ACFTA and AKFTA), Ishido (2011) found that Cambodia, Viet Nam and Singapore have higher values on the Hoekman index than those of other countries; that is, the liberalization of trade in services is at a higher level in these countries.[15] However, the average indices of market access and national treatment are relatively low for ACFTA compared with other agreements, which indicates a low level of trade liberalization in services under ACFTA.

The low level of trade liberalization in services under ACFTA has been improved by the 2011 Protocol. In this protocol, members' specific commitments extend to many more services sectors. Most countries doubled the number of committed sectors in the first package under the 2007 agreement. The expanded coverage indicates a deeper liberalization in terms of market access and national treatment in services sectors, even though, according to the estimations of Fukunaga and Ishido (2013), most of the "improvements" made in the ACFTA 2nd Package are mere additions of countries' earlier commitments in the GATS. In other words, GATS-plus components remain low.

The mutual recognition provision states that each party may recognize the education or experience obtained, requirements met, or licenses or certifications granted in another

[15] The Hoekman index is a measure of the GATS-style degree of commitment in the service sector. This method assigns the following values to each of 8 cells (4 modes and 2 aspects—market access and national treatment): N=1, L=5, U=0; then calculates the average value by service sector and by country. N: No limitation (and bound); L: Limited (or restricted) but bound; U: Unbound.

party. This is to facilitate service provision by employees from foreign companies. Overall, the agreement on trade in services somewhat increases the openness of most services markets to member countries and provides convenience and national treatment for foreign firms. However, estimations concerning the services liberalization of ACFTA show that ACFTA has not created substantive preferential access to services sectors. Thus, I anticipate that the FDI impact of the agreement on trade in services is limited.

3.2.2. FDI Activities

These two agreements have set up a bridge for business activities, including trade and investment between China and ASEAN, thus connecting the two markets. ASEAN-China FTA forms the third-largest economic group in the world, after the EU and NAFTA (Figure 1). It has 1.85 billion people and covers an area of 14 million square kilometers. In 2012, the total GDP of China and ASEAN was US$10.71 trillion, accounting for 15% of the world economy. Between 2002 and 2012, the annual growth rate of China was 10.78%, and 5.34% for ASEAN. With these rapid growth rates, ACFTA becomes increasingly important in the world economy.

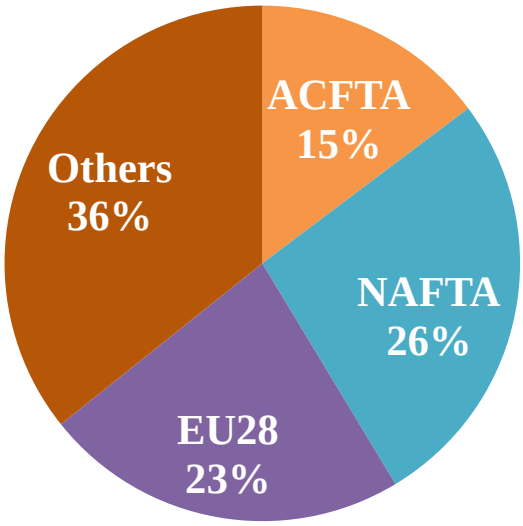

Figure 1 The GDP shares of three largest trade blocs in the world economy in 2012.
Data Source: UNCTAD

Along with the rapid growth of their economies, China and ASEAN have experienced growing FDI inflows. Figure 2 shows the FDI stocks in China and ASEAN from 2000 to 2013. Their FDI stocks start in very close proximity, with China scoring a little lower. Prior to 2005, FDI in the two parties grows slowly, with the FDI stocks in ASEAN growing a little faster than in China. Between 2005 and 2007, the FDI stock of ASEAN increased quickly, widening the gap between ASEAN and China. The growth trend of ASEAN was slowed in 2008, when the Global Financial Crisis (GFC) happened. However, the GFC held back the FDI growth impetus in ASEAN only for one year. ASEAN's FDI recovered in 2009, and the growth trend has since lasted to 2013. China's growth rate began to pick up pace after 2007. Since then, the FDI stock of China has increased at a steady rate.

The growth patterns of FDI in ASEAN and China indicate a slow increase before 2005 and a growth surge after 2005 in the total FDI stock. The cause of the different growth rates before and after 2005 could be due to a variety of reasons. One possible reason is the implementation of ACFTA, given that 2005 is the year of the agreement on trade in goods entry into force. In addition, the fact that ASEAN started to accelerate its FDI growth in 2005 could be attributed to the increasing attractiveness of ASEAN to multinationals, along with the gain of preferential access to the China market under ACFTA.

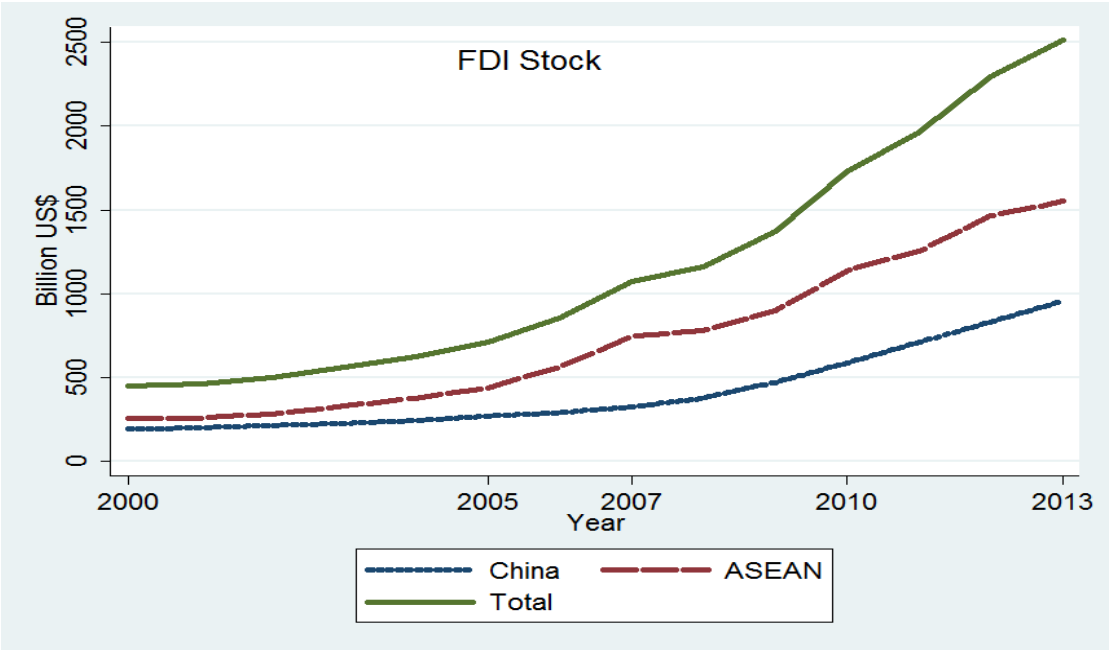

Figure 2 FDI stock in ACFTA from 2000 to 2013, in billions of US$.
Data Source: UNCTAD

Although China has less FDI stock than the ASEAN total, its FDI stock is higher than that of most individual ASEAN economies (Figure 3). China and Singapore dominate among member countries in terms of inward FDI stock. Thailand, Malaysia and Indonesia are in the second tier of countries followed by Viet Nam. The Philippines has the lowest FDI stock among China and ASEAN6.[16] Figure 3 presents the FDI stock in each country at the years of 2000, 2005 and 2010. In both 2000 and 2005, China had more FDI than Singapore, but in 2010, it was slightly overtaken by Singapore. The large increase in FDI in Singapore from 2005 to 2010 led to the surge of total FDI in ASEAN. Another large increase in this period occurred in Indonesia. In the years 2000 and 2005, Indonesia had less FDI than Thailand and Malaysia. However, a considerable increase in FDI from 2005 to 2010 pushed it to the lead position in the second tier of countries. Thailand, Malaysia and Viet Nam also show significant increase from 2005 to 2010, coinciding with the fast growth in the ASEAN total.

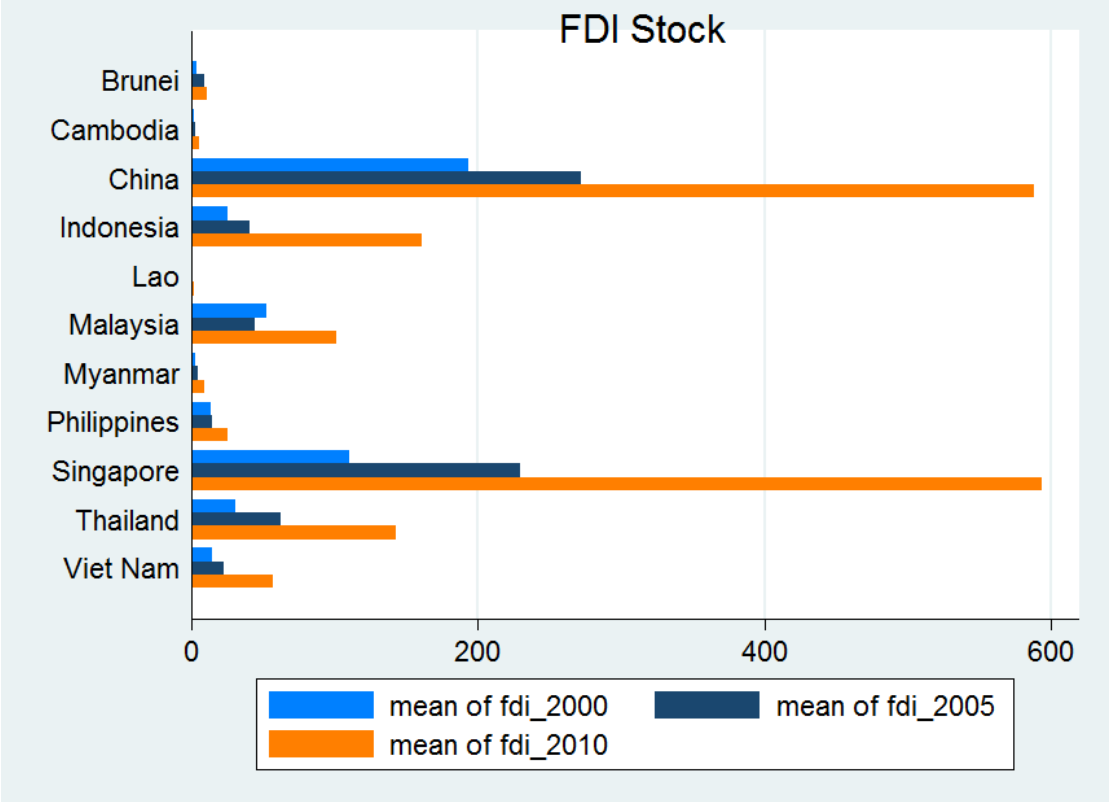

Figure 3 FDI stock in China and ASEAN 10, in billions of US$.
Data Source: UNCTAD

[16] From here on, ASEAN6 refers to Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam. Because Brunei, Cambodia, Myanmar and Laos are small economies and their data are poor, I have excluded them from the FDI study.

Figure 4 displays inward FDI stock shares for China and ASEAN in the world from 2000 to 2013. The share for ASEAN is higher than that of China throughout all the years under consideration. Prior to 2005, the shares for both parties' went up and down simultaneously. Initially they went up and then dropped before moving slightly upward again. Following this, from 2005 to 2007 the China's share dropped to less than 2%. At the same time, the ASEAN share slowly increased. These opposing trends widened the gap between the two parties. After 2007, the FDI stock shares of both China and ASEAN rose rapidly. The rising trend was slowed by GFC in 2009, but recovered immediately. The FDI share of China has been continuing increase until 2013, while the ASEAN share stopped growth in 2012.

The simultaneous and swift increase happened in 2007 coincided with the large tariff reduction of the year 2007 under the agreement on trade in goods. This may indicate a positive correlation between ACFTA and FDI. However, whether ACFTA has promoted FDI to member countries is an empirical question.

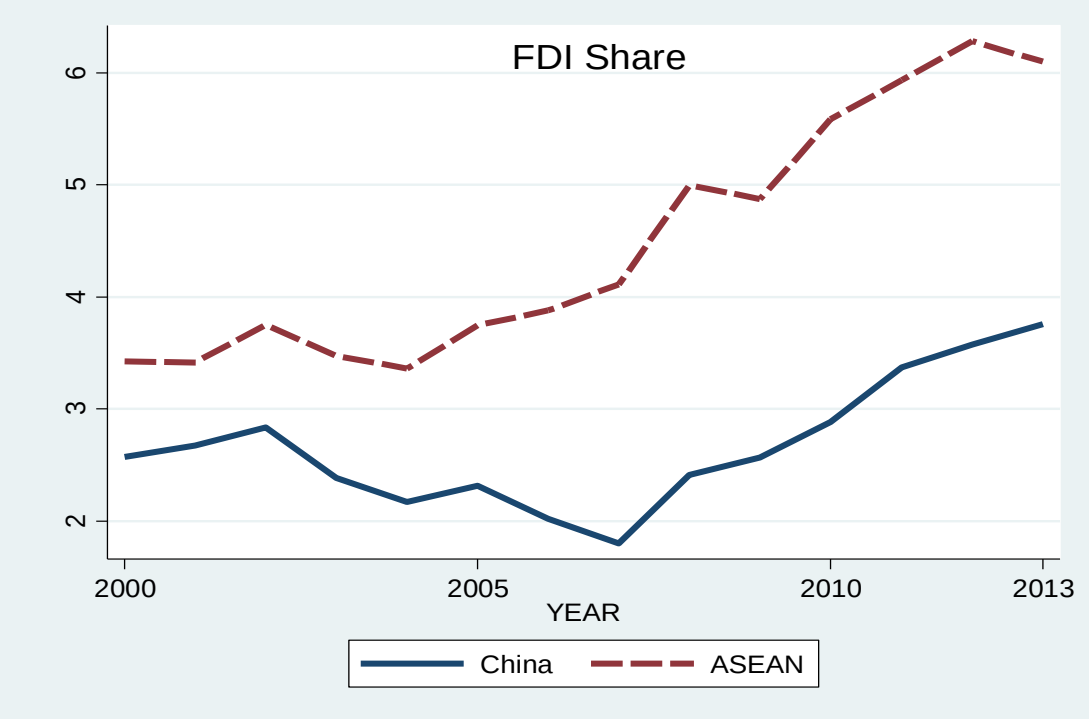

Figure 4 FDI stock of China and ASEAN as percentages of the world total (%).
Data Source: UNCTAD

3.3. The Impacts of ACFTA on FDI

Drawing from the literature review, this section synthesizes three effects of FTA on FDI. First is the vertical fragmentation effect. The complementarity between vertical FDI and trade in intermediate goods lays the foundation for this impact. By removing trade barriers on intermediate goods, the FTA enables multinationals to reduce production costs by splitting their production process between member countries according to the comparative advantages of each. In the case of ACFTA, the vertical fragmentation effect should be very significant. This is because ACFTA member countries have been involved in the advanced East Asian production networks which generate intense trade in intermediate goods. The reduction of trade costs of intermediates would greatly improve the efficiency of firms operating vertically in the networks. Athukorala and Yamashita (2005) state that when a one percentage point reduction in tariff occurs, the cost of production of a vertically-integrated product declines by a multiple of this initial reduction. The gain in efficiency would thus intensify vertical fragmentation in the free trade area.

Second is the market expansion effect. The market expansion effect strengthens the attractiveness of member countries to FDI, which aims for big markets. This effect mainly affects external firms that are blocked by high tariffs. They are at a disadvantage in competition with internal firms when supplying the integrated market. Thus, the formation of FTA promotes tariff-jumping FDI (horizontal FDI) from external countries. The market expansion effect also encourages export platform FDI. The reduction in trade costs among member countries enables MNCs to set up a plant in one country, while supplying other countries through exportation. In the case of ACFTA, the market expansion effect should promote a larger amount of market-seeking FDI to ASEAN than to China. The China market is much bigger than that of ASEAN. Preferential access to such a vast market should assist ASEAN member countries in attracting more FDI. To the contrary, the market expansion effect may be less significant for China.

Last is the plant rationalization effect. This impact represents the substitution of horizontal FDI with trade. Due to the reduction in trade costs, multinationals rationalize production plants in fewer locations for the source of output, and supply other markets

by exporting, thereby gaining economies of scale. Thus, this effect also promotes export platform FDI, but at the cost of horizontal FDI. Based on the findings of Heinrich and Denise Eby (2000), the plant rationalization effect of ACFTA could be significant given the relatively high barriers among member countries before the agreement. However, it is unlikely to be a strong impact. One reason for this is that given the large size of the ACFTA region, high transportation costs in the free trade area mitigate against firms becoming overly concentrated.

Taking account of the three effects, I hypothesis that the overall effect of ACFTA is positive. The hypothesis is drawn from two aspects. First, as noted above, the vertical fragmentation effect of ACFTA should be very significant, while the plant rationalization effect is unlikely to be strong. Second, data show that bilateral trade and FDI in this area have a clear complementary relationship (Figure 5). Since 2001, bilateral trade between China and ASEAN6 increased continually and peaked in 2008. During the same time period, FDI flows to China and ASEAN6 grow slowly but steadily. FDI flow to China peaked in 2008, the same year as bilateral trade. The peak of ASEAN's FDI arrived one year earlier. The complementarity between trade and FDI, together with the finding of the trade creation effect of ACFTA by Yang and Martinez-Zarzoso (2014), implies that FDI is likely to be increased by ACFTA. The underlying mechanism is that ACFTA indirectly encourages FDI through its trade impact.

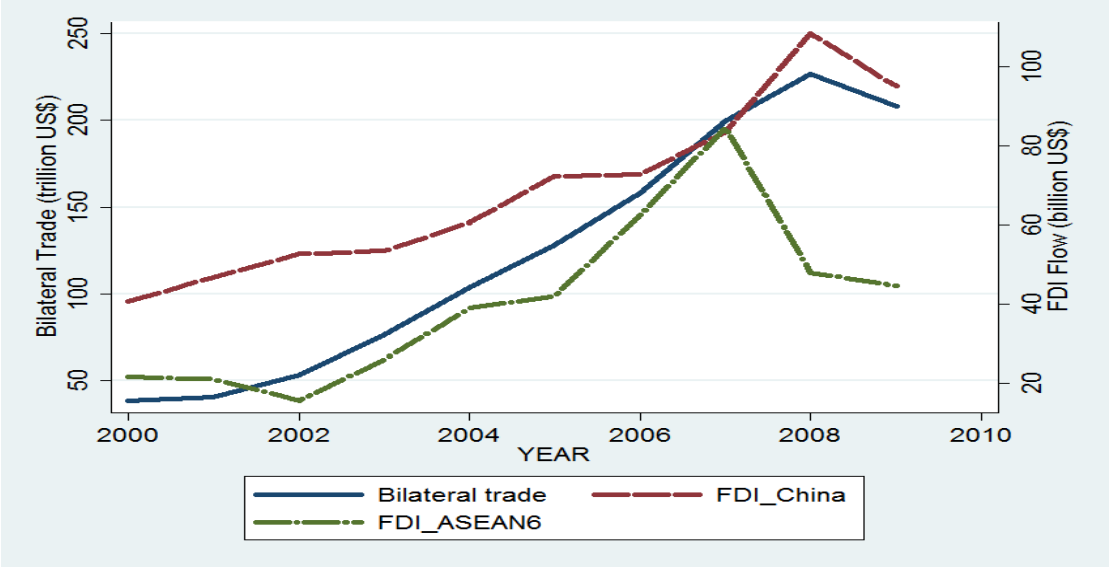

Figure 5 The complementarity between trade and FDI.
The trade data indicate bilateral trade between China and ASEAN6, in trillions of US$.
The FDI data indicate FDI flow to China and ASEAN6 respectively, in billions of US$.
Data source: UNComtrade and UNCTAD

3.4. Data and Methodology

3.4.1. Data

To investigate the effects of ACFTA on inward FDI, I collected bilateral FDI stock data for China and ASEAN6, with FDI from both external and internal sources. The external sources include 27 OECD member countries, Hong Kong and Taiwan. Hong Kong and Taiwan have been added to our database because they are important FDI sources for both China and ASEAN. The Hong Kong FDI data were been sourced from the Hong Kong Census and Statistics Department; the Taiwan data come from the Investment Commission, Ministry of Economic Affairs (MOEA).[17] Taiwan only reports approved FDI data rather than stock data, but I include it with the FDI stock database in the main test because it is an important FDI source for ACFTA member countries, especially China, and there are no alternative FDI statistics. In this research, Taiwan was excluded from a sensitivity test to see whether or not the results would change.

Only Singapore data are available for intra-bloc FDI. Singapore is one of the Asian NIEs, and also a member of ASEAN. It plays an important role in intra-regional investment. It is the third-largest investor in China and supplies over half of the flows of FDI to other ASEAN countries. With two-way bilateral FDI data between Singapore and other ACFTA member countries, I secured approximately half of intra-bloc FDI, even though the small number of observations prohibits us to separately estimate the effects of ACFTA on intra-bloc FDI.

Let $\ln(FDI_{dit})$ denote the log of the bilateral FDI stock from home country d to host country i at year t.[18] The FDI host countries are China and ASEAN6. The FDI home countries include 29 external countries (27 OECD members, Hong Kong and Taiwan)

[17] When Hong Kong is considered in FDI studies, researchers are usually concerned about round-tripping FDI in relation to Mainland China. Round-tripping FDI means that some FDI from Hong Kong is actually from Mainland China. This kind of FDI is first transferred from the mainland to Hong Kong and then returned to China. Round-tripping FDI takes advantage of Hong Kong's advanced financial services and China's preferential policies. Xiao (2004) argues that the amount of round-tripping FDI is the gap between FDI inflow statistics, as reported by China, and FDI outflow statistics, as reported by source regions, since there are no incentives for foreign investors to report fake investment in China to their home countries. Based on Xiao's argument, round-tripping FDI is not a problem for our study because I use the FDI statistics of Hong Kong.

[18] Converting FDI stock data to logarithm form, I dropped 102 zeroes (6.8% of observation) and 5 negative values (0.3% of observation) from the FDI stock database. The zero observations mainly appear in the early years of 2000-2009. A few home-host country pairs with negligible investment also show some zero observations.

and 7 internal countries (China and ASEAN6). Appendix A.1 lists the home and host countries. The FDI data period is from 2000 to 2009. With five years' data at each side of the year of 2005 agreement, the database facilitates the drawing of a good comparison between FDI changes before and after ACFTA. The data period also emphasizes that the examination of the effect of ACFTA focuses on the 2005 and 2007 agreement, but not on either the 2010 agreement on investment or later updates for each of those agreements. The number of country pairs of home and host ($d - i$) varies with year. It varies from a minimum of 125 country pairs in 2001 to a maximum of 157 country pairs in 2008. The total number of observations is 1377 based upon 181 unique country pairs. The FDI sources in the database contribute about 80% of total FDI inflow to ACFTA, which means the result could explain most of the inward FDI in this area.[19] All data are deflated by the GDP deflators of the FDI reporting country (World Bank Database).

3.4.2. Model

The empirical analysis adopts the model developed by Baltagi et al. (2007). The model is set up on a three-factor knowledge capital model and augmented by spatially weighted variables to account for third country effects. The knowledge capital model has two factors, skilled and unskilled labor. MNCs tend to locate headquarters in the skilled labor abundant country and locate plants in the unskilled labor abundant country. The model is extended to include capital as a third factor in the model of Baltagi et al. (2007). Capital movement is an important feature in MNC activities. Capital would move from a capital abundant location to a capital scarce location. China and most ASEAN states are scarce in capital under the current circumstance of fast growth. In terms of labor endowment, this area has abundant unskilled labor while the amount of skilled labor is growing quickly. Capital scarcity and labor cost advantage would help this area to attract FDI.

The most distinguished characteristic of the Baltagi et al. model is that it captures third country effects through spatially weighted variables. The capture of third country effects is particularly important in analyzing FDI in China and ASEAN given the

[19] The remaining 20% of FDI is mainly sourced from the Virgin Islands, Bermuda, the Cayman Islands and other similar territories.

sophisticated production network in this region. According to the authors, third markets affect bilateral FDI due to their weight in world-wide demand or supply, and to their general equilibrium effects on product and factor prices. In the study of FDI in ACFTA, third country demand and supply effect is mainly reflected in the East Asian production networks involving China and ASEAN. East Asian production networks involve the most advanced countries (Japan, the US) that constitute external demand, less advanced Asian NIEs, China and the developing countries of ASEAN. Asian NIEs, China and ASEAN states take different tasks in production processes and cooperate to complete the production of numerous products, forming the 'world factory'. The integration with production networks has involved intense FDI activity. Productions on the network link to each other and the whole network links to external demand. FDI change in one place may directly influence FDI in another place on the network and FDI in different nodes may increase or decrease simultaneously. Therefore, it is important to take account of the effects of all these countries that may affect FDI flow to ACFTA member countries through production networks.

In addition, third country effects could refer to the competition for FDI from other countries. For instance, Mexico and Latin American countries could be FDI competitors to ACFTA members. These countries also have large amounts of low-cost labor and they are close to the US market. MNCs may invest in these countries instead of ACFTA members. Thus, third country effects in this study include the effects of countries outside East Asian production networks.

In sum, the Baltagi et al. model suits FDI study in ACFTA member countries. Dee (2006) finds this model fits FDI data far better than a gravity model estimated on similar data, especially for Asian countries. Thus, I apply the Baltagi et al. model to investigate the effects of ACFTA on FDI. The full specification used for estimation purposes is as follows:

$$\ln(FDI_{dit}) = \beta_0 + \beta_1 D05_t + \beta_2 JOINT_t + \beta_3 \ln(dis_{di}) + \beta_4 G_{dit} + \beta_5 S_{dit} + \beta_6 k_{dit} + \beta_7 h_{dit} + \beta_8 l_{dit} + \beta_9 \Gamma_{dit} + \beta_{10} \Theta_{dit} + \beta_{11} R_{it} + \beta_{12} FTA_{dit} + \beta_{13} wG_{dit} + \beta_{14} wS_{dit} + \beta_{15} wk_{dit} + \beta_{16} wh_{dit} + \beta_{17} wl_{dit} + \beta_{18} w\Gamma_{dit} + \beta_{19} w\Theta_{dit} + \beta_{20} wR_{it} + \beta_{21} wFTA_{dit} + u_{di} + \vartheta_t + \varepsilon_{dit} \quad \text{Eq.(1)}$$

Table 3 shows variable definitions and their expected signs with four modes of FDI. $D05$ and $JOINT$ are the main variables that reflect the trade liberalization defined by the two agreements of ACFTA. In 2005 and 2006, only the 2005 agreement existed and affected the FDI inflow. $D05$ captures the effects of the 2005 agreement in this period. After 2007, the two agreements influence FDI flow to all member countries at the same time. It is impossible to separate the effects of the two agreements. Hence, I use $JOINT$ to indicate the mixed effects of the two trade agreements on FDI. As analyzed in Section 3.3, the two ACFTA dummy variables are expected to positively correlate with vertical FDI and export platform FDI, while horizontal FDI could be increased or decreased.

Table 3 Variable definitions and expected signs of determinants of complex FDI from d to i

Variable	**Definition**	**Mode of FDI**			
		Horizontal	Export platform	Vertical	Complex vertical
$\ln(FDI_{dit})$	natural logarithm of FDI stock from home country d to host country i in year t				
D05	dummy variable to indicate the 2005 agreement of ACFTA	+/-	+	+	+
JOINT	dummy variable to indicate the joint effect of the 2005 and 2007 agreements of ACFTA	+/-	+	+	+
Bilateral changes[a]					
$ln(dis_{di})$	natural logarithm of distance between home and host countries	+/-	+/-	+/-	+/-
$G_{dit} = ln(GDP_{dt} + GDP_{it})$	bilateral market size	+	+	+	+
$S_{dit} = ln(1 - {s_{dt}}^2 - {s_{it}}^2)$	similarity in country size, where $s_{dt} = GDP_{dt}/(GDP_{dt} + GDP_{it})$ $s_{it} = GDP_{it}/(GDP_{dt} + GDP_{it})$	+/-	+/-	+	+/-
$k_{dit} = \ln(K_{dt}/K_{it})$	home-to-host capital endowment ratios	+	+	+	+
$h_{dit} = \ln(H_{dt}/H_{it})$	home-to-host skilled labor ratios	+	+	+	+
$l_{dit} = \ln(L_{dt}/L_{it})$	home-to-host unskilled labor ratios	-	-	-	-
$\Gamma_{dit} = G_{dit} * k_{dit}$	interaction term	+	+	+	-
$\Theta_{dit} = ln(dis_{di}) * (k_{dit} - l_{dit})$	interaction term	+	+	-	+/-
R_{it}	political risk of host country	+	+	+	+
FTA_{dit}	binary dummy variable to indicate whether home and host countries are in a same free trade area	-	+	+	+
Third-country changes[b]					

$wG_{dit} = \sum_{j=1}^{52} w_{ij} ln(GDP_{dt} + GDP_{jt})$	spatially weighted bilateral market size of home and third countries $w_{ij} = d_{ij}^{-1} / \sum_{j=1}^{52} (d_{ij}^{-1})$ if $i \neq j$ $w_{ij} = 0$ if $i = j$, $d_{ij}$is the distance between host country i and third country j	+	+	+	+
$wS_{dit} = \sum_{j=1}^{52} w_{ij} ln(1 - {s_{dt}}^2 - {s_{jt}}^2)$	spatially weighted market similarity between home and third countries	+	+	+/-	+/-
$wk_{dit} = \sum_{j=1}^{52} w_{ij} \ln(K_{dt}/K_{jt})$	spatially weighted capital endowment difference between home and third countries	-	+	+	-
$wh_{dit} = \sum_{j=1}^{52} w_{ij} \ln(H_{dt}/H_{jt})$	spatially weighted skilled labor endowment difference between home and third countries	+	+	-	-
$wl_{dit} = \sum_{j=1}^{52} w_{ij} \ln(L_{dt}/L_{jt})$	spatially weighted unskilled labor endowment difference between home and third countries	+	-	+	-
$w\Gamma_{dit} = \sum_{j=1}^{52} w_{ij} G_{djt} * k_{djt}$	spatially weighted interaction term	+	+	-	+
$w\Theta_{dit} = \sum_{j=1}^{52} w_{ij} ln(dis_{dj}) * (k_{djt} - l_{djt})$	spatially weighted interaction term	+	+	+/-	+
$wR_{it} = \sum_{j=1}^{52} w_{ij} R_{jt}$	spatially weighted political risk indexes of third country	-	-	-	+/-
$wFTA_{dit} = \sum_{j=1}^{52} w_{ij} FTA_{djt}$	spatially weighted FTA indexes of home and third countries	+	+/-	+	+

Notes: a d is home, i is host and j is third country.
b Predicted signs of spatially weighted variables are based on reasonably low values of transport costs.
Source: Based on Baltagi et al. (2007) and Dee (2006)

The remaining variables in Eq.(1) could be regarded as control variables and most of them are the same as the Baltagi et al. model. According to the simulation results of Baltagi et al. (2007), all four types of bilateral FDI between d and i should be expected to increase with bilateral market size (G_{dit}), with the home-to-host capital endowment ratio (K_d/K_i), with the home-to-host skilled labor ratio (H_d/H_i), and to decrease with the unskilled labor ratio (L_d/L_i). The effect of similarity in size(S_{dit}) between d and i is mixed. The two interaction terms ($\Gamma_{dit}, \Theta_{dit}$) are added to disentangle the effects on horizontal and vertical FDI. Γ_{dit}, which equals G_{dit} times k_{dit}, capturing the fact that d's capital abundance is more in favor of bilateral FDI with larger bilateral size. Θ_{dit}, which equals log distance times ($k_{dit} - l_{dit}$), accounts for the fact that an increase in transport costs would lead to more horizontal-type investment (simple or complex) and less vertical-type investment. The data for GDP, labor and capital endowments were drawn from the World Bank. Appendix A.2 gives the details of how I converted the

original data to the indicators required by the model. An indicator of political risk (R_{it}) of the host country is included as a measure of investment cost.[20] The political risk indices were taken from the International Country Risk Guide (PRS, 2000 - 2009).

The variables prefixed with w measure third country effects. The indicators for third country effects are the same as the bilateral determinants, including bilateral market size and market similarity of home and third countries, home-to-third factor endowment ratios and interaction terms. Different from bilateral determinants, indicators for third country effects enter as spatially weighted variables. Using bilateral market size of home and third countries as an example, for each country pair $d-i$ at year t, wG_{dit} is equal to a summation over third country (j) of weighted bilateral market size of d and j, $wG_{dit} = \sum_{j=1}^{52} w_{ij} ln\left(GDP_{dt} + GDP_{jt}\right)$. The spatial weights ($w_{ij}$) are based on distances (d_{ij}) between the capitals of host country i and third country j. The weight is expressed as $w_{ij} = d_{ij}^{-1} / \sum_{j=1}^{52} d_{ij}^{-1}$ if $i \neq j$ and $w_{ij} = 0$ if $i = j$, reflecting that third country effects are more important the lower the trade costs and the smaller the distance between markets i and j (Baltagi et al., 2007). The summation is over 52 third countries. There are a total of 53 third countries in the database, including all home and host countries in the bilateral FDI stock database, as well as 17 other countries. But for each home-host country pair, third country cannot be the same as the home country, and so there are 52 third countries left.[21] The third countries are listed in Appendix A.1.

According to the simulation results of Baltagi et al. (2007), any type of bilateral FDI from d to i unambiguously increases with the third country's market size. However, as I take account of the competition effect from third countries, the big market size of a

[20] The political risk index assesses the political stability on a comparable basis with other countries by assessing risk points for each of the component factors of government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality. Political risk is indexed by the July value of each country, ranging from 0 to 100. The higher the value, the less risk there is. I observed that the data of political risk for individual countries do not vary much across years, so the data would be unlikely to vary much across month. The July value can then be taken as a realistic indicator of political risk for the year in question.

[21] As noted before, the third country effects include the effect of production networks and the competition effect from countries all over the world. Thus, ideally I want to include as many third countries as possible. However, due to data limitation, there are only 53 third countries. Fortunately, the 53 third countries include the main players on East Asian production networks and countries constituting external demands, as well as some FDI competitors.

third country may constitute competition to host country in terms of attracting FDI. Based on the simulation results, the similarity in size of d and j presents a mixed effect. The impact of third country (d-to-j) relative factor endowments exhibits a rather diverse pattern, depending on the type of FDI. The lower political risk in third country tends to decrease FDI from d to i. The signs of third country effects are useful ways to distinguish the type of FDI.

As shown by Eq.(1), there are some extra control variables beside those in the Baltagi et al. model, including distance ($\ln(dis_{di})$) and FTA variables (FTA_{dit} and $wFTA_{dit}$). In fact, these variables represent the extensions of the Baltagi et al. model by Dee (2006).[22] Distance between d and i is an indicator of transportation cost, and thus greater distance increases the cost of serving i's market via exports (promoting FDI). However, it may also increase the costs of establishing and operating a branch in i, thus reducing FDI. Hence the sign of this variable is ambiguous, irrespective of the type of FDI taking place (Dee, 2006).

FTA_{dit} is an FTA dummy variable that equals to 1 when home country d and host country i are in the same free trade area and 0 otherwise. Based on the theoretical analysis relating to FTA and FDI, FTA_{dit} is expected to decrease horizontal FDI, and to promote export platform FDI and vertical FDI. The inclusion of the FTA variable may result in an endogeneity problem. I try to address this problem by controlling for country-pair fixed effects through a fixed effects regression. However, as argued by Yang and Martinez-Zarzoso (2014), controlling for the country-pair fixed effect may not be effective for tackling the endogeneity problem. I drop the FTA variable in a sensitivity test to fully remove the endogeneity problem.

$wFTA_{dit}$ is a spatially weighted FTA variable, $wFTA_{dit} = \sum_{j=1}^{52} w_{ij} FTA_{djt}$, with FTA_{djt} indicating whether home country d and third country j are in a same free trade area. The addition of $wFTA_{dit}$ not only helps in the capture of third country effects, but also helps to tackle the spatial correlation problem in the model because FTA is an obvious source of spatial correlation. With the addition of $wFTA_{dit}$, the model is

[22] Dee (2006) follows the working paper of Baltagi et al. (2007), which came out in 2005.

unlikely to suffer from spatial correlation bias. Data sources for all control variables are presented in Appendix A.2.

3.5. Results

3.5.1. The Impact of ACFTA on FDI

Table 4 presents my estimated results for the impact of ACFTA on FDI. Model 1 includes the two ACFTA variables and the bilateral regressors of the three-factor knowledge-capital model but ignores any third-country impact on bilateral FDI. I estimated model 1 to provide a contrast to model 2, which includes the spatially weighted averages of the regressors in model 1.

Starting with model 1, the results from pooled regression, fixed effects regression and random effects regression all show that, since 2007, ACFTA has started to positively affect FDI. For the control variables, the random effects model generates more significant coefficients than the other two models, and the Hausman test did not reject the random effects model. Thus, we will concentrate on interpreting its results. Distance shows negative correlations with FDI, and its coefficient is significant at 1% level. This means long distance frustrates foreign investment activities. Both bilateral size and market similarity generate positive coefficients, supporting horizontal FDI. The home-to-host physical capital ratios have a significantly positive impact on FDI, corresponding to the fact that FDI in ACFTA member countries are mainly sourced from capital abundant places. The estimate of the interaction term between home-to-host physical capital endowment ratios and bilateral size, as well as the estimate of FTAs, are in accordance with the vertical model of MNCs.

Table 4 Results about the impact of ACFTA on FDI flow to member countries

Dependent variable: log of bilateral FDI stock, time period 2000-2009, unbalanced panel

	No spatial effects			Spatial effects in regressors		
	OLS	Fixed effects	Random effects	OLS	Fixed effects	Random effects
ACFTA variables						
$D05$	-0.00033	-0.0932	0.0921	0.0838*	0.85***	0.437***
	(-0.01)	(-0.82)	(1.45)	(1.67)	(4.12)	(3.15)
$JOINT$	0.0682**	0.138*	0.136***	0.131***	0.526***	0.24***
	(2.12)	(1.75)	(3.04)	(3.41)	(4.72)	(3.96)
Bilateral determinants						

dis_{di}	-2.921		-1.385***	0.844		-1.788***
	(-0.65)		(-4.93)	(0.17)		(-6.83)
G_{dit}	2.397***	2.614***	2.017***	6.277***	5.571***	4.816***
	(4.88)	(2.86)	(10.23)	(3.93)	(3.25)	(5.63)
S_{dit}	1.307***	1.441*	0.723***	4.448***	4.807***	2.391***
	(2.61)	(1.91)	(3.20)	(4.35)	(4.42)	(4.90)
k_{dit}	5.651	5.162	5.458***	-4.177	-2.334	0.675
	(1.47)	(1.32)	(3.26)	(-0.83)	(-0.46)	(0.29)
h_{dit}	-0.0859	-0.126	0.28	-0.336	0.119	0.237
	(-0.40)	(-0.51)	(1.62)	(-1.29)	(0.41)	(1.19)
l_{dit}	4.092	4.386	-0.109	9.298***	10.12***	1.344
	(1.24)	(1.32)	(-0.12)	(2.74)	(2.99)	(1.63)
Γ_{dit}	-0.784***	-0.763***	-0.423***	-0.272	-0.412	-0.0695
	(-3.44)	(-3.32)	(-3.59)	(-0.75)	(-1.12)	(-0.37)
Θ_{dit}	1.134	1.206	-0.007	2.129**	2.081**	0.297
	(1.38)	(1.45)	(-0.03)	(2.54)	(2.49)	(1.38)
R_{it}	-0.394	-0.293	0.0025	-0.301	-1.154**	-1.386***
	(-1.11)	(-0.79)	(0.01)	(-0.78)	(-2.09)	(-2.75)
FTA_{dit}	0.0617	0.0587	0.135**	-0.00306	0.0435	0.114
	(0.94)	(0.89)	(2.07)	(-0.04)	(0.61)	(1.62)
Spatially weighted third-country effects						
wG_{dit}				-5.079***	-9.482***	-4.75***
				(-2.70)	(-4.12)	(-3.41)
wS_{dit}				-6.431***	-12.75***	-4.614***
				(-4.31)	(-5.69)	(-4.14)
wk_{dit}				23.58***	26.47***	13.9***
				(3.34)	(3.69)	(2.98)
wh_{dit}				0.259	0.229	0.347
				(0.81)	(0.60)	(1.13)
wl_{dit}				-0.184	0.00168	-0.493
				(-0.55)	(0.00)	(-1.44)
$w\Gamma_{dit}$				-1.939***	-2.17***	-1.165***
				(-3.30)	(-3.62)	(-3.00)
$w\Theta_{dit}$				0.11**	0.138*	0.324***
				(2.09)	(1.71)	(4.82)
wR_{dit}				-2.71	-11.69**	-14.51***
				(-1.10)	(-2.37)	(-3.34)
$wFTA_{dit}$				0.63***	0.594***	0.346*
				(3.25)	(3.02)	(1.88)
constant	-15.01	-27.97***	-16.26***	-13.01	67.11***	35.29***
	(-0.87)	(-2.62)	(-6.51)	(-0.68)	(3.06)	(2.79)
Time effect	No	Yes	Yes	No	Yes	Yes
Country-pair effect	Yes	Yes	No	Yes	Yes	No
N	1054	1054	1054	1054	1054	1054
R-sq	0.9432	0.1048	0.4023	0.9453	0.1004	0.578
Hausman test		chi2(17) = 3.52 p-value = 0.9998			chi2(26) = 211.73 p-value = 0.000	

Note: T statistics in parentheses * p<0.1, ** p<0.05, *** p<0.01

Model 2 includes spatially weighted third country effects. In comparison with model 1, model 2 is preferred. This is because most of the spatially weighted variables are significant and consistent with expectation. In the meantime, the bilateral determinants have not lost significance from those in model 1. The estimates from the pooled regression are highly consistent with the results from the fixed effects and random effects models. Since the Hasuman test rejects the random effects model, I concentrate on describing the fixed effects estimates.

The finding reveals that ACFTA has a positive effect on FDI to member countries. The estimated coefficients for both $D05$ and $JOINT$ are positive and significant at the 1% level. ACFTA has started to positively affect FDI since its first agreement on trade in goods. The joint effect of the 2005 and 2007 agreements is also significantly positive, but it seems less strong than the effect of the single 2005 agreement. Even though the difference between the two coefficients for $D05$ and $JOINT$ is not very significant, the finding that the joint effect is no stronger probably implies that the 2007 agreement on trade in services has either no, or limited impact, corresponding to the limited services liberalization under ACFTA.

The finding about the positive FDI impact of ACFTA is consistent with our hypothesis that the positive effects of market expansion and vertical fragmentation dominate within ACFTA. The free trade agreement may have encouraged market-seeking MNCs to invest in member countries due to the opening of other members' markets to their exports. The agreement should also have promoted vertical FDI to this region by facilitating production fragmentation among member countries. The finding about ACFTA is consistent with predominant findings about other FTAs. The positive correlation between ACFTA and FDI indicates that members become more attractive to MNCs after joining the free trade agreement. When combined with the findings of trade creation effect of ACFTA from Yang and Martinez-Zarzoso (2014), we can conclude that the formation of ACFTA has not only facilitated bilateral trade, but also increased the attractiveness of member countries to FDI. The findings about the impacts of ACFTA on trade and FDI justify the active participation of East Asian countries to trade liberalization initiatives from an economic perspective.

Bilateral market size and market similarity between home and host countries still positively correlate with FDI. Both of the home-to-host capital endowment ratio and skilled labor ratio are insignificant, while the home-to-host unskilled labor ratios generate a significantly positive coefficient. Compared with those of model 1, the results for bilateral factor endowments in model 2 are likely to be affected by the addition of third-country factors. Third-country factors may diminish the factor endowment effects. The insignificant and perverse signs for coefficients of factor endowments happen in Baltagi et al. (2007) and Dee (2006) as well. For instance, in their estimates on all industries, Baltagi et al. (2007) found that factor endowment differences do not show significant effects on FDI in all industries. Finally, the estimate of the interaction term between the differences in bilateral capital-unskilled-labor ratios and bilateral distance is positive, corresponding to horizontal FDI.

In terms of spatially weighted variables, wG_{dit} and wS_{dit} are significantly negative, which are in line with the spatial generalized moments estimation results of Baltagi et al. (2007). One tentative interpretation is that the large market of third countries and the similarity in market size between home and third countries both divert FDI from the host country. This may reflect the competition effect of third countries.

The positive coefficient of the home-to-third capital endowment ratio and the negative coefficient of the weighted interaction term between bilateral market size and capital endowment ratio jointly support the modes of vertical FDI. The existence of vertical FDI corresponds to the East Asian production networks, and the significant third-country effects on vertical FDI should be attributed to the effect of production networks. The effect of production networks is re-emphasized by the positive effect of FTAs between home and third countries. FTAs liberalize exports from third to home countries, stimulating foreign investment in the production networks involving third and host countries. Finally, the high risk of third country (the low value of wR_{dit}) tends to drive foreign investment to the host country.

3.5.2. Sensitivity Analysis

In Table 5, I assess the robustness of the findings with respect to the choice of the spatial weighting scheme, following Baltagi et al. (2007). In the first block of results, I consider a spatial weighting matrix that relies on squared inverse distances, implying a faster

spatial decay of third country effects. By way of contrast, the second block of results assumes a much slower decay, this is, associated with a spatial weighting scheme based on inverse square roots of bilateral distances. Following the two tests with different weights, I exclude Taiwan in the third block to test the model without Taiwan's data of approved FDI. In the last block of results, I drop the FTA variable, FTA_{dit}, which would bring an endogeneity problem to the model. In this table, I run Eq.(1) with fixed effects models, controlling for both country-pair fixed effects and time effects.

Table 5 Sensitivity analysis of results for the impact of ACFTA on FDI to member countries

Dependent variable: log of bilateral FDI stock, time period 2000-2009, unbalanced panel, fixed effects model

	Spatial weights are based on $(1/d_{ij})^2$ Fast spatial decay	Spatial weights are based on $(1/d_{ij})^{0.5}$ Slow spatial decay	Drop Taiwan	Drop FTA_{dit}
ACFTA variables				
$D05$	0.395**	0.616***	0.884***	0.829***
	(2.18)	(3.14)	(4.39)	(4.08)
JOINT	0.404***	0.519***	0.573***	0.521***
	(3.48)	(4.11)	(5.26)	(4.69)
Bilateral determinants				
G_{dit}	0.897	6.503***	4.047**	5.539***
	(0.60)	(3.58)	(2.36)	(3.23)
S_{dit}	1.458*	4.762***	4.133***	4.796***
	(1.69)	(4.26)	(3.83)	(4.41)
k_{dit}	4.751	0.434	4.637	-2.215
	(0.92)	(0.09)	(0.82)	(-0.44)
h_{dit}	-0.0967	0.0739	0.218	0.104
	(-0.36)	(0.25)	(0.75)	(0.36)
l_{dit}	5.081	7.088**	7.717*	10.06***
	(1.52)	(2.14)	(1.92)	(2.98)
Γ_{dit}	-0.784**	-0.431	-0.814**	-0.417
	(-2.01)	(-1.15)	(-2.21)	(-1.13)
Θ_t	1.242	1.465*	1.508	2.064**
	(1.48)	(1.78)	(1.51)	(2.47)
R_{it}	-0.583	-0.228	-0.809	-1.132**
	(-1.42)	(-0.40)	(-1.47)	(-2.05)
FTA_{dit}	-0.0326	-0.0333	0.0516	
	(-1.06)	(-1.10)	(0.75)	
Spatially weighted third-country effects				
wG_{dit}	-1.487	-9.917***	-7.963***	-9.36***
	(-0.89)	(-3.94)	(-3.48)	(-4.08)
wS_{dit}	-4.667***	-14.22***	-12.18***	-12.63***
	(-3.25)	(-5.61)	(-5.59)	(-5.66)
wk_{dit}	9.187	29.47***	18.83***	25.93***
	(1.44)	(3.85)	(2.62)	(3.65)

wh_{dit}	0.0625	0.0811	0.393	0.252
	(0.25)	(0.18)	(1.01)	(0.66)
wl_{dit}	0.0105	0.294	-0.173	-0.0183
	(0.04)	(0.60)	(-0.41)	(-0.04)
$w\Gamma_{dit}$	-0.735	-2.461***	-1.549**	-2.124***
	(-1.38)	(-3.87)	(-2.58)	(-3.58)
$w\Theta_{dit}$	0.0121	0.299***	0.127	0.137*
	(0.27)	(2.80)	(1.58)	(1.70)
wR_{dit}	-1.294	-4.831	-11.04**	-11.16**
	(-1.15)	(-0.50)	(-2.25)	(-2.30)
$wFTA_{dit}$	0.0695	0.0534	0.465**	0.634***
	(0.84)	(0.65)	(2.34)	(3.42)
constant	10.24	45.69*	65.36***	65.1***
	(0.58)	(1.75)	(3.03)	(3.00)
Time effect	Yes	Yes	Yes	Yes
Country-pair effect	Yes	Yes	Yes	Yes
N	1054	1054	1054	1054
R-sq	0.0494	0.1753	0.1123	0.1021

Note: T statistics in parentheses * p<0.1, ** p<0.05, *** p<0.01

In the first block with fast spatial decay, the estimated coefficients are less significant than the corresponding coefficients in Table 4. In the second block with slow spatial decay, the estimated coefficients for spatially weighted variables are larger at similar levels of significance, and the R-sq is higher. The results suggest that the model with slow decay of third country effects can better fit the data, once again emphasizing the importance of third country effects. More importantly, the two ACFTA variables are always positive and significant. The third and fourth block results are very similar to those in Table 4. In sum, the finding about the positive impact of ACFTA on FDI is robust.

3.6. Summary

This study examines the overall impact of ACFTA on FDI flow to member countries and finds a positive correlation. The positive impact of ACFTA mainly comes from the 2005 agreement on trade in goods. Theoretical analyses indicate that trade liberalization on goods has three possible effects on FDI, with two FDI-promoting effects (the vertical fragmentation and market expansion effects) and one FDI-decreasing effect (the plant rationalization effect). The finding of a positive correlation between ACFTA and FDI suggests that the FDI-promoting effect dominates, which is consistent with my hypothesis. ACFTA expands the market of individual members, forming a big market. The big market increases the importance of this area, attracting more attentions of

MNCs. Given the outstanding position of this area as the world factory, the establishment of ACFTA facilitates intense trade in intermediate goods on production networks by reducing trade costs. The reduced production costs on the networks stimulate more vertical MNCs.

This study rejects the standard gravity model approach in favour of a model incorporating insights from the knowledge-capital model of Markusen (2002) and its extension by Baltagi et al. (2007) to include capital as a third mobile factor and in particular to use spatially-weighted variables to capture production network effects, which is important in explaining FDI effects in the context of an FTA between China and ASEAN. The finding of a positive FDI impact is in line with the general conclusions of empirical literature for FTAs.

The FDI effects, joining with the trade effects from Yang and Martinez-Zarzoso (2014), show that ACFTA can benefit member countries by promoting bilateral trade and FDI inflow. These contributions of ACFTA justify the active participations of countries in economic integration movements.

Chapter 4 The Industry Impacts of ACFTA on FDI

4.1. Introduction

Recent studies show that China has started to lose its appeal with MNCs as a result of rising costs, more intense competition from local firms and other reasons (Ianchovichina, Hertel, & Walmsley, 2014). This observation is echoed in a study of the profiles of inward FDI in China by Davies (2012), which shows that although China remains the pre-eminent recipient of inward FDI among developing countries, other developing countries, such as Indonesia and Viet Nam, are starting to steal China's thunder, offering themselves as cheaper alternatives. Along with the shift of foreign affiliates from China to other low-wage countries, policy emphasis in China itself is switching from attracting labor-intensive, low-technology investment toward more efficient, more productive and less polluting investment. At the same time, the Chinese national and sub-national investment promotion agencies will remain active in their efforts to encourage FDI in activities considered important for China's rapidly growing economy and its sustainable development.

Chapter 3 finds a positive FDI effect of ACFTA, suggesting that forming FTA could be an effective way for China to keep its attractiveness to MNCs. This chapter explores the mechanism of how ACFTA positively impacts on FDI, with an aim to increase our understanding about the correlation between FTA and FDI and to shed lights how to select FTA partners to facilitate FDI. In theory, FTAs are found to positively correlate with FDI through a market expansion effect and a vertical fragmentation effect. But there has no empirical evidence for the existent of the two effects. This study will provide an empirical test of the two effects through an FDI industry model.

An FDI industry model can help to detect the two effects because I assume that ACFTA impacts on different sectors through different effects. The market expansion effect relates to market-seeking FDI, and thus this effect mainly affects sectors which have extended domestic market to partners' through export expansion. These sectors are termed export-increasing sectors. The vertical fragmentation effect relates to vertical FDI, and thus this effect mainly affects sectors where it is easy to split production processes. These sectors are termed pro-fragmentation sectors. The FDI industry model

requires industrial FDI data. Due to the availability of sectoral FDI data in China's manufacturing industry, this study focuses on 30 manufacturing sectors of China (Appendix A.3).[23]

I identify the pro-fragmentation sectors and the export-increasing sectors via trade study. Trade in intermediate goods is an indicator of production fragmentation, and thus could be used to find the pro-fragmentation sectors (Ando and Kimura, 2005). A study of trade in intermediate goods between China and ASEAN suggests that the pro-fragmentation sectors concentrate in machinery and electrical goods (4 sectors according to China's industrial classification). A study of total trade finds 14 export-increasing sectors, among which textiles, metal products, furniture and culture, education & sport (CE&S) articles show the most significant increases in exports to the ASEAN market. Results from trade studies display a clear-cut separation between the export-increasing and the pro-fragmentation sectors, which makes it easy to isolate the market expansion and the vertical fragmentation effects.

After identifying the pro-fragmentation and the export-increasing sectors, I adopt an FDI industry model developed by Caves (1974) to test the impact of ACFTA on them. The model explains the industry distribution of FDI from a perspective of entry barriers to industry based on the argument that MNCs tend to enter sectors with entry barriers because of the disadvantages to them of operating away from their home base. To detect industry effects of ACFTA, I extend the model to include sector group dummy variables and their interaction terms with ACFTA. The sector group dummy variables indicate the various sector groups, including one group of pro-fragmentation sectors and four groups of export-increasing sectors.

Results show that both of the market expansion and the vertical fragmentation effects exist. The market expansion effect exists in the sectors with international

[23] The reason that I choose the manufacturing industry is that the two FDI effects are defined to impact on manufacturing sectors. In the availability of disaggregated FDI data, China outcompetes all ASEAN members by providing FDI data in 30 sectors of manufacturing industry. ASEAN members generally report more aggregated sectoral data. Indonesia, Philippines and Singapore only have data for the whole manufacturing industry, but no sub-sectoral data. Thailand reports data in 12 sectors, but the time period of the database starts from 2005. There is no data available before ACFTA. Malaysia has the most disaggregated data among ASEAN states, with 19 sectors, which is still less than that of China. However, Malaysia is the one with the greatest possibility to be the next research target in exploring the industry impact of ACFTA.

competitiveness, suggesting that these sectors benefit from ACFTA in terms of both export expansion and FDI increases. The vertical fragmentation effect exists in the pro-fragmentation sectors. Liberalization of trade in intermediate goods reduces production costs for and improves accessibility to intermediate goods of MNCs operated vertically in production value chain.

In the following part, section 4.2 analyzes trade data between China and ASEAN, with an aim to revealing the export-increasing sectors and the pro-fragmentation sectors. Section 4.3 introduces the FDI industry model and applies it to the study of ACFTA. The results are presented and discussed in section 4.4. Section 4.5 provides a summary.

4.2. Trade Facts

4.2.1. Exports from China to ASEAN

This subsection examines exports from China to ASEAN by total and by sector to find the market expansion of Chinese firms to the ASEAN markets and the export-increasing sectors. ASEAN, as an integrated market, is one of China's top export destinations.[24] From 2004 to 2010, ASEAN moved up from the 5th to 4th largest export market of China, overtaking Japan. The upward movement reflects increasing closeness of the economic relations between China and ASEAN. The ASEAN-China free trade agreement is a result of the close relationship, thus further promoting bilateral trade.

Figure 6 shows a steep increase in China's exports to ASEAN in recent year. From 2000 to 2008, the exports of China increased from US$17 billion to 114 billion. The strong growth trend was stopped by the Global Financial Crisis (GFC). The exports from China to ASEAN dropped to US$106 billion in 2009, but recovered immediately and strongly, reaching US$170 billion in 2011. Along with the expansion of exports from China to ASEAN, ASEAN's share of China's total export markets has grown from 7% to 9%. The growth of ASEAN's share has mainly occurred since 2006. In the first six years (2000-2006), ASEAN's share increased by only 0.5%. After 2006, it rose from less than 7.5% to 8% in 2007 and further to 9% in 2010. The significant increases coincide with ASEAN's steps in tariff reduction under the provisions of ACFTA. In

[24] Single economies such as the US, Japan and Hong Kong, together with the combined economy of EU are China's main export markets.

2007 ASEAN almost halved MFN tariff rates on imports from China, resulting in far more goods than previously being able to move across the borders of China and the ASEAN states. Export expansion pushed up ASEAN's share of China's total export market. When tariffs on 90% goods were eliminated in 2010, ASEAN's share increased even further.[25]

Figure 6 Exports from China to ASEAN, in billions of US$; and shares of ASEAN in China's total exports, by percentage.
Data source: UNComtrade

Despite the fact that ASEAN has gained a share of China's exports to the global market, nevertheless, sectoral exports from China to ASEAN display diverse patterns. The export expansion by sector is measured in percentage terms.[26] In order to ascertain ASEAN's share of China's export total by sector, I aggregated the sectoral exports to ASEAN and to the world respectively from UNComtrade 4-digit Database of Trade in Commodities. Among the 30 sectors in the manufacturing industry of China, 14 sectors show increases in shares with a possible association with ACFTA from 2000 to 2010.

[25] From 2008 to 2009, while the exports of China to ASEAN were decreased by the GFC, ASEAN's share of China's total exports shows a sharp increase. The opposite changes indicate that GFC had reduced China's total exports to an even greater extent, corresponding with the fact that China's main export markets were at the heart of GFC.
[26] This is because the percentage change can, to some extent, avoid export increases due either to China itself, or to the world economy; thus, reflecting export expansion in association with ACFTA in a more effective way than absolute value.

The remaining sectors show either no change or increase in total export shares prior to the establishment of ACFTA; thus their level of export expansion is unlikely to correlate with the trade agreement. I have plotted the shares of the 14 sectors in Figure 7 and classified them into four groups according to their patterns of increase. All sectors are listed in Appendix A.3.

Figure 7 ASEAN's share of China's total exports to the global market by sector group (%).
Note: CE&S Articles refer to Culture, Education & Sport Articles
Data Source: UNComtrade

Among the four sector groups, Group I shows a clear connection between export increases and ACFTA. There are four sectors in Group I, namely, furniture, metal products, textiles and CE&S articles.[27] The increase rates of exports in all four sectors accelerate after 2006. The most dramatic increase in export share for ASEAN is in furniture. ASEAN's share of China's furniture export market increased from 2% to 8% in 2010; 2% was the level at which it had been since long before 2006. Similarly, ASEAN's share in metal products had fluctuated below 2% for a long period of time

[27] Trade in toys dominates in the sector of CE&S articles.

before starting to increase in 2006. By 2010, ASEAN was taking up 4% of China's international sales total for metal products. Textiles and CE&S articles fluctuated at a higher level, 6%~8%. After 2006, ASEAN's shares in both sectors of the Chinese export market rose to over 8%. The significant and simultaneous increases in ASEAN's share in the four sectors coincided with tariff reduction steps in the corresponding sectors under ACFTA. Thus, the four sectors in group I are regarded as export-increasing sectors.

Groups II, III & IV also show export increases following the establishment of ACFTA; however the growth trends are less steady and less clear in these groups relative to Group I. In Group II, petroleum processing levelled off after a surge in 2009. Sectors in Group III took off in 2005 and peaked either in 2008 or in 2009, depending on the sector being referred to. The sectors in Group IV show fluctuations with modest increases overall. The modest or short-term increases in Groups II, III & IV could be the result of uneven reductions in tariffs across sectors and ASEAN states. For the automobiles in Group III, while Malaysia cut its tariff rates dramatically, most ASEAN states did not. Sectors in Group IV received a relatively small tariff reduction as the pre-FTA rates were already very low.

Given the less clear links between export increases and ACFTA in these groups, sectors in Groups II, III & IV are still regarded as export-increasing sectors. The export-increasing sectors include all the sectors showing export increases, in order to avoid the case that we miss any chance to capture the market expansion effect.

4.2.2. China's Imports of Intermediate Goods from ASEAN

This subsection examines China's imports of intermediate goods from ASEAN in order to ascertain the pro-fragmentation sectors and explore the possible effect of ACFTA on trade in intermediate goods.[28] Following Vezina (2010) and Ando and Kimura (2005), intermediate goods are defined as all HS6 digit product lines whose definitions contain the words "parts" or "components". Examples include fittings for plastic tube, pipe or hose, pneumatic tyres for motor cars or various integrated circuits. Six hundred and forty intermediate goods are drawn from more than 6600 products in China's tariff

[28] China's imports of intermediate goods are chosen because China adopts unique tariff rates on goods from different ASEAN states so that it is easy to detect trade changes in response to tariff reduction.

reduction schedule under ACFTA. The majority of intermediate products come from machinery components and parts (HS-84), electrical parts (HS-85) and automobile components (HS-87). The remaining intermediate goods consist of chains and springs (HS-73), objective lenses for camera and other optical products (HS-90), and movements and other parts for watches and clocks (HS-91), etc.

The export data of intermediate goods from ASEAN to China are drawn from the UNComtrade HS 6-digit database from 2000 to 2010.[29] The data show that over 90% of trade in intermediate goods occurs in the areas of machinery and electrical goods. According to the industry classification of China, there are four sectors comprising machinery and electrical goods; these are presented in Appendix A.3 under the heading "Pro-fragmentation Sectors".[30]

Having ascertained the pro-fragmentation sectors, we wish to establish whether ACFTA had facilitated trade in intermediate goods. If trade in intermediate goods has increased by the initiative of trade liberalization, then ACFTA may have promoted the development of vertical fragmentation in the area. In turn, we would hypothesis that the vertical fragmentation effect on FDI exists for ACFTA.

Intermediate goods are separate into goods with zero tariffs before ACFTA and goods with non-zero tariffs. China's tariff reduction schedule shows that a considerable number of intermediate goods were already traded freely with ASEAN prior to the introduction of ACFTA. To the contrary, the remaining goods had high tariffs imposed on them under China's MFN commitments to WTO. Following the establishment of ACFTA, the high tariffs were gradually reduced, and then eliminated for most goods. Thus, tariff liberalization may have boosted trade in goods that used to be blocked. However, it could no longer facilitate trade in the goods that had been previously freely traded. Figure 8 shows exports of the two types of intermediate goods and in total from ASEAN to China.

[29] UNComtrade database has another product classification system, the Broad Economic Categories (BEC), which collects trade data of intermediate goods (Sturgeon and Memedovic, 2010). However, the BEC categories are too aggregated to be used for the identification of pro-fragmentation sectors.
[30] Due to data limitation, we cannot split the four sectors further.

Figure 8 Exports of intermediate goods from ASEAN to China, in billions of US$. Data source: UNComtrade

Prior to 2006, the export of zero-tariff goods completely dominated total exports. The exporting totals for non-zero-tariff goods were almost zero. After 2006, the exporting of non-zero-tariff goods surged and then dropped a little before growing steadily after 2008. Meanwhile trade in zero-tariff goods dropped continuously until 2009. After that it fluctuated between US$10~20 billion. In 2009, trade in non-zero-tariff goods overtook trade in zero-tariff goods. By 2010, the exports of non-zero-tariff goods reached US$22 billion. In the period of 2006 ~ 2011, total trade of intermediate goods has increased from US$27.9 to 39.4 billion given the switch between zero- and non-zero-tariff goods. The switch between zero- and non-zero-tariff goods could infer that firms had gained efficiency by choosing the most suitable types of intermediate goods after the increase in varieties allowed through trade liberalization.[31]

[31] The decrease in exports of zero-tariff goods after ACFTA might suggest a substitution between zero- and non-zero-tariff goods. Before tariff reduction on non-zero-tariff goods, firms chose zero-tariff goods even though these goods might not fit very well. Since the establishment of ACFTA, firms can access a larger amount of intermediate goods and can also substitute some zero-tariff goods with non-zero-tariff goods.

The strong increase in the exports of non-zero-tariff goods after 2006 forms a very clear comparison with the previously occurring long-term zero growth; thus it is likely to reflect the component trade impact of ACFTA identified by Sheng, Tang, and Xu (2014). Sheng et al. (2014) find that ACFTA has a significant trade creation effect on component trade between China and ASEAN, which seems stronger than the trade creation effect on final goods. The author concludes that the large trade flows in parts and components imply that industries in ASEAN and China will become more closely integrated. Put another way, the production value chain in the free trade area will thrive after the establishment of ACFTA. Based on the fact that vertical MNCs are the main users and drivers of production value chain, we could hypothesis that vertical FDI would increase in the production value chains of this area.

The exporting of intermediate goods to China, in other words, the importing of goods by China, can be linked to China's policy of export tax rebating. Since 1994, in order to promote exports, the Chinese government has refunded domestic taxes for all inputs for the production of final export products to firms, including the import tariffs on intermediate goods from overseas. This means that import tariffs on intermediate goods used for the production of export products are refundable following their exportation. This being the case, the preferential tariffs under ACFTA should have no impact on trade in intermediate goods in instances in which most of imported parts and components are used for the production of export goods. However, Figure 8 shows that non-zero-tariff goods respond significantly to tariff reduction, suggesting that the export tax rebate does not alter the expectation for ACFTA. A partial explanation for this could be that some of imported intermediates are not used to produce export goods; however, the more likely reason is that in practice, firms prefer to import zero tariff goods, in order to avoid administrative costs in relation to the tariff rebate.

In summary, section 4.2 examines total exports from China to ASEAN and the importing of intermediate goods of China from ASEAN. The trade study finds 14 export-increasing sectors and 4 pro-fragmentation sectors. Within the 14 export-increasing sectors, the sectors in Group I show the most significant export expansion following the establishment of ACFTA. Trade in intermediate goods liberalized by ACFTA also responded dramatically. Having identified the export-increasing and the

pro-fragmentation sectors, the next aim is to detect the market expansion and the vertical fragmentation effects through econometric models.

4.3. Model

The two FDI-promoting effects of ACFTA are examined through an FDI industry model, which is derived from Caves (1974). Caves (1974) is a pioneer paper exploring FDI determinants at industry level. The author reviewed three groups of hypotheses that had been advanced to explain the substantial inter-industry variance in the prevalence of MNCs. The first and most important hypothesis comes from intangible capital.[32] In some industries, MNCs possess intangible assets that can more than offset the disadvantages for the entrepreneur of operating away from his/her home base. Relevant intangible capital will generally be with industries marked by product differentiation. Two important corollaries follow this "intangible capital" explanation of direct investment. First, returns to intangible capital often can be wrested from foreign markets by strategies other than FDI, such as licensing and exporting. An important factor that bears on the choice among these methods will be the absolute size of the potential investing firm. FDI entails higher costs of search and investigation than do exporting or licensing, and thus is more likely to be the game of big firms. Second, the conjunction of production differentiation and large size of firm indicates that the MNC is apt to operate primarily in market structures of "differentiated oligopoly" where firms entering the market must face some barriers.

Based on the theoretical analysis, Caves (1974) designed and applied an econometric model to study the industry distribution of FDI in Canada and UK with FDI from the US. The model includes three entry barriers, namely, capital intensity, R&D expenditure and advertising expenditure. Capital intensity is usually a barrier to small firms. R&D and advertising expenditures reflect product differentiation, which help to generate monopolistic power. According to Caves, the height of these barriers and the

[32] The other two views of the incidence of FDI are multi-plant enterprise and entrepreneurial resources. Firms choose multi-plant organization to minimize costs and MNC is a species of the multi-plant firm when the economies to the multi-plant firm do not stop at the national boundary. This view has since been questioned due to the uncertainty of the nature of economies to the multi-plant firm (Bain, 1966). The third hypothesis about entrepreneurial resources suggests the MNC expands abroad in order to give full employment to the coordinating abilities of its fixed stock of entrepreneurial talent. The entrepreneurial talent is more like a firm level FDI determinant than an industry level determinant. Therefore, these two explanations about the prevalence of MNCs are not captured in this study.

prevalence of MNCs should be positively related. Caves found a mixed result for the correlations between barriers and FDI.

Following Caves's theory, W. S. Kim and Lyn (1987) examined FDI industry distribution in the US in relation to entry barriers. In terms of empirical test, this study differs from Caves (1974) in three aspects. First, it analyzes industrial FDI from all sources to the US, while Caves studies bilateral FDI from the US to Canada and the UK. Second, because there is no specific FDI home country, W. S. Kim and Lyn (1987) took account of only the barriers of the host country, but not the barriers of FDI home markets as Caves (1974) did. Apart from capital intensity, R&D expenditure and advertising expenditure, Kim and Lyn included monopolistic power as another entry barrier. The monopolistic power is measured by industry average Tobin's q-ratio.[33] Finally, according to W. S. Kim and Lyn (1987), if these entry barriers frustrate investment from national firms, they should discourage FDI as well. Their findings show that capital and advertising intensities frustrate FDI inflow to the US, while R&D intensity combined with marketing efforts promote FDI. The diverse results in regard to correlations between entry barriers and FDI industry distribution shown in the two papers indicate that entry barriers perform differently in different host countries. This paper explores their performance in China.

My model follows W. S. Kim and Lyn (1987) by employing the industry indicators of the FDI host country (China) to measure entry barriers. The basic model includes four entry barriers and sales. The first barrier is capital intensity. Caves stated that MNCs can overcome this barrier with relatively greater ease because of their easy access to both internally and externally generated funds. Thus, we expect a positive correlation between capital intensity and FDI. The second barrier is concentration ratio or monopolistic power. In contrast to the US, State-Owned-Enterprises (SOEs) have played an important role in the Chinese economy. In this study, the share of SOEs in output by sector is used to indicate monopoly power. Because of their government background, SOEs can acquire resources (for instance, skilled-labor and capital) with greater ease. It is not surprising that SOEs take a large market share in many sectors. Even though MNCs are also big firms with rich resources, there are disadvantages for

[33]Tobin's q is the ratio of the market value of a firm to replacement costs of existing assets.

them operating in China relative to SOEs. Hence, a negative correlation is expected between concentration ratio and FDI in China.

The other two entry barriers are advertising expenditure and R&D expenditure. Advertising expenditure links to marketing expertise. On the one hand, MNCs that invest in China have accumulated marketing expertise by serving different markets (Zhou, Li and Tse, 2002). On the other hand, foreign firms may be less familiar with Chinese customers. Thus, the correlation between advertising expenditure and FDI is not clear. Endowed with vast and multinational supplies of financial and human resources, MNCs usually invest heavily in R&D and thus may hold some of the most advanced technologies. Even though MNCs have an advantage in R&D and high technology, it is not easy to anticipate the correlation between the R&D barrier and FDI. The R&D barrier may be effective for MNCs as it forms a barrier to small local firms. But the barrier may frustrate MNCs in the same way in which it frustrates national firms. The basic FDI industry distribution model for China is as follows:

$$\boldsymbol{ln(FDINO_{it}) = \alpha + \beta_1 CI_{it} + \beta_2 CONCEN_{it} + \beta_3 ADV_i + \beta_4 RD_{it} + \beta_5 ln(SALES_{it}) + \epsilon_{it}} \quad \text{Eq.(2)}$$

$\boldsymbol{FDINO}$	The number of foreign invested firms in each sector,
$\boldsymbol{CI}$	Capital intensity, using the ratio of fixed asset to sales as a proxy variable,
$\boldsymbol{CONCEN}$	Concentration ratio, using the ratio of SOEs' output to total output as a proxy variable,
$\boldsymbol{ADV}$	Advertising intensity, a binary dummy variable to indicate the top 5 sectors in advertising expenditure (Medicine, Food, Apparel, Autos and Cosmetics),
$\boldsymbol{RD}$	R&D of Chinese large and medium-sized enterprises, using the ratio of R&D expenditure to sales as a proxy variable,
$\boldsymbol{SALES}$	Sales, a proxy for scales of industry,

China's statistical yearbooks report rich industry data. The data characterizing each sector include the number of enterprises, gross output, total assets, fixed assets, liabilities, sales, employees, etc. The data for foreign invested firms, which is a special group in the economy, are separately reported. In total, this research includes a panel dataset with 30 sectors from 2000 to 2010.

Based on the availability of FDI data by industry, the number of foreign invested firms by sector is selected as the dependent variable. These are the foreign invested firms in

China from all source countries. Firm number and asset size are two indicators of FDI industry distribution, and they usually change in parallel. However, comparing these two indicators, firm number is more suitable to reflect FDI distribution. First, the asset of a foreign invested firm may consist of foreign capital and domestic capital, and the share of each varies across industries and firms. Second, total assets of foreign invested firms in a sector may increase sharply due to the launch of one large project, while it is unlikely to see sudden increases in firm numbers. Hence, firm number is chosen to be the dependent variable. By thus doing, the FDI model explains the correlations between ACFTA and the extensive margins of FDI increase, that is, the increase of FDI due to new entrants.

The data for all variables are from China's statistical yearbooks, with the exception of advertising expenditure, $\boldsymbol{ADV}$. The advertising expenditure by sector is unavailable. Fortunately, the State Administration for Industry & Commerce of the PRC reported on the top 5 sectors in advertising expenditure in 2007 and 2008, which were the same for both years. The top 5 sectors include food, wearing apparel, chemical products, medicines and automobiles. Even though only data for two years' data are available, it is assumed here that the top 5 sectors in advertising expenditure have been unchanged for all the years between 2000 and 2010.[34]

In order to test the market expansion and the vertical fragmentation effects of ACFTA on FDI in China's manufacturing industry, a group of dummy variables are added to the basic model. $ACFTA$ is a dummy variable indicating the free trade agreement. $ACFTA$ equals 0 before 2007, and 1 after. The choice of 2007 as the year of FTA, rather than 2005, is due to the fact that two significant changes in trade occurred in 2007. First, the four export-increasing sectors in Group I started a clear and continuous increase in 2007. Second, the trade in non-zero-tariff intermediate goods soared from almost zero in 2007. This is likely to indicate that the ACFTA began to affect the related elements of the Chinese economy in 2007. Nevertheless, I did a sensitivity test by allowing ACFTA to begin to exert an effect in 2005.

$GROUP\ I, II, III\ \&\ IV$ are dummy variables indicating the four groups of export-increasing sectors as shown in Figure 7. FRA is a dummy variable to indicate the group

[34] This assumption is based on conventional observations.

of pro-fragmentation sectors. Following Pain (1997) and Pain and Lansbury (1997), we use the interaction terms of these group dummies with ACFTA to reflect the industry impact of ACFTA. In addition, the group dummies enter the model independently, and the coefficients of these variables reflect the attractiveness of each group to FDI due to group characteristics. As time invariant variables, they will be dropped in fixed effects model. Thus, we adopt a random effects model as the main regression method. By including the group dummies, the random effects model is analogous to the fixed effects model since the group dummies have controlled for group fixed effects. However, the fixed effects model differs from the random effects model as it controls for sectoral fixed effects rather than group fixed effects. In order to get a robust result, the full specification is regressed by both random and fixed effects models. The full specification is as follows:

$$ln(FDINO_{it}) = \alpha + \beta_1 CI_{it} + \beta_2 CONCEN_{it} + \beta_3 ADV_i + \beta_4 RD_{it} + \beta_5 ln(SALES_{it}) + \beta_6 GROUPI_i + \beta_7 GROUPII_i + \beta_8 GROUPIII_i + \beta_9 GROUPIV_i + \beta_{10} FRA_i + \beta_{11} ACFTA_t + \beta_{12} TIME_t + \beta_{13} ACFTA_t * TIME_t + \beta_{14} ACFTA_t * GROUPI_i + \beta_{15} ACFTA_t * GROUPII_i + \beta_{16} ACFTA_t * GROUPIII_i + \beta_{17} ACFTA_t * GROUPIV_i + \beta_{18} ACFTA_t * FRA_i + \epsilon_{it} \quad \text{Eq.(3)}$$

i is industry, from 1 to 30; t is year, from 2000 to 2010.

$GROUPI$	A dummy variable to indicate the export-increasing sectors in Group I (Furniture, Metal products, Textiles and CE&S articles),
$GROUPII$	A dummy variable to indicate the export-increasing sectors in Group II (Petroleum Processing and Non-Metal products),
$GROUPIII$	A dummy variable to indicate the export-increasing sectors in Group III (Wood, Leather, Artwork and Other, and Automobiles),
$GROUPIV$	A dummy variable to indicate the export-increasing sectors in Group IV (Food, Beverage, Apparel and Paper),
FRA	A dummy variable to indicate the pro-fragmentation sectors (General Machinery, Special Machinery, Electrical Equipment and Electronic Equipment),
$ACFTA$	A dummy variable to indicate the free trade agreement. It equals 1 between 2007 and 2010, and 0 between 2000 and 2006,
$TIME$	A dummy variable to indicate time trend, which ranges from 1 to 11.

4.4. Results

4.4.1. Industry Impacts of ACFTA on FDI

Table 6 presents the regression results for the industry effects of ACFTA on FDI in China's manufacturing industry. Model 1 is the basic model, which is run to test whether the model is able to explain FDI in China. Model 2 adds the five group dummy variables, aiming to find the attractiveness of each group to FDI. $ACFTA$ and $TIME$ are included in model 3 to test the overall impact of ACFTA and to control for the effect of time trend. Models 4&5 show the industry effects of ACFTA through the interaction terms of $ACFTA * GROUP\ (I, II, III, IV, FRA)$. The first four models are run by the random effects method, while model 5 is a fixed effects model.

Starting with model 1, the coefficients for all variables are significant. They present the specific preferences of MNCs in the manufacturing sectors of China. MNCs tend to invest in capital intensive sectors, reflecting their high level of financing capabilities. The presence of SOEs frustrates FDI and so MNCs are likely to try to avoid competition with SOEs. Sectors with high advertising expenditure attract FDI. The positive coefficients of advertising expenditure and capital intensity correspond to Caves's hypothesis that MNCs are apt to invest in market structures of "differentiated oligopoly". R&D expenditure correlates negatively with FDI. This may be caused by two factors. First, MNCs' investment in China is mainly due to the availability of low-cost labor. China's R&D intensive sectors have not gained competitive advantages. Second, China's weak protection of intellectual property rights may hinder the investment of foreign firms from the high-technology sectors.

As expected, industrial sales relate positively to FDI. All variables in model 1 generate significant and reasonable coefficients and the R-square is relatively high. The model can well explain FDI industry distribution in China.[35]

In Model 2, the five sector group dummy variables are added, all of which show positive correlations with FDI. This means that all of the groups of export-increasing sectors

[35] Given the good performance of this model, it is surprising that we have not seen this model being used to explain FDI industry distribution in China, especially under the circumstances that Chinese government wants to lead FDI to high-end sectors in order to be consistent with its strategy of industrial structural upgrading (Jiabao, 21/12/2013).

and the group of pro-fragmentation sectors are attractive to FDI due to their own characteristics. Only Group II is not significant, which could be caused by the inclusion of the petroleum processing sector due to the fact that a high proportion of SOEs in this sector.

Table 6 Results of the industry impact of ACFTA on FDI in China

Dependent var: ln(FDINO)	Model 1	Model 2	Model 3	Model 4	Model 5
ACFTA			0.603***	0.478***	0.543***
			(4.37)	(3.58)	(4.27)
CI	0.66***	0.732***	1.231***	0.94***	0.826***
	(2.87)	(3.33)	(6.07)	(4.67)	(4.10)
CONCEN	-3.199***	-3.12***	-3.213***	-3.192***	-2.248***
	(-10.80)	(-10.79)	(-11.85)	(-12.03)	(-7.37)
ADV	0.68**	1.05***	0.739***	0.772***	
	(2.57)	(4.10)	(2.85)	(2.99)	
RD	-12.95**	-14.52***	-6.354	-5.322	-5.779
	(-2.43)	(-2.84)	(-1.38)	(-1.23)	(-1.40)
ln(SALES)	0.28***	0.288***	0.717***	0.662***	0.707***
	(8.41)	(8.83)	(9.79)	(9.19)	(8.64)
GROUPI		1.006***	1.092***	0.954***	
		(3.34)	(3.65)	(3.17)	
GROUPII		0.575	0.141	0.162	
		(1.48)	(0.36)	(0.42)	
GROUPIII		0.879***	1.009***	0.931***	
		(3.04)	(3.51)	(3.22)	
GROUPIV		0.544*	0.494*	0.486*	
		(1.88)	(1.72)	(1.69)	
FRA		1.591***	1.09***	0.99***	
		(5.37)	(3.53)	(3.22)	
ACFTA*GROUPI				0.198***	0.162***
				(3.83)	(3.29)
ACFTA*GROUPII				0.086	0.0763
				(1.31)	(1.24)
ACFTA*GROUPIII				0.0485	0.0161
				(0.94)	(0.33)
ACFTA*GROUPIV				0.0207	0.0171
				(0.42)	(0.37)
ACFTA*FRA				0.237***	0.234***
				(4.57)	(4.75)
ACFTA*TIME			-0.0488**	-0.0479**	-0.0815***
			(-2.25)	(-2.31)	(-5.14)
TIME			-0.0806***	-0.0735***	-0.0407*
			(-4.58)	(-4.41)	(-1.87)
Constant	4.982***	4.218***	0.775	1.399**	1.418**
	(12.92)	(10.38)	(1.34)	(2.41)	(2.18)
N	232	232	232	232	232
R-sq	0.7739	0.7402	0.8122	0.8391	0.6796

T statistics in the parentheses * p<0.1, **p<0.05, *** p<0.01

$ACFTA$ is added to Model 3 in order to find an overall effect of trade liberalization on FDI in the manufacturing industry. The result suggests that ACFTA has a strong and positive correlation with FDI flow to China. However, the interaction term, $ACFTA * TIME$, suggests that the effect declines with time from 2007 to 2010. Since the Global

Financial Crisis (GFC) occurred one year later after the year of $ACFTA$ (2007) in this regression, the decline in the effect of ACFTA may be combined with the occurrence of the GFC.[36]

Models 4&5 reveal the industry impacts of ACFTA on FDI with the addition of the interaction terms of ACFTA with groups. Model 4 is a random effects model, which controls for group fixed effects through group dummies. Model 5 is a fixed effects model, which controls for industry fixed effects but drops time-invariant group dummies and ADV. Given these differences between the random effects and the fixed effects models, the results are very similar and could be interpreted in combination.

The results of the two models show that $ACFTA * GROUPI$ and $ACFTA * FRA$ generate significantly positive coefficients while the interactive terms with other sector groups generate positive but insignificant coefficients. This means that the export-increasing sectors showing clear association between export expansion and ACFTA (Group I), and the pro-fragmentation sectors may receive more FDI due to ACFTA. Specifically, the results indicate that on the basis of general positive effects of ACFTA on the manufacturing industry, an additional 21.9% FDI increase in Group I could be explained by the trade agreement.[37] Similarly, an additional 26.7% FDI increase in the pro-fragmentation sectors could be attributed to ACFTA.

The positive FDI impact on Group I demonstrates the existence of the market expansion effect of ACFTA. Group I sectors show clear export expansion to the ASEAN market along with the implementation of ACFTA, which has strengthened the attractiveness of these sectors to market-seeking FDI. Sectors in Group I (furniture, metal products, textiles and CE&S articles) are the ones in which China possesses international competitiveness. These sectors are more likely to expand exports to partner countries, and thus attract FDI. When FTA partners have a bigger market, the export expansion in these sectors would be more significant, as well as the market expansion effect on FDI.

[36] During the period of ACFTA, the GFC has drawn down global FDI flow significantly (UNCTAD, 2010). A regression of model 3 was run by adding a dummy variable GFC. The results show the effect of GFC could not be separated from ACFTA as GFC has an insignificant positive coefficient.
[37] EXP(0.198)-1=0.219, EXP(0.237)-1=0.267

Similarly, the positive FDI impact on the pro-fragmentation sectors demonstrates the existence of the vertical fragmentation effect of ACFTA, verifying our hypothesis. Through the elimination of tariffs on non-zero-tariff intermediate goods, ACFTA has reduced production costs for and improved the efficiency of MNCs that operate vertically in international production networks, and thus, increasing vertical FDI. The advanced production networks involving China and ASEAN could be the main reason that leads to a significant vertical fragmentation effect of ACFTA. The finding infers that when countries on the same production networks eliminate tariffs and reduce other trade barriers, they would like to receive more vertical FDI.

Thus, we can infer that an FTA between China and Korea or Japan would bring China more FDI than ACFTA both because Korea and Japan are bigger market than ASEAN and they are key players on the East Asian production network.

4.4.2. Sensitivity Tests

In Table 7, the robustness of the findings is assessed from two aspects. In the first result block, the start year of ACFTA has been changed from 2007 to 2005. In 2005, the first and main agreement on trade in goods came into force. Although many significant changes occurred in 2007, ACFTA may have started to affect FDI right from the time when it was first established. In the second result block, the way of controlling for time effect has been changed. The time trend variable is changes to year dummies. With one time trend variable, we assume that the time effect is linear. With year dummies, we assume that the time effect could vary across years. For each block, the results of both fixed effects and random effects models are reported.

In the first block, the results from the two regressions are very similar to each other and to those of Table 6. Thus, changing the year of ACFTA does not affect the finding relating to the two effects of ACFTA. In the second block, most variables perform similarly to those in Table 6. The estimated coefficients for the interaction terms of ACFTA with group dummies still suggest that ACFTA has a market expansion effect on Group I and a vertical fragmentation effect on the pro-fragmentation sectors. One notable change is that the estimated coefficients for ACFTA become negative. One interpretation could be that some of the positive effect of ACFTA on FDI has been captured by the year dummy. The finding also corresponds to the negative coefficient

Table 7 Sensitivity tests about the industry effect of ACFTA

	ACFTA (2005)		Time Effect	
	Fixed Effect	Random Effect	Fixed Effect	Random Effect
ACFTA	0.357**	0.338**	-0.675***	-0.688***
	(2.35)	(2.10)	(-5.57)	(-6.09)
CI	0.823***	0.94***	0.776***	0.907***
	(4.23)	(4.84)	(3.84)	(4.46)
CONCEN	-2.314***	-3.258***	-2.142***	-3.128***
	(-7.47)	(-12.19)	(-7.00)	(-11.70)
ADV		0.769***		0.756***
		(2.99)		(2.91)
RD	-7.683*	-7.476*	-0.000341	0.304
	(-1.92)	(-1.79)	(-0.00)	(0.05)
ln(SALES)	0.718***	0.673***	0.716***	0.665***
	(9.04)	(9.58)	(8.79)	(9.21)
GROUPI		0.847***		0.977***
		(2.80)		(3.23)
GROUPII		0.17		0.163
		(0.43)		(0.41)
GROUPIII		0.885***		0.939***
		(3.04)		(3.23)
GROUPIV		0.49*		0.507*
		(1.70)		(1.75)
FRA		0.896***		0.957***
		(2.92)		(3.09)
ACFTA*GROUPI	0.203***	0.248***	0.158***	0.195***
	(3.60)	(4.21)	(3.24)	(3.79)
ACFTA*GROUPII	0.0338	0.0393	0.0733	0.084
	(0.48)	(0.53)	(1.20)	(1.29)
ACFTA*GROUPIII	0.0442	0.0808	0.0153	0.0491
	(0.79)	(1.38)	(0.31)	(0.96)
ACFTA*GROUPIV	-0.0105	-0.0157	0.0161	0.0199
	(-0.20)	(-0.28)	(0.35)	(0.40)
ACFTA*FRA	0.268***	0.267***	0.243***	0.245***
	(4.87)	(4.61)	(4.94)	(4.71)
ACFTA*TIME	-0.0619**	-0.0642*		
	(-1.98)	(-1.94)		
TIME	-0.0464	-0.0432		
	(-1.31)	(-1.19)		
Constant	1.37**	1.34**	1.07	1.148*
	(2.11)	(2.27)	(1.42)	(1.83)
Industry effect	Yes	No	Yes	No
Time effect	Yes	Yes	Yes	Yes
N	232	232	232	232
R-sq	0.6977	0.8644	0.6555	0.8557

T statistics in the parentheses * p<0.1, **p<0.05, *** p<0.01

of the interaction term $ACFTA * TIME$ in Table 6, since when the value of $TIME$ is large enough, the total impact of ACFTA ($\beta_{11} + \beta_{13} * TIME$) will change from

positive to negative. However, the main finding concerning the existence of the two effects is robust.

4.5. Summary

By examining the industry impacts of ACFTA on FDI for China's manufacturing industry, this paper demonstrates the existence of the market expansion effect and the vertical fragmentation effect. The market expansion effect positively affects sectors with international competitiveness. Through this effect, the free trade agreement strengthens the attractiveness of these sectors to market-seeking FDI. The vertical fragmentation effect positively affects the pro-fragmentation sectors such as machinery and electrical goods. These sectors would be likely to receive more vertical FDI along with the trade liberalization of intermediate goods.

Another notable finding of this study is that, within trade in intermediate goods, ACFTA has created a substitution of zero-tariff goods with non-zero-tariff goods. The surge in trade of non-zero-tariff goods echoes the finding of a trade creation effect of ACFTA on component trade by Sheng et al. (2014).

A policy implication from the results is that the formation of an FTA could be an efficient way of attracting FDI. When FTA partners have large markets, trade liberalization can help China to attract market-seeking FDI. When FTA members participate in the same production value chain, China would receive more vertical FDI. Thus, an FTA between China and Korea or Japan would bring more FDI to China than ACFTA. These FTAs can assist China to keep its position of the pre-eminent recipient of inward FDI among developing country.

Chapter 5 Analyzing Effects of RCEP on FDI in a Firm Heterogeneity CGE Framework

5.1. Introduction

Chapters 3 & 4 have used econometric methods to quantify the effects of ACFTA on FDI, both at country level for China and ASEAN6, and at industry level for China. Both papers have found that ACFTA has encouraged FDI flow to member countries. The positive FDI effect is mainly attributed to the liberalization of goods trade but not services liberalization because the latter is not a main achievement of ACFTA. Consequently, what these papers have not shown is the impact of services liberalization. In this chapter, I intend to complement the previous studies by analyzing the FDI impacts of services liberalization as well as other trade and investment facilitation initiatives.

That services liberalization is not the focus of Chapter 3 & 4 however does not mean that it is unimportant. Quite the contrary, services liberalization has been found to affect FDI in a direct and significant way (Dee & Hanslow, 2000; Konan & Maskus, 2006). FDI has historically been crucial to the effective delivery of services (Tarr, 2012). According to the estimation of WTO, trade through commercial presence (FDI) represents 50% of total services trade (Fink & Jansen, 2007). FDI being involved in services trade constitutes fully two-thirds of the inward stock of FDI, a figure that continues to increase dynamically (Stephenson, 2014). The large amount of overlap between services trade and FDI indicates that services liberalization could almost be equivalent to FDI liberalization. That services liberalization would have a significant effect on FDI and welfare also relates to the high share of services trade in total trade. Based on trade in value added data (TIVA), the average services content of exports for G20 economies is 42% in 2009, and is at or above 50% for countries such as the US, UK, India, France and the EU as a whole (OECD, WTO, & UNCTAD, 2013). The importance of services trade suggests that extending the analysis of free trade agreement from trade in goods to services is a great complement to Chapter 3 & 4.

In this chapter, I experiment with RCEP to simulate its potential impacts on FDI. RCEP is a region-wide FTA under negotiation among ASEAN and its 6 dialogue partners (China, Japan, Korean, India, Australia and New Zealand). The guiding principles and objectives for negotiating RCEP state that it will be a high-quality FTA covering trade in goods, trade in services and other issues. The wide coverage and possible deep trade liberalization make RCEP an ideal research target.

The analysis of RCEP is conducted through CGE modelling as CGE modelling is a proper way to simulate effects of potential FTAs. The CGE model developed in this chapter is grounded in the firm heterogeneity theory of Melitz (2003) and Helpman et al. (2004). Helpman et al. (2004) extend the Melitz model from the selection of exporters and non-exporters to the selection of export and FDI as the way of supplying foreign markets. The main finding is that among firms supplying foreign markets, the most productive ones choose FDI and the less productive ones choose export because firms choosing FDI face higher fixed costs than firms choosing export.

The theories of Melitz and Helpman et al. lay the foundation for my model. In my model, heterogeneous firms are first categorized into foreign firms and domestic firms, and then within each firm type, they are further classified into exporters and non-exporters. According to the theory of Helpman et al. (2004), foreign firms face high entry costs to invest and operate in the host region. Only the most productive firms in home region can become the foreign firms in host region. The foreign firms should be more productive than domestic firms of the host region. That explains the high productivity of multinationals and positive spillovers of FDI. Among foreign firms, as among domestic firms, some can only supply the local market while the more productive ones can supply the export market. Based on this theoretical foundation, I develop a CGE model that integrates FDI into the Firm Heterogeneity model (FHFDI model).

The FHFDI model is based on Zhai (2008), which innovatively introduces the firm heterogeneity theory of Melitz (2003) into a global CGE model of trade. To model firm heterogeneity in a general equilibrium model, Zhai (2008) made a number of assumptions and adjustments, which are significant contributions to the literature and offer insights for

future studies. Applying his model to simulate trade liberalization enables Zhai to compare the results of the firm heterogeneity and traditional Armington models. The comparison shows that the firm heterogeneity model is able to capture more trade (and welfare) effects because it can capture the extensive margin of trade, which is missed by the Armington model. With his focus on the exploration of new techniques, Zhai (2008) treats trade barriers in a relatively simple way, with tariffs as the only trade barriers, and does not consider NTBs or services barriers.

In addition, Zhai (2008) did not seek to incorporate FDI into the firm heterogeneity framework. Although in a later application of the Zhai model, Petri et al. (2012) developed an FDI side model to assess the investment effect of trade liberalization, the FDI side model is mainly based on econometric estimations, rather than incorporating FDI into the CGE model. Therefore, the estimated investment effect is more like the result of a partial equilibrium model, and less likely to reflect structural changes in the economy as a result of trade liberalization.

FHFDI model essentially extends the Zhai model by carefully dealing with the two aspects. First, it builds FDI to the firm heterogeneity CGE framework through sourcing capital to home region and differentiating firms by owners. Firms owned by foreigners are foreign firms. They source capital only from the home region, that is, FDI. Domestic firms source capital from both domestic and foreign markets. That domestic firms use FDI reflects joint ventures in the real economy. Second, FHFDI model deals with both tariff and non-tariff barriers in the simulation of trade liberalization. In addition, FHFDI model treats services barriers differently from tariff barriers. While tariffs raise trading costs, services barriers not only raise costs to imports, but also generate rents to incumbent firms. This treatment of services restraints follows the approach of Konan and Maskus (2006) in dealing with restraints on foreign ownership in services. Empirical findings show that some elements in prices of banking and telecommunication are caused by the monopoly power from services barriers (Kaleeswaran, McGuire, Nguyen-Hong, & Schuele, 2000; Warren, 2000). This way of dealing with services barriers is closer to the real economy.

Accompanying the two main extensions to the Zhai model, FHFDI model also add a capital allocation block. This block determines capital allocation among sectors, regions and firms by following a hierarchal structure. When capital moves across regions, it becomes FDI. Therefore, this section is important in presenting results about the FDI effects of RCEP. Finally, the FHFDI model is calibrated to a Social Accounting Matrix (SAM) built on GTAP 8 Data Base and two FDI databases. The two FDI databases include a global FDI stock database and a global foreign affiliate sales database. Both are the latest developments in FDI data collection and computation (Fukui & Lakatos, 2012; Lakatos, Walmsley, & Chappuis, 2011). With the two FDI databases, I construct a SAM table with foreign firms being separated from the economy.

FHFDI model is a comparative static model, and like most comparative static models, it includes no treatment of time. Economic entities make within-period decisions in comparative static models. With FDI at its core, FHFDI model needs further extension to better model FDI movements since investment decisions are generally regarded as between-period. However, comparative static models are good to start with, and make it easy to focus on important policy issues.

The FHFDI model has three regions (China, its RCEP partners (PTN) and rest of the world (ROW)). China is the country of interest. Simulation results show that China can gain FDI and welfare from RCEP. Services dominate in FDI increases. The results indicate that services liberalization has more significant effect on FDI than tariff reduction. With a 95% reduction in tariffs, a small step of services liberalization in China would increase FDI by US$2 billion, while a big step of services liberalization can generate more FDI increases. A big step services liberalization plus a 50% reduction in fixed trading costs would generate an increase of US$4 billion FDI to China, with US$3.68 billion flowing to services. The welfare gains of China from the three scenarios of RCEP are US$82 billion, 97 billion and 154 billion, accounting for 0.9~1.6% of its GDP.

This chapter is organized as follows: the next section reviews the firm heterogeneity model and its application in CGE frameworks. Section 5.3 presents the model structure and specifications. Section 5.4 illustrates data and calibration. The FHFDI model is tested in

Section 5.5. This section also reports and discusses simulation results. Section 5.6 concludes.

5.2. Literature Review

Chapter 2 has reviewed CGE studies which incorporate modelling aspects of FDI. That review indicates that this is the first time to model FDI within a framework of firm heterogeneity developed by Melitz (2003). The firm heterogeneity model and its application in CGE studies are reviewed in this section.

The firm heterogeneity model is first proposed by Melitz (2003). It is a model of monopolistic competition with heterogeneous firms, which is designed to explain that only the more productive firms are able to export. Opening the economy to trade or increasing the exposure to trade generates a reallocation of market power within the domestic and export markets based on the productivity differences of firms (Akgul, Villoria, & Hertel, 2014). In particular, firms with higher productivity levels are induced to enter the export market; firms with lower productivity levels continue to produce for the domestic market and firms with the lowest productivity levels are forced to exit the industry. These inter-firm reallocations generate a growth in the aggregate industry productivity which then increases the welfare gains of trade. According to Akgul et al. (2014), the main premise of the Melitz model is that aggregate productivity can change even though there is no change in a country's productive technology.

Developed from the Melitz model, Helpman et al. (2004) build a firm heterogeneity FDI model. The model is designed to explain the decision of heterogeneous firms to serve foreign markets either through exports or local subsidiary sales (FDI). The main insights of this model are derived from an interaction between productivity differences across firms and fixed costs of serving foreign markets. Exporters face fixed costs of distribution and servicing costs in foreign markets while firms choosing to serve foreign markets via FDI face these distribution and servicing network costs, as well as the costs of forming a subsidiary in a foreign country and the duplication of the overhead production costs embodied in the sunk cost of entry in the industry in the home country. In equilibrium, only the more productive firms choose to serve the foreign markets and the most productive

among this group will further choose to serve the overseas market via FDI. This study together with the Melitz model lay the foundation for the FHFDI model.

In the CGE application of the firm heterogeneity theory, Zhai (2008) is a pioneering work. Zhai (2008) introduces firm heterogeneity in a global CGE model of trade, and compares the firm heterogeneity model with the traditional Armington model in terms of the ability to capture trade and welfare effects of trade liberalization. The comparison shows that the firm heterogeneity model is able to capture more trade effect because it can capture the extensive margin of trade which is missed by the Armington model. In terms of welfare effect, the firm heterogeneity model introduces three additional channels through which trade liberalization yields welfare gains. The first is the Dixit-Stiglitz "love-of-variety effect"; the second is the gains in aggregate productivity from intra-industry reallocation and the third is the gains from scale effects as a result of the exit of the least productive firms. Under the scenario of a global cut in manufacturing tariffs, the estimated gains in welfare and exports are more than double that obtained from the Armington CGE model.

In modelling, Zhai (2008) abstracts from the Melitz model in several ways to avoid computational difficulties. First, it assumes no entry and exit of firms, characterizing a static equilibrium. In each sector, the total number of registered firms is fixed. But not all registered firms are active. A firm is active in market only if its productivity is not lower than the productivity threshold to enter the market. When the productivity threshold changes, there will be entry or exit of registered firms. Thus, the number of active firms in each market is not fixed. Second, it assumes no sunk costs, but fixed trading costs for firms' domestic sales and exports. The model is calibrated to GTAP 6.2 Data. Simulation results show that the introduction of firm heterogeneity improves the ability of CGE model to capture trade and welfare effects of trade liberalization.

The Zhai model has set a good example in applying the firm heterogeneity model in CGE studies. To introduce the firm heterogeneity model to the GTAP Model, Akgul et al. (2014) follow Zhai's approach to modelling firm heterogeneity and parsing productivity threshold to enter domestic and export markets. But it differs from the Zhai model by incorporating endogenous firm entry and exit behaviors and fixed sunk costs.

In addition to specific efforts devoted to the CGE application of the firm heterogeneity model, a series of studies seek to present and calibrate the Armington model, Krugman's monopolistic competition model and the firm heterogeneity model in a unified CGE framework. Balistreri and Rutherford (2011) present the three basic theories in a general equilibrium framework. The main point of this study is to show how to calibrate different models, especially large models. Inspired by this paper, Dixon, Michael, and Maureen (2013) draw out connections between the three models by developing them sequentially as special cases of a common basic model. They derive the Arminton model by imposing strong assumptions on the basic model and relax some of these assumptions to derive the Krugman model and make further relaxations to derive the Melitz model. Solving the Melitz general equilibrium model using GEMPACK software, they find that the Melitz welfare result is close to that which could be obtained from an Armington model with a higher inter-variety substitution parameter.

Based on the study of Dixon et al. (2013), Oyamada (2014) shows how an Armington-Krugman-Melitz encompassing model can be calibrated. In particular, the author finds that the choice of an initial level for the number of registered firms or sunk costs is perfectly neutral, and when one is given, the other one can be calibrated accordingly. It is the same for the initial level for the proportion of registered but inactive firm and fixed trading costs. As a consequence, only one type of additional information, which is on the shape parameter related to productivity, is required in order to incorporate Melitz-type monopolistic competition and heterogeneous firms into a standard applied general equilibrium model.

The Melitz general equilibrium model has been well developed and integrated to an encompassing module with the Armington model and the Krugman model. But there have been no studies that introduce its extension in terms of FDI as established by Helpman et al. (2004) to a CGE framework. This study contributes to the literature by innovatively incorporating the FDI firm heterogeneity model into a CGE framework. In doing so, this study also contributes in a way that using a theory-based approach to model the high productivity of multinationals.

5.3. Model

This section describes the theoretical structure of the FHFDI model. Built on Zhai (2008), the FHFDI model characterizes a monopolistically competitive market with no sunk costs and no free entry and exit of firms.[38] The main departure from the Zhai model is to separate foreign firms from each economy. Foreign firms refer to foreign affiliates owned by foreigners operating in the host region. They source capital only from the home region, that is, FDI. The production activities of foreign firms directly relate to FDI demand and movements. The FHFDI model takes account of export platform FDI by allowing foreign firms to export. The same as firms in the Melitz model, only more productive foreign firms can export and the less productive ones can only serve the local market of the host region.

For domestic firms, less productive firms sell to the local market and more productive ones export to foreign markets. They source capital from both domestic regions and foreign regions.[39] That some FDI is used by domestic firms reflects joint ventures in the real economy. According to the SAM table of China, joint ventures use the majority of FDI. Until now, the Melitz model has been sufficient to explain the productivity difference between exporters and non-exporters among foreign and domestic firms. The following discussion illustrates the differences between foreign firms and domestic firms in terms of productivity, which relies on the model of Helpman et al. (2004).

To enter the same market, foreign firms need to be more productive than domestic firms operating in the same region. According to Helpman et al. (2004), firms supplying foreign markets through FDI are the most productive ones in the home region because the firms conducting FDI face the highest fixed trading costs. Following the same reasoning, foreign firms in host region are more productive than domestic firms of the host region because these foreign firms face higher costs to operate away from the home region of the foreign firms. The higher costs incurred in producing in the host region determine that foreign firms

[38] Adopting this assumption is to simulate a short-term static equilibrium and be consistent with the modelling of capital under an assumption of no capital accumulation.

[39] Initially, I assume all FDI is consumed by foreign affiliates. Later when constructing the SAM table, I found in some sectors foreign firms cannot exhaust all FDI from its home region. The excess FDI is allocated to domestic firms, forming joint venture. However, I have not separated joint venture from domestic firms as a third firm type.

always face higher trading costs in supplying every market. Thus, foreign firms need to be more productive. In the FHFDI model, the productivity difference is reflected by firm type-specific productivity variables. Originated from here, foreign firms have different industry aggregate price and profits from domestic firms.

In the application of RCEP, the FHFDI model distinguishes three regions, three factors and five sectors. The three regions are China, its RCEP partner (PTN) and rest of the world (ROW). The three factors are land, labor and capital. Within the three factors, land is a specific factor for agriculture. Labor and capital are used in all sectors and fully employed. Labor can move freely across sectors but cannot move across borders. Capital can move across sectors and borders. But the movement of capital across sectors and borders is not free. The five sectors consist of an agriculture sector, two manufacturing sectors and two services sectors. Agriculture is a reference sector with homogeneous firms. In other sectors, firms are heterogeneous.

The classification of manufacturing and services sectors needs more explanation. The manufacturing industry is split into two sectors, with pro-fragmentation sectors as one group and the remaining sectors as another.[40] As defined in Chapter 4, the pro-fragmentation sectors include machinery and electrical goods (GSC2 NO.41, 42 in GTAP database). FTA has a specific vertical fragmentation effect on FDI in these sectors, as highlighted in the literature. However, the FHFDI model is unable to capture this effect because the model has not separated trade in intermediate goods, an important indicator of production fragmentation. Without this impact, the FDI effects of RCEP on manufacturing sectors might be underestimated. To fix this problem, the pro-fragmentation sectors are isolated to receive an additional positive FDI impact on the top of simulation results. The pro-fragmentation sectors are aggregated to the first manufacturing sector ($m1$). The remaining manufacturing sectors are aggregated to the second sector ($m2$).

The services industry is split into two sectors as well. Sector $s1$ includes air transport, water transport and land transport. Sector $s2$ aggregates the remaining services such as finance,

[40] Pro-fragmentation sectors are defined in Chapter 4 as the sectors that are easy to split production process to different countries, conducting production via international production network.

telecommunication, retail trade and business. The split of services is based on the idea that commercial presence is a more important way of delivering services in sector $s2$ than sector $s1$. Based on the close relation between services trade and FDI, and the high proportion of services in FDI stocks, I expect that RCEP would have a significant FDI effect on sector $s2$.

Due to the specification of sectors, markets and firms in the model, a quick summary of the notation that I adopt in this paper is warranted. In the sections that follow F denotes foreign firm while D denotes domestic firm. Country or region is indicated by g, i or j. For variables indicating foreign firms' behaviors, g usually denotes home region, i for host region and j for market. s or c denote a commodity or a sector. In addition, it is important to highlight that the FHFDI model only has industry-level variables and they are distinguished between foreign firms and domestic firms throughout this paper. Appendix C presents all equations of the model.

5.3.1. Demand

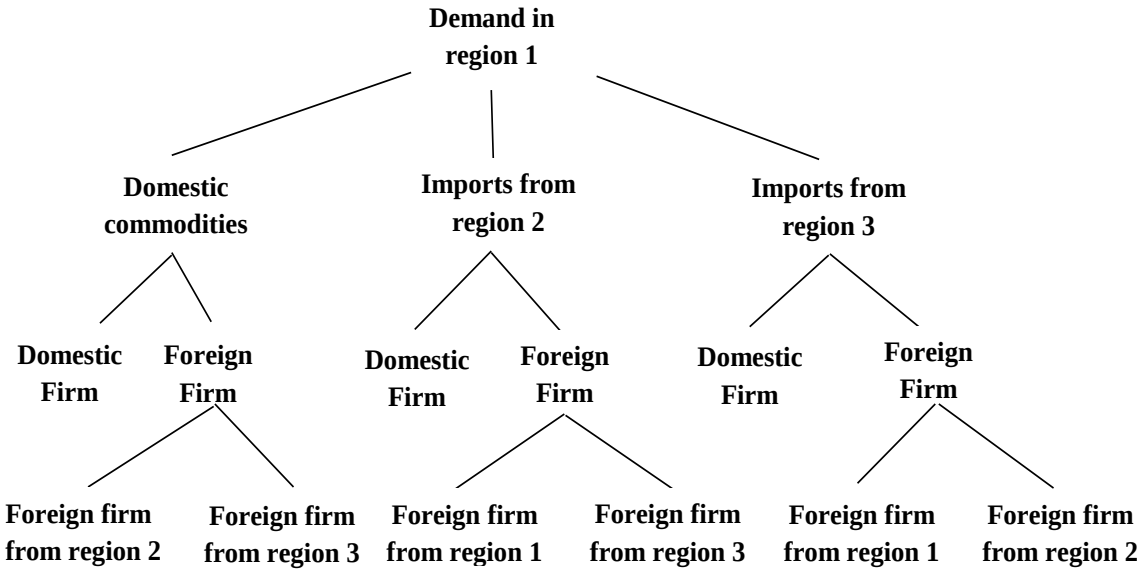

Figure 9 Demand system in a region.

In each region, the representative consumer receives income from the supply of production factors to and dividends of profits from firms. The details of household incomes are given in Section 5.3.4.1. Consumers allocate their disposable income among the consumer goods

and saving using the extended linear expenditure system (ELES), which is derived from maximizing a Stone-Geary utility function. The consumption/saving decision is completely static. Following the Zhai model, saving enters the utility function as a "good" and its price is set equal to the average price of consumer goods. Investment demand and government consumption are exogenous, the values of which are fixed to their initial values in the SAM table. In each sector a composite good is used for household consumption, investment, government consumption and intermediate input, the detailed function is presented in Section 5.3.4.2. In sector $s1$, the transport sector, there is an additional demand from an international transportation pool.[41] The demand from the international transportation pool is exogenous in this model.

In each region, the composite good for consumption is aggregated by following the demand system in Figure 9. Each layer of the system follows a Constant Elasticity Substitution (CES) format. The first layer allocates the aggregate demand in region 1 to commodities sourced from each of the three regions (China, Partner, ROW). Sourcing demand to the origin is a distinguishing feature of monopolistically competitive models, which differs from the Armington approach that differentiates commodities 'at the border' into imported and domestically produced commodities (Akgul et al., 2014; Swaminathan & Hertel, 1996).[42] The second layer allocates the demand for commodities produced in each region to domestic firms and foreign firms. Each type of firm supplies different products with distinct prices. In the final layer, foreign firms are differentiated by ownership. The demand system indicates that in the FHFDI model, varieties are characterized by firm-type product differentiation with national differences.[43]

[41] International transportation pool is a term from the GTAP model, which represents a sector that supplies international transportation services that account for the transportation costs in import price. The supply of these services is provided by individual regional economies, which export them to the global transport sector.
[42] Sourcing imports reflects the assumption of monopolistically competitive model that products are different.
[43] The sectoral demand for each firm type has not been allocated to individual firms. Within each firm type, individual firms face the same price under the assumption of 'large-group monopolistically competition'. Individual firms believe they are too small to influence the composite price of their group. Thus, allocating demand to individual firms does not give many implications.

5.3.1.1. Demand Determination

In each layer, the preferences of a representative consumer are given by a CES sub-utility function over varieties. For the first layer:

$$Q_j^s = [\sum_i \theta_{ij}^{s\frac{1}{\sigma^s}} Z_{ij}^{s\frac{\sigma^s-1}{\sigma^s}}]^{\frac{\sigma^s}{\sigma^s-1}} \qquad \textbf{Eq.(4)}$$

Q_j^s is a CES aggregate good of commodity s demanded in region j sourced from different regions, which is an analogue to utility (Melitz, 2003). Z_{ij}^s is the demand for variety of commodity s produced in region i and sold in region j, θ_{ij}^s is the Armington preference parameter reflecting consumers' tendency for home or imported products, and σ^s is the constant elasticity of substitution among different varieties ($\sigma^s > 1$).

The demand for variety Z_{ij}^s is determined by consumers' optimal consumption decision. The representative consumer choses Z_{ij}^s that minimizes his expenditure:

$$\min_{Z_{ij}^s} \sum_i PZ_{ij}^s Z_{ij}^s$$

$$s.t. Q_j^s = [\sum_i \theta_{ij}^{s\frac{1}{\sigma^s}} Z_{ij}^{s\frac{\sigma^s-1}{\sigma^s}}]^{\frac{\sigma^s}{\sigma^s-1}}$$

where $PZ_{ij}^s$is the price of variety Z_{ij}^s. The minimization problem yields the CES derived demand for variety Z_{ij}^s as:

$$Z_{ij}^s = \theta_{ij}^s Q_j^s [\frac{PQ_j^s}{PZ_{ij}^s}]^{\sigma^s} \qquad \textbf{Eq.(5)}$$

By substituting the derived demand into the utility function (Eq.(4)) and rearranging we can obtain the dual Dixit-Stiglitz price index for product s in region j:

$$PQ_j^s = [\sum_i \theta_{ij}^s PZ_{ij}^{s\,1-\sigma^s}]^{\frac{1}{1-\sigma^s}} \qquad \textbf{Eq.(6)}$$

PQ_j^s is the price of product s faced by consumers in region j. The sectoral average of PQ_j^s is the price of saving in region j, $PSAV_j$.

As the demand for variety from region i, Z_{ij}^{s}, has been determined, we can obtain the optimal demand for product s produced by domestic firm in region i sold to region j in the second layer following the same way of determining Z_{ij}^{s}:

$$QD_{ij}^{s} = \theta D_{ij}^{s} Z_{ij}^{s} [\frac{PZ_{ij}^{s}}{PD_{ij}^{s}}]^{\sigma^{s}} \qquad \textbf{Eq.(7)}$$

QD_{ij}^{s} is total sectoral demand for the variety of commodity s produced by domestic firms in region i sold to region j, θD_{ij}^{s} is the preference parameter for domestic firm products and PD_{ij}^{s} is the aggregate price received by domestic firms. Similarly, we can get the optimal demand for the variety of aggregate foreign firm products:

$$QFS_{ij}^{s} = \theta FS_{ij}^{s} Z_{ij}^{s} [\frac{PZ_{ij}^{s}}{PFS_{ij}^{s}}]^{\sigma^{s}} \qquad \textbf{Eq.(8)}$$

QFS_{ij}^{s} is aggregate sectoral demand for the variety of commodity s produced by foreign firms operating in region i sold to region j, θFS_{ij}^{s} is the preference parameter for foreign firm products and PFS_{ij}^{s} is the dual price. In the final layer, consumers choose the optimal demand for variety of commodity s produced by foreign firms from different home region.

$$QF_{gij}^{s} = \theta F_{gij}^{s} QFS_{ij}^{s} [\frac{PFS_{ij}^{s}}{PF_{gij}^{s}}]^{\sigma^{s}} \qquad \textbf{Eq.(9)}$$

QF_{gij}^{s} is aggregate sectoral demand for the variety of commodity s produced by foreign firms from home region g operating in region i sold to region j, θF_{gij}^{s} is the preference parameter for products of foreign firms owned by region g and PF_{gij}^{s} is the price received by foreign firms from home region g operating in region i sold to region j.

5.3.1.2. Issues with Behavioral Parameters

In the demand system, there are two types of behavioral parameters. One type is preference parameters and the other is substitution elasticity. For the preference parameters, the Melitz model sets them to 1 to isolate the effect of fixed costs in trade determination, which is different from the assumption of the Armington model that the taste bias of consumers is an important determinant of trade pattern. The FHFDI model follows the Melitz theory to

emphasize the importance of fixed trading costs, but it also captures consumers' preference. The preference parameters are calibrated from the real data, which are not equal to 1, but less than 1. That is, the trade data show that there is taste bias of consumers.

For the elasticity of substitution among varieties, I choose the same elasticity for all layers in the demand system. That is to facilitate the model calibration. Choosing the same elasticity for all layers is not new to my model. In his modeling of foreign firms, Tarr (2012) has set the same elasticity of substitution for varieties from different sources and varieties from different firms. Tarr states that when the elasticity of substitution are equal at all levels, the CES function reduces to strictly firm-level product differentiation. In the FHFDI model, firm-level product differentiation has incorporated national differences. [44] That is because in each sector, firms are distinguished from each other in terms of ownership, production region and market. The difference in production region determines national differences of variety.[45]

5.3.2. Production

In sectors with heterogeneous firms, the total number of potential firms is fixed. The productivity of firms follows a Pareto distribution, from which firms get their productivity draws before entering an industry. Entry into a market requires paying fixed trading costs that are specific to a destination market. The fixed trading costs include the distribution and servicing network costs, as well as the costs occurred in registration, approval and operation. The firm-level heterogeneity means that production is carried out only by firms that are productive enough to afford staying in the market given fixed trading costs. Even in the domestic market, there is a selection of firms because fixed trading costs exist in

[44] Differently, in the Tarr model, the final good sector is completely indifferent between a domestic or foreign variety. This is drawn from the assumption that foreign varieties have identical cost structures and the demand for all foreign varieties is identical, which implies that foreign firms are indifferent to each other. Similarly, domestic firms are indifferent too. Firm-level product difference substitutes national difference.

[45] By choosing the same elasticity of substitution for all layers, the FHFDI model avoids the contrast between the Petri model (Petri, 1997) and the FTAP model in terms of commodity substitution. The elasticity of substitution among commodities produced by the same firm from different location is the same as that of commodities produced in the same location by firms with different nationality.

supplying the domestic market. Therefore, not all potential firms carry out production. The number of active firms in each market varies with the possibility of entry into the market.

Facing the highest fixed trading costs, firms that choose to supply foreign markets through setting up subsidiaries should be the most productive. The foreign subsidiaries of these most productive firms become foreign firms of the host region. The number of foreign firms is determined by the total mass of potential firms in home region and the probability of productive enough to invest in a host region. Hence, in a host region such as China, there are two types of firms, domestic firms and foreign firms. The two types of firms can supply all three markets (China, PTN and ROW). In supplying the PTN and ROW markets, domestic firms and foreign firms located in China choose exportation rather than FDI. The case that Chinese firms choose FDI to supply PTN and ROW has been captured by the existence of foreign firms owned by China operating in these markets. The case that foreign firms supply third market through re-investment is not considered in this study.

In supplying the export market, firms face higher fixed trading costs than supplying the local market. Following the Melitz theory, only more productive firms among each firm type can enter the export market. Thus, within each firm type, the number of exporters is less than that of active firms in the host market. Trade liberalization alters productivity thresholds to enter each market, and thus, firm numbers change accordingly.

The following sub-sections discuss the production structures of foreign firms and domestic firms that characterize the monopolistically competitive industry with firm-level heterogeneity. The derivation of functions for domestic and foreign firms follows a similar approach. To save space and clarify new features of this paper relative to literature, the following sections mainly show the functions of foreign firms.

5.3.2.1. Trade Barriers

Trade barriers consist of tariff barriers and non-tariff barriers (NTBs). In the FHFDI model, tariff barriers exist in agriculture (a) and the two manufacturing sectors ($m1$ and $m2$), while NTBs exist in all sectors. Thus, in the two services sectors, NTBs are the only trade restrictions. In comparison with tariff barriers, NTBs are more difficult to quantify. Many papers have endeavored to quantify NTBs, not least because NTBs are important in

analyzing services trade and FDI.[46] This paper adopts the estimation of Petri et al. (2012), which is in turn drawn from the World Bank estimations for NTBs on goods (Helble, Shepherd, & Wilson, 2007; Looi Kee, Nicita, & Olarreaga, 2009) and estimations for NTBs on services of Wang, Mohan and Rosen at the Peterson Institute for International Economics. Their estimations are well grounded in trade theory and account for different forms of trade protection. The estimation results coincide with expectation for NTBs that poor countries tend to have more restrictive trade policies but they also face higher trade barriers on their exports.

Table 8 presents the estimated tariff equivalences of NTBs by region and sector at the year of 2007. China, as a developing country, adopts relatively high NTBs, especially in the services sectors. Its services barriers are as high as twice those in PTN and more than three times of those in ROW. Its agriculture sector is also protected from imports by restrictive NTBs. The NTBs in manufacturing sectors are relatively low, not only in China, but also in PTN and ROW. The NTBs of PTN in the agriculture sector are the highest among the three regions. ROW adopts the lowest NTBs in all sectors. As with PTN, agriculture sector exhibits the most restrictive trade barriers among all sectors in ROW. Those are the NTBs before trade liberalization under RCEP and each region adopts the same NTBs on imports from all sources. After RCEP, China and PTN would preferentially reduce trade barriers to each other, but retain high barriers to ROW.

Table 8 Tariff equivalences of NTBs by region and sector (Units: ratio of tariff to imports)

	a	m1	m2	s1	s2
China	0.334	0.167	0.167	0.747	0.766
PTN	0.404	0.155	0.155	0.363	0.376
ROW	0.281	0.129	0.129	0.196	0.205

Note: According to the studies estimating NTBs, the unit of these indices for NTBs is the same as tariff, which is the ratio of tariff to trade value. The values for sectors $a, m1, m2, s1$ of China are directly drown from Petri et al. (2012), while the values for sector $s2$ are the simple average of its sub-sectors, and the values for PTN and ROW are obtained by following the same way.

In the FHFDI model, NTBs in sector $s2$ are treated differently from those in other sectors. In other sectors, NTBs raise costs to imported goods and services, the same as tariff barriers. In sector $s2$, however, NTBs are modelled as tax equivalences that not only raise costs to

[46] See, for example, Hoekman (1996), Hanslow (2000) and Petri et al. (2012).

imported services, but also generate rents to incumbent firms in the protected market. The inclusion of a rent-creating effect of services barriers is drawn from the literature (Dee & Hanslow, 2000; Konan & Maskus, 2006). These studies argue that trade restrictions in some services sectors, including banking and telecommunications, can help existing firms to gain some monopoly power, resulting in a rent-creating distortion in price. However, there is no exact measurement of the rent-creating effect and cost-raising effect of services barriers. Dee and Hanslow (2000) adopt a full rent-creating effect, but at the same time, they admit that in some services sectors, trade restrictions raise costs. Konan and Maskus (2006) experiment with different mechanisms for allocating the total price wedge between the distortions of rent-creating and cost-raising. The rent from services barriers goes to firms' profit, while the tariff revenue from tariff equivalents of NTBs is modeled to flow to ice-berg costs.

In the FHFDI model, the price distortion from services barriers is allocated between rent-creating (v_j^{s2}) and cost-raising (λ_{ij}^{s2}) such that:

$$v_j^{s2} = \alpha * \frac{\sum_i tn_{ij}^{s2}}{2}, \ \lambda_{ij}^{s2} = tn_{ij}^{s2} - v_j^{s2}, i \neq j \qquad \textbf{Eq.(10)}$$

where v_j^{s2} represents the rent-creating effect of services barriers which impacts on all firms in sector $s2$ supplying market j, including domestic firms of region j. tn_{ij}^{s2} is the tariff equivalents of NTBs being imposed by region j on services $s2$ imported from region i. λ_{ij}^{s2} represents the cost-raising effect of services barriers on imports from region i. $\lambda_{ij}^{s2} = 0$ when $i = j$. α is the percentage share of the rent-creating effect in the total price wedge from trade restrictions. A simulation of NTBs reduction in services sector $s2$ will lower v_j^{s2} and λ_{ij}^{s2} accordingly.

The calculation of the rent-creating effect is based on the average of NTBs being imposed by region j on imports from different regions. The average of NTBs is $\frac{\sum_i tn_{ij}^{s2}}{2}$, as there are two other regions besides j in the FHFDI model. The reason for calculating the rent share based on the average of NTBs is because the rent-creating effect applies to all firms supplying market j, and all the incumbent firms should have the same monopoly power

based on the trade restrictions. Using the average of services barriers as the base for the rent share is the most suitable way I could find. The value of α is set to 10%. The value is chosen based on the tariff equivalents of NTBs and market structures of the three regions. In PTN and ROW, the main markets such as the US and EU are relatively competitive and firms are unlikely to have high monopoly power. In China, services sector $s2$ is protected by high trade barriers, which means the monopoly power of existing firms could be high. Given the high services barriers (0.766) in China, a 10% rent-creating effect of the barriers is equal to a 7.66% price markup on marginal costs, which seems to be a sufficient markup from trade restrictions.

The cost-raising effect of services barriers, λ_{ij}^{s2}, comprises the remaining NTBs after subtracting the rents. It is specific to the source region of services and is the trade variable costs in sector $s2$. The trade variable costs in other sectors are equal to the sum of tariff rates and NTBs:

$$t_{ij}^{s} = tm_{ij}^{s} + tn_{ij}^{s}, s \neq s2,\ t_{ij}^{s2} = \lambda_{ij}^{s2} \qquad \textbf{Eq.(11)}$$

t_{ij}^{s} is the trade variable costs on imported goods or services s from region i to region j and tm_{ij}^{s} is the corresponding tariff rates. $t_{ij}^{s} = 0$ when $i = j$. In sectors other than $s2$, a simulation of tariff and NTBs reduction will lower t_{ij}^{s} through reductions in tm_{ij}^{s} and tn_{ij}^{s}.

5.3.2.2. Fixed Trading Costs

As noted before, fixed trading costs determine firms' self-selection into each market. The fixed trading costs of domestic firms, FD_{ij}^{s}, differentiate themselves in terms of firms' operating region i, market j and sector s. The fixed trading costs of foreign firms, FF_{gij}^{s}, vary with one more index, the home region g. As $g \neq i$, foreign firms from home region g usually face some entry barriers to conduct production in region i that can be avoided by domestic firms of region i. Thus, we have $FF_{gij}^{s} > FD_{ij}^{s}$. In addition, fixed trading costs are higher in exportation when $i \neq j$ relative to $i = j$. In the FHFDI model, fixed trading costs of each firm type are exogenous and they are made up of capital, labor and intermediate input costs.

5.3.2.3. Production Variable Costs

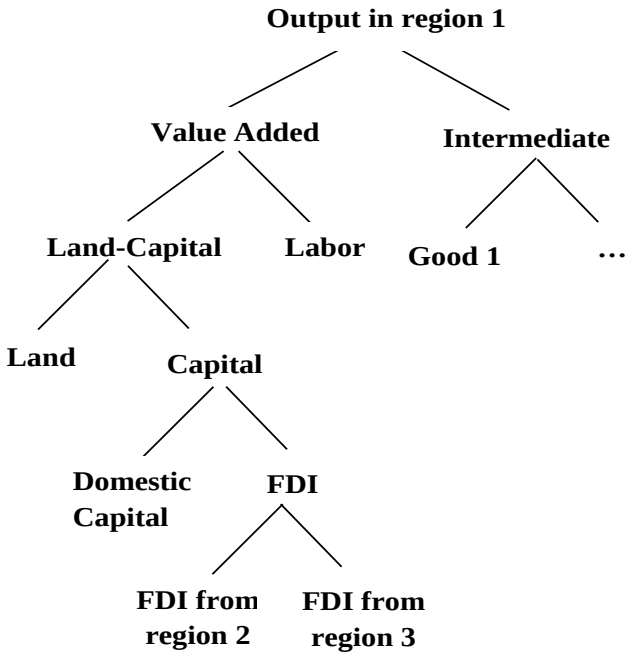

Figure 10 Production tree in a sector.

Production variable costs are made up of value added costs and intermediate costs, as shown in the production tree of Figure 10. The top level output is a CES aggregate of value added and intermediate inputs. The top level unit cost is dual to the CES aggregation function and it defines the marginal cost of sectoral output. In the second layer, value added is a CES aggregate of primary inputs while aggregate intermediate demand is split into each commodity according to Leontief technology. Land is a specific factor for the agriculture sector. In manufacturing and services sectors, firms use labor and capital as primary factors. Labor inputs of foreign firms are sourced from the host region. Capital inputs of foreign firms are sourced from home region.

Capital inputs of domestic firms are sourced from three regions. Since foreign firms cannot exhaust all FDI from the home region, the excess FDI flows to domestic firms. Thus, in the production tree of domestic firms, capital input is first decomposed into domestic capital

and FDI following a CES technology, and then FDI input is decomposed into different sources following a Leontief technology. [47]

For the layers with CES aggregation, firms minimize cost according to the following cost minimization problem:

$$\min_{x_{gij}^{fs}} \sum_{f} w_{gi}^{fs} x_{gij}^{fs}$$

$$s.t. XF_{gij}^{s} = \omega_{gij}^{s} [\sum_{f} \delta_{gij}^{fs\frac{1}{\sigma'}} x_{gij}^{fs\frac{\sigma'-1}{\sigma'}}]^{\frac{\sigma'}{\sigma'-1}}$$

where w_{gi}^{fs} is the price of input f employed by foreign firms from home region g operating in region i industry s. Even though the input price is indexed by sector and regions, it does not necessarily change with all indexes. For instance, the wage of labor is only specific to the production region and it does not change across firm types and sectors. That is because I assume labor can freely move across sectors and firms but cannot move across borders. Returns to capital vary with all indexes.

x_{gij}^{fs} is the demand for input f of foreign firms from home region g operating in region i sector s sold to region j. Different from input prices, input demand varies across all indexes. ω_{gij}^{s} is a scale parameter of the production function and δ_{gij}^{fs} is a share parameter of input f. σ' is the CES substitution elasticity among inputs.

XF_{gij}^{s} is the industry output of foreign firms from home region g operating in region i industry s sold to region j. However, it is not the final industry output, but more like an aggregate of inputs. The final output for consumption equals demand, QF_{gij}^{s}. The relation between XF_{gij}^{s} and QF_{gij}^{s} without considering the quantity loss in international transportation (iceberg cost) is represented in the following equation:

[47] Leontief technology is chosen to allocate FDI being used by domestic firms to different sources because of zero FDI values. According to the SAM table, FDI from some sources are exhausted by foreign firms and no FDI is left for domestic firms. The existence of zero values makes it hard to adopt a CET technology. Adopting the Leontief technology infers that the cells with zero values in the SAM table will be always zero.

$$QF^{s}_{gij} = \widetilde{\varphi F^{s}_{gij}} XF^{s}_{gij} \qquad \textbf{Eq.(12)}$$

$\widetilde{\varphi F^{s}_{gij}}$ is the industry average productivity of foreign firms in sector s from home region g operating in region i sold to region$j$. In the agriculture sector with homogeneous firms, $\widetilde{\varphi F^{s}_{gij}} = 1$, and output equals demand. In sectors with heterogeneous firms, $\widetilde{\varphi F^{s}_{gij}} > 1$, suggesting the final output is more than the aggregate of inputs.

The cost minimization problem yields the optimal demand for each input:

$$x^{fs}_{gij} = \frac{1}{\omega^{s}_{gij}} \frac{XF^{s}_{gij} {\delta^{fs}_{gij}}^{\sigma'} {w^{fs}_{gij}}^{-\sigma'}}{[\sum_f {\delta^{fs}_{gij}}^{\sigma'} {w^{fs}_{gij}}^{1-\sigma'}]^{\frac{\sigma'}{\sigma'-1}}} \qquad \textbf{Eq.(13)}$$

Bringing Eq.(13) to the cost function, we can get the due cost, CF^{s}_{gij}:

$$CF^{s}_{gij} = \frac{1}{\omega^{s}_{gij}} [\sum_f \delta^{fs}_{gij} {w^{fs}_{gi}}^{1-\sigma'}]^{\frac{1}{1-\sigma'}} \qquad \textbf{Eq.(14)}$$

CF^{s}_{gij} is the unit cost of XF^{s}_{gij} and $CF^{s}_{gij}/\widetilde{\varphi F^{s}_{gij}}$ is the unit cost of QF^{s}_{gij}. When the relation between demand and output is adjusted by iceberg costs and firm numbers, the unit cost of demand will be adjusted accordingly, which is illustrated in the next section.

5.3.2.4. Productivity Draw

Firms are assumed to draw their productivity level, φ, from a Pareto distribution with the lower bound $\varphi_{min} = 1$, and shape parameter γ. The cumulative distribution function of the Pareto distribution, $G(\varphi)$, and the density function, $g(\varphi)$ are:

$$G(\varphi) = 1 - \varphi^{-\gamma}, \; g(\varphi) = \gamma\varphi^{-\gamma-1} \qquad \textbf{Eq.(15)}$$

The shape parameter γ is specific to sector. It is an inverse measure of the firm heterogeneity. If it is high, it means that the firms are more homogeneous. It is also assumed that $\gamma > \sigma - 1$, with σ as the elastisity of substitution among varieties in a sector. This assumption is important in aggregation and it ensures that the size of distribution of firms has a finite mean (Zhai, 2008). The number of foreign firms in sector s from home region g operating in region i sold to region j, MF^{s}_{gij}, is:

$$MF_{gij}^{s} = N_g^s \left(1 - G\left(\varphi f_{gij}^{s\ *}\right)\right) \qquad \textbf{Eq.(16)}$$

N_g^s is the total mass of potential firms in home region g sector s, which is an exogenous variable and $\varphi f_{gij}^{s\ *}$ is the productivity threshold for foreign firms owned by region g operating in sector s region i to enter the market j. $1 - G\left(\varphi f_{gij}^{s\ *}\right)$ is the probability that foreign firms owned by region g operating in sector s region i can enter the market j, or the probability of foreign firms that are at a higher or at least the same productivity level as the productivity threshold. Since the total mass of potential firms is fixed, the number of foreign firms is totally dependent on productivity threshold.

With the assumption that each firm corresponds to one variety, the number of foreign firms represents the number of varieties produced by foreign firms. Adjusted by the Dixit-Stiglitz variety effect and iceberg cost, the relation between XF_{gij}^{s} and QF_{gij}^{s} becomes:

$$XF_{gij}^{s} = \frac{\tau_{ij}^{s} QF_{gij}^{s}}{\widetilde{\varphi F_{gij}^{s}}} MF_{gij}^{s\ {}^{1}/_{1-\sigma^s}} \qquad \textbf{Eq.(17)}$$

where τ_{ij}^{s} is the iceberg cost whereby only a fraction $1/\tau_{ij}^{s}$ arrives after shipping one unit of good from region i to region j ($\tau_{ij}^{s} = 1$ for $i = j$). The unit cost of QF_{gij}^{s} becomes $\frac{\tau_{ij}^{s} CF_{gij}^{s}}{\widetilde{\varphi F_{gij}^{s}}} MF_{gij}^{s\ {}^{1}/_{1-\sigma^s}}$.

5.3.2.5. Markup Pricing

The model assumes "large-group monopolistic competition". Under this assumption, individual firms believe they are too small to influence the composite price of their group (Tarr, 2012). The optimal pricing rule for a monopolistic competition industry is to charge a constant markup over marginal cost which is referred to as the mark-up pricing rule given by:

$$PF_{gij}^{s} = (1 + v_j^s) \frac{\sigma^s}{\sigma^s - 1} \frac{(1 + t_{ij}^{s}) \tau_{ij}^{s} CF_{gij}^{s}}{\widetilde{\varphi F_{gij}^{s}}} MF_{gij}^{s\ {}^{1}/_{1-\sigma^s}} \qquad \textbf{Eq.(18)}$$

where PF_{gij}^{s} is the industry aggregate price of product s produced by foreign firms from home region g operating in region i sold to region j. $(1 + v_j^s)$ is the price wedge from the

rent-creating effect of NTBs in sector $s2$. $\frac{\sigma^s}{\sigma^s-1}$ is the mark-up drawn from optimal pricing rule; $(1+t_{ij}^s)$ is the trade variable costs on goods s being shipped from region i to region j and $\frac{\tau_{ij}^s CF_{gij}^s}{\widetilde{\varphi F_{gij}^s}} MF_{gij}^s{}^{1/1-\sigma^s}$ is the unit cost of QF_{gij}^s. Trade liberalization between i and j can pull down PF_{gij}^s through reducing trade variable costs and rents, and through increasing the number of firms in market j.

For the agriculture sector (a) with homogeneous firms, the markup is zero and productivity is fixed and normalized to one. Their producer prices are simply equal to marginal costs:

$$PF_{gij}^a = (1+t_{ij}^a)\tau_{ij}^a CF_{gij}^a \qquad \textbf{Eq.(19)}$$

5.3.2.6. Firm Profits (Productivity Threshold)[48]

Each foreign firm with productivity φf_{gij}^s makes the following profit from selling product s on the $i-j$ link:

$$\pi f_{gij}^s = \frac{pf_{gij}^s qf_{gij}^s}{1+t_{ij}^s} - cf_{gij}^s \frac{\tau_{ij}^s qf_{gij}^s}{\varphi f_{gij}^s} - FF_{gij}^s \qquad \textbf{Eq.(20)}$$

where the first component, $\frac{pf_{gij}^s qf_{gij}^s}{1+t_{ij}^s}$, gives the total revenue, the second component, $cf_{gij}^s \frac{\tau_{ij}^s qf_{gij}^s}{\varphi f_{gij}^s}$, gives the total variable cost and FF_{gij}^s is the fixed trading cost of selling on the $i-j$ link. Before deriving the productivity threshold, we substitute price and demand quantity in Eq.(20) by the optimal price and optimal demand as shown in the following two equations:

$$pf_{gij}^s = (1+v_j^s)\frac{\sigma^s}{\sigma^s-1}\frac{(1+t_{ij}^s)\tau_{ij}^s cf_{gij}^s}{\varphi f_{gij}^s} \qquad \textbf{Eq.(21)}$$

$$qf_{gij}^s = \theta_{ij}^s \theta FS_{ij}^s \theta F_{gij}^s Q_j^s [\frac{PQ_j^s}{pf_{gij}^s}]^{\sigma^s} \qquad \textbf{Eq.(22)}$$

[48] The lower case letters in this section are used to represent the variables for individual firms rather than industry aggregate variables.

For individual firms, price and demand are not adjusted by the Dixit-Stiglitz variety effect. The price equation (Eq.21) is drawn from (Eq.18). The demand function (Eq.22) is drawn from the optimal demand functions (Eq.5, 8, 9) in section 5.3.1.1. The unit cost faced by each firm is the same as the industry unit cost, $cf_{gij}^{s} = CF_{gij}^{s}$. After substitution, we obtain the maximized profit for each firm as follows:

$$\pi f_{gij}^{s} = \theta_{ij}^{s}\theta fs_{ij}^{s}\theta f_{gij}^{s}(1 + v_j^{s}\sigma^{s})\left(\frac{\tau_{ij}^{s}CF_{gij}^{s}}{(\sigma^{s}-1)\varphi f_{gij}^{s}}\right)^{1-\sigma^{s}}\left(\frac{PQ_j^{s}}{(1+v_j^{s})(1+t_{ij}^{s})\sigma^{s}}\right)^{\sigma^{s}}Q_j^{s} - FF_{gij}^{s}$$

Eq.(23)

Foreign firms from region g in industry s are active on the $i-j$ link as long as the variable profit can cover the fixed trading costs. The marginal firm that makes zero profits produces at the threshold productivity level. Thus, the zero-cutoff level of productivity for foreign firms from region g supplying on the $i-j$ link is where:

$$\pi f_{gij}^{s}\left(\varphi F_{gij}^{s}{}^{*}\right) = 0$$

Solving it, we get the productivity threshold for foreign firms from region g supplying on the $i-j$ link:

$$\varphi F_{gij}^{s^{*}} = \frac{\tau_{ij}^{s}CF_{gij}^{s}}{(\sigma^{s}-1)}\left(\frac{P_j^{s}}{\sigma^{s}(1+t_{ij}^{s})(1+v_j^{s})}\right)^{\frac{\sigma^{s}}{1-\sigma^{s}}}\left(\frac{FF_{gij}^{s}}{Q_j^{s}(1+v_j^{s}\sigma^{s})\theta_{ij}^{s}\theta FS_{ij}^{s}\theta F_{gij}^{s}}\right)^{\frac{1}{\sigma^{s}-1}} \qquad \textbf{Eq.(24)}$$

Any foreign firms from region g that has a productivity level below $\varphi F_{gij}^{s^{*}}$ cannot afford to produce and supply on the $i-j$ link, and therefore exits. On the other hand, any firm that has a productivity level above $\varphi F_{gij}^{s^{*}}$ stays in the market. This is one of the most important functions in the FHFDI model. It reflects the main feature of the firm heterogeneity model. The productivity threshold is higher with higher costs, including fixed trading costs, production variable costs and trade costs. It is lower with higher price and demand, or revenue. It determines the probability of firms that can enter a specific market and in turn, determines the number of active firms in the market.

The formation of RCEP will lower the productivity threshold for firms located in member countries to enter partners' markets. The main reason is the reduction in trade costs.

Specifically, t_{ij}^{s} will be reduced by RCEP and the reduction of t_{ij}^{s} results in lower $\varphi F_{gij}^{s^*}$. On the contrary, we are not sure about the results from the reduction of v_j^s. In addition, trade liberalization will lead to a lower productivity threshold through reducing production variable costs since the price of intermediate goods will go down along with the formation of RCEP.

With the Pareto distribution, the average productivities for foreign firms from region g supplying on the $i-j$ link can be expressed as:

$$\widetilde{\varphi F_{gij}^{s}} = \varphi F_{gij}^{s^*}\left(\frac{\gamma^s}{\gamma^s-\sigma^s+1}\right)^{1/(\sigma^s-1)} \qquad \textbf{Eq.(25)}$$

The average productivity enters the industry aggregate demand and price functions (Eq.17, 18).

5.3.2.7. Industry Profits

With the assumption of no entry and exit of firms, the industry profits for each firm type could be non-zero. The function of industry profit follows the format of individual firms' profit equation, with substitution of firm level variables with industry aggregate variables.

$$\Pi F_{gij}^{s} = \frac{PF_{gij}^{s} QF_{gij}^{s}}{1+t_{ij}^{s}} - CF_{gij}^{s} XF_{gij}^{s} - MF_{gij}^{s} FF_{gij}^{s} \qquad \textbf{Eq.(26)}$$

where ΠF_{gij}^{s} is the total industry profits of foreign firms from home region g supplying on the $i-j$ link. As with the profit function for individual firms, the first component in Eq.(26) is the total industry revenue; the second component is the total industry variable cost and the third component is the total industry fixed trading cost.

Following the approach of Zhai (2008), I calibrate the fixed trading costs, FF_{gij}^{s}, which could be expressed as:

$$FF_{gij}^{s} = \frac{PF_{gij}^{s} QF_{gij}^{s}}{\left(1+v_j^s\right)\left(1+t_{ij}^{s}\right)} \frac{1}{\sigma^s} \frac{1}{MF_{gij}^{s}} \frac{\gamma^s-\sigma^s+1}{\gamma^s} (1+v_j^s \sigma^s) \qquad \textbf{Eq.(27)}$$

Bringing Equations (17, 18 & 27) into Eq.(26), the total industry profits can be simplified to:

$$\Pi F_{gij}^{s} = \frac{PF_{gij}^{s} QF_{gij}^{s}}{\left(1+v_j^s\right)\left(1+t_{ij}^{s}\right)} \frac{1}{\sigma^s} \frac{\sigma^s - 1}{\gamma^s} (1 + v_j^s \sigma^s) \qquad \textbf{Eq.(28)}$$

5.3.3. Capital Allocation

Capital allocation is an additional and distinguishing block in FDI-CGE models. This section follows the way of Petri (1997) and the FTAP model of Hanslow, Phamduc, and Verikios (2000) to deal with capital allocation. Capital is allocated to the highest return activities. We first introduce rate of return before illustrating how capital is being allocated.

5.3.3.1. Rate of Return

Drawn from the FTAP model, rate of return to capital is determined by rental price of capital and the price of investment (capital price) as expressed in the following equation:

$$R = \frac{WK}{PA} \qquad \textbf{Eq.(29)}$$

where R is rate of return, WK is rental price of capital and PA is capital price. Rental price is determined by the market clearance condition for capital. It varies across regions and sectors. Capital price is specific to the host region and is uniform across industries. It is equal to the price of capital creation, which can be expressed as:

$$PA_j = \frac{EINV_j}{\sum_s QINV_j^s}, EINV_j = \sum_s PQ_j^s QINV_j^s \qquad \textbf{Eq.(30)}$$

where PA_j is the price of investment in region j, $EINV_j$ is the expenditure on investment of region j and $QINV_j^s$ is investment demand for product s in region j.

With rental price and investment price, rate of return can be derived. Following the assumption of Petri (1997) that each unit of investment provides a return of \$1, the inverse of rate of return is the price of the asset, $1/R$. Asset price is the channel through which rate of return enters the system of capital allocation and the details are given in the following section.

5.3.3.2. Capital Allocation Tree

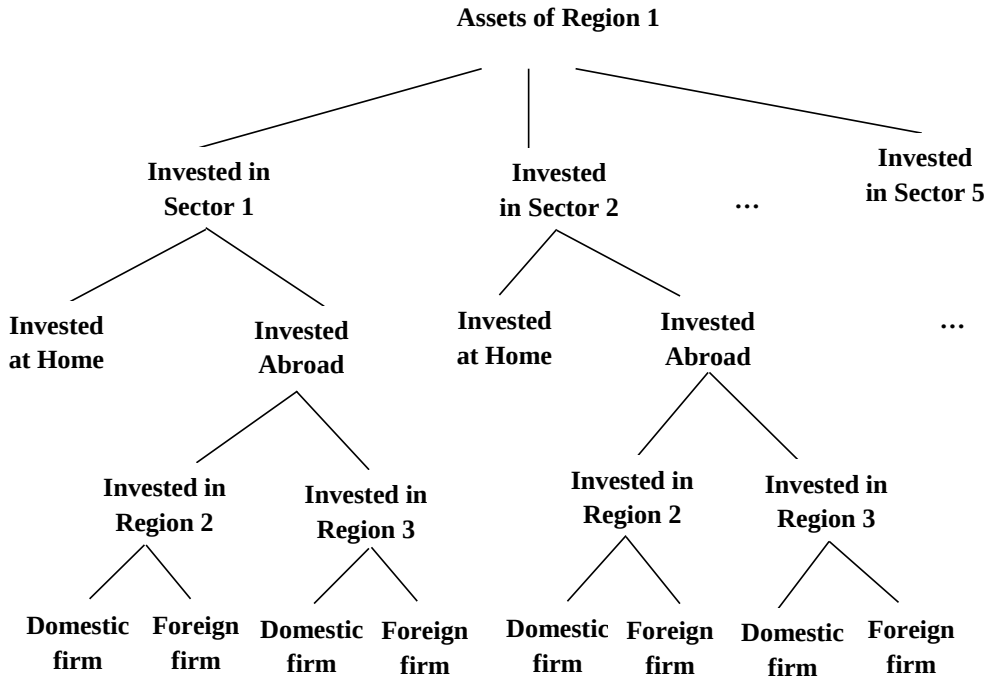

Figure 11 Capital allocation structure.

Following the rule of chasing the highest return activities, capital is allocated to different sectors, regions and firms according to Figure 11. The top layer determines the allocation of regional assets across production sectors. The choice of sector is relatively early in the nesting structure, so that the implied elasticity guiding the choice of sector, holding only total wealth constant, is relatively low. The relatively low transformation elasticity of capital across sectors captures the idea that FDI knowledge capital will often be sector-specific (Markusen, 2002). The next layer allocates regional assets between domestic and foreign investment (FDI) by sector. Then, foreign investments are allocated to specific host regions. This level determines bilateral FDI flow between regions, which reflects the result that the model looks for. Finally, FDI in each host region is allocated between domestic firms and foreign affiliates. Each of these branches uses a CET-based allocation function

except the final layer. In the final layer, FDI is distributed to domestic firms and foreign firms following a Leontief technology. [49]

In the layers with CET-based allocation functions, the investor is assumed to derive benefits from investments as given by a utility function. The following equations show the utility maximizing problem in the top layer:

$$\max_{AK_g^s} U = \left(\sum_s \alpha a_g^{s\,\frac{1}{\sigma_1^a}} AK_g^{s\,\frac{\sigma_1^a-1}{\sigma_1^a}}\right)^{\frac{\sigma_1^a}{\sigma_1^a-1}}$$

$$S.T \sum_s \left(AK_g^s \frac{1}{RK_g^s}\right) = W_g$$

where AK_g^s is the physical asset allocated to sector s region g and $\frac{1}{RK_g^s}$ is the price of asset with RK_g^s as rate of return. $AK_g^s \frac{1}{RK_g^s}$ is the value of asset. The total value of assets across sectors is the wealth of region g, W_g. The total wealth of each region is exogenous. Thus, total asset value is a constraint, within which rate of return is contained. In this way, rate of return enters the system to determine capital allocation. αa_g^s is the share parameter for asset in sector s region g. σ_1^a is the transformation elasticity of assets among sectors. Following the FTAP model, it is set to 1.2. The following transformation elasticity of asset is all set to the corresponding value in the FTAP model.

Solving the utility maximization problem, we get the optimal capital supply in each sector:

$$AK_g^s = \frac{\alpha a_g^s RK_g^{s\,\sigma_1^a} W_g}{\sum_c \alpha a_g^c RK_g^{c\,\sigma_1^a-1}} \qquad \textbf{Eq.(31)}^{50}$$

[49] The reason for adopting Leontief function in the final layer is because of data issues. In some cases, there is no FDI being distributed to domestic firms. The existence of zero values makes it difficult to adopt a CET format.

[50] The function of AK_g^s looks different from the conventional optimization results of CET aggregation problems. That is because W_g is not a physical asset and does not have a price. In the other layers with price in total asset value, the optimal supply of asset is expressed in a similar way as the optimal demand in section 5.3.1.1.

Eq.(31) shows that the supply of asset, AK_g^s, positively correlates with its rate of return, RK_g^s, which reflects the rule of capital allocation that capital chases the highest rate of return. The capital allocation rule is even clearer in the other layers. In the second layer where sectoral assets are distributed to domestic and foreign markets, the optimal supplies are:

$$AD_g^s = \alpha D_g^s AK_g^s [\frac{RD_g^s}{RK_g^s}]^{\sigma_2^a}, AF_g^s = \alpha F_g^s AK_g^s [\frac{RF_g^s}{RK_g^s}]^{\sigma_2^a} \quad \textbf{Eq.(32)}$$

where AD_g^s and AF_g^s are the assets of sector s in region g being allocated to the domestic market and foreign markets respectively, αD_g^s and αF_g^s are the preference shares of domestic and foreign markets and RD_g^s and RF_g^s are the corresponding rates of return. σ_2^a is the transformation elasticity of assets among domestic and foreign markets, which is set to 1.3.

In the third layer, AF_g^s is allocated to different foreign markets and the optimal supply of assets from region g to region i in sector s is:

$$AFDI_{gi}^s = \alpha FDI_{gi}^s AF_g^s [\frac{RFDI_{gi}^s}{RF_g^s}]^{\sigma_3^a}, g \neq i \quad \textbf{Eq.(33)}$$

where $AFDI_{gi}^s$ is the FDI invested by the home region g in the host region i, $RFDI_{gi}^s$ is the rate of return and αFDI_{gi}^s is the preference share of region i. $AFDI_{gi}^s$ is an important variable for the model result since it reflects bilateral FDI flow. Trade liberalization under RCEP would change its value and its changes represent the FDI impact of RCEP. σ_3^a is the transformation elasticity of assets among different host regions, which is set to 1.4.

In the final layer, $AFDI_{gi}^s$ is distributed to domestic firms and foreign firms in region i by following a Leontief function:

$$AFDID_{gi}^s = \alpha N_{gi}^s AFDI_{gi}^s, AFDIF_{gi}^s = \alpha F_{gi}^s AFDI_{gi}^s, g \neq i \quad \textbf{Eq.(34)}$$

where $AFDID_{gi}^{s}$ is the FDI being used by domestic firms and $AFDIF_{gi}^{s}$ is the FDI being used by foreign firms, while αN_{gi}^{s} and αF_{gi}^{s} are the corresponding shares. In some cases, αN_{gi}^{s} equals to zero, but αF_{gi}^{s} is always higher than zero.

5.3.4. Household Income and Closure

5.3.4.1. Household Income

In each region, households are the factor owners and collect income from supplying factors to firms. Factor income in this model is different from conventional models. In conventional model, factor income is equal to the production costs of value added. In the FHFDI model, factor income contains factor-attributed fixed trading costs and profits (hereafter, FP) on top of value added costs. That is, factor income is equal to the sum of factor-attributed FP and production variable costs. "Factor-attributed" means the share of factor input in total costs and profits given that factor is not the only input. Intermediate inputs are important complements to factors in fixed trading costs and value added costs. The distribution of costs and profits between factor and intermediates is according to the shares of each in total inputs. The household income is expressed as:

$$\begin{aligned} YH_j = {} & WLAN_j LAN_j + WL_j L_j + \sum_s QDK_j^s WDK_j^s \\ & + \sum_s \sum_g [QFDID_{jg}^s WFDID_{jg}^s + QFDIF_{jg}^s WFDIF_{jg}^s] \\ & + \sum_{ss} \sum_i [(SDK_{ji}^{ss} + SDL_{ji}^{ss})(FD_{ji}^{ss} + \Pi D_{ji}^{ss})] \\ & + \sum_{ss} \sum_i \sum_g [SFL_{gji}^{ss}(FF_{gji}^{ss} + \Pi F_{gji}^{ss})] \\ & + \sum_{ss} \sum_i \sum_g [SFK_{jgi}^{ss}(FF_{jgi}^{ss} + \Pi F_{jgi}^{ss})] \end{aligned} \qquad \textbf{Eq.(35)}$$

where YH_j is the household income in region j. The first component is the income from land endowments of region j. The second is the income from labor inputs in value added costs of domestic and foreign firms in region j. The third one is the income from domestic

capital inputs in value added costs of domestic firms. The next summation represents the income from FDI owned by region j invested in the value added of firms located in foreign regions. These are the total factor income from value added costs.

The next three components represent factor income from fixed trading costs and profits (FP). Since FP exists only in sectors with heterogeneous firms, the factor income is summed over sector index ss, rather than s. The first is the income from FP of domestic firms being distributed to labor and domestic capital. SDL_{ji}^{ss} and SDK_{ji}^{ss} are the shares of labor and domestic capital in the total inputs of labor, domestic capital and intermediate goods of domestic firms. The second is the income from FP of foreign firms operating in region j being distributed to labor since foreign firms source labor inputs from the local region. SFL_{gji}^{ss} is the share of labor in total inputs of foreign firms. The last one is the income from FP of foreign firms owned by region j being distributed to FDI since foreign firms source capital input from the home region. SFK_{jgi}^{ss} is the share of FDI in total inputs of foreign firms. The detailed functions of these shares will be given in the calibration section 5.4.

5.3.4.2. Goods Market Clearance

Equilibrium in the goods markets requires that output equals demand. For sectors with heterogeneous firms, the market clearance is represented by Eq.(17). For the agriculture sector with homogeneous firms, the market clearance is expressed as:

$$XF_{gij}^{a} = \tau_{ij}^{a} QF_{gij}^{a} \qquad \textbf{Eq.(36)}$$

where XF_{gij}^{a} is the output of foreign firms from home region g operating in region i and sold to region j in sector a, τ_{ij}^{a} is the iceberg cost and QF_{gij}^{a} is the demand for commodity a in region j.

Another thing that needs to be noted in the goods market is the distribution of aggregate demand. The aggregate demand, as represented by Eq.(4), is allocated to intermediate inputs, household demand, government demand, investment demand and international transportation demand, as shown by the following equation:

$$Q_j^s = \sum_c \sum_i INTCD_{ji}^{sc} + \left[\sum_{ss} \sum_i SDI_{ji}^{sss}\left(FD_{ji}^{ss} + \Pi D_{ji}^{ss}\right)\right]/PQ_j^s + \sum_g \sum_c \sum_i INTCF_{gji}^{sc} + \left[\sum_{ss} \sum_i SFI_{gji}^{sss}\left(FF_{gji}^{ss} + \Pi F_{gji}^{ss}\right)\right]/PQ_j^s + +QH_j^s + \overline{QG_j^s} + \overline{QINV_j^s} + \overline{TS1_j}$$

Eq.(37)[51]

where $INTCD_{ji}^{sc}$ is the intermediate demand for commodity s of domestic firms in sectors c operating on the $j-i$ link. The first component is the intermediate inputs in value added of domestic firms. The second term represents intermediate inputs in FP of domestic firms. SDI_{ji}^{sss} is the share of intermediate good s in total inputs of domestic firms excluding FDI inputs. As with the shares of labor and capital, the function of SDI_{ji}^{sss} is given in the calibration section 5.4. Since costs and profits are in value terms, the FP being distributed to intermediate goods is divided by price PQ_j^s to get the demand quantity of intermediate good s. Similarly, $INTCF_{gji}^{sc}$ is the intermediate demand for commodity s of foreign firms in sectors c from home region g operating on the $j-i$ link. The third component is the intermediate inputs in value added of foreign firms operating in region j. The following component represents the intermediate inputs in FP of foreign firms operating in region j. SFI_{gji}^{sss} is the share of intermediate good s in total inputs of foreign firms. The remaining components represent household demand, QH_j^s, government demand, QG_j^s, investment demand, $QINV_j^s$, and international transportation demand, $TS1_j$.

5.3.4.3. Factor Market Clearance

Equilibrium in the factor markets requires that endowments equal demand. The capital market has more strict equilibrium constraints. That is, it requires not only the clearance in the aggregate capital market, but also the clearance in three capital sub-markets:

$$AD_g^s = QDK_g^s * PA_g \ , \ AFDID_{gi}^s = QFDID_{gi}^s * PA_i \ , \ AFDIF_{gi}^s = QFDIF_{gi}^s * PA_i, g \neq i$$

Eq.(38)

The first equation represents the constraint that assets being supplied to the domestic market of sector s region g should be equal to the demand for domestic capital. QDK_g^s is

[51] The variables with a bar on top are exogenous.

the physical domestic capital demanded by domestic firms. Multiplying by capital price in the production region, PA_g, the demand for physical capital become the asset demand. The second equation represents the constraint that FDI supplied from region g to domestic firms in region i should be equal to the demand for FDI from domestic firms. The last equation represents the constraint that FDI supplied from region g to foreign firms owned by region g operating in region i should be equal to the demand for FDI from corresponding foreign firms.

5.3.4.4. Additional Closures

There are four additional closure rules — net government balance, international transportation services balance, current-account balance and investment-savings. In each region, the income of government comes from tariffs, which is collected from imported goods on the basis of their pre-tax value.[52] In the net government balance, the net of government income less government expenditure is government saving or deficit.

The international transportation services balance requires that the total demand for international transport services in the global market equals to the total supply of services from all regions. In the FHFDI model, the demand for international transport services is reflected by the iceberg-cost of trade and the supply of services from each region is the international transportation demand in Eq.(37), $TS1_j$. For each region, the supply of international transport services may be not equal to the demand for services from its imports of goods. The difference between supply and demand generates foreign savings from the international transportation pool.

Based on the model structure, the current-account balance has three components, namely, trade balance of domestic firms' products, trade balance of foreign firms' products and international capital transaction balance. The two trade balances are:

[52] In order to simplify the process of deriving the price equations (Eq.18) and other equations relating to the price equations, all other taxes aside of tariff are not taken into account in this study. Thus, the results from this study are more like experiment results than prediction.

$$FSAVD_{ij} = \sum_s [\frac{PD_{ij}^s QD_{ij}^s}{1+t_{ij}^s} - \frac{PD_{ji}^s QD_{ji}^s}{1+t_{ji}^s}], i \neq j$$

$$FSAVF_{ij} = \sum_s [\sum_g \frac{PF_{gij}^s QF_{gij}^s}{1+t_{ij}^s} - \sum_h \frac{PF_{hji}^s QF_{hji}^s}{1+t_{ji}^s}], i \neq j, g \neq i, h \quad \text{Eq.(39)}$$

$$\neq j$$

where $FSAVD_{ij}$ is the foreign saving from region i to region j by trading commodities produced by domestic firms in each region and $FSAVF_{ij}$ is the foreign saving from region i to region j by trading commodities produced by foreign firms in each region.

The international capital transaction balance captures the movement of FDI and profits of foreign firms across regions, which is expressed as:

$$FSAVK_{ij} = \sum_s [WFDID_{ij}^s QFDID_{ij}^s + WFDIF_{ij}^s QFDIF_{ij}^s - WFDID_{ji}^s QFDID_{ji}^s - WFDIF_{ji}^s QFDIF_{ji}^s] + \sum_g \sum_{ss} [SFK_{ijg}^{ss}(FF_{ijg}^{ss} + \Pi F_{ijg}^{ss})] - \sum_g \sum_{ss} [SFK_{jig}^{ss}(FF_{jig}^{ss} + \Pi F_{jig}^{ss})] \quad \textbf{Eq.(40)}$$

where $FSAVK_{ij}$ is the foreign saving from the capital account from region i to region j. The first summation represents the net FDI income of region i, which equals the income from outward investment less the payment to inward FDI. The second summation represents the income from outward investment in fixed trading costs and inward transfer of profits. The third summation is the payment to inward investment in fixed trading costs and outward transfer of profits. The investment-savings equilibrium requires that domestic investment equals the sum of household saving, government saving and foreign savings.

5.4. Data and Calibration

The model is calibrated to the GTAP 8.0 global database.[53] The GTAP SAM table is augmented with the global data of FDI stock (home-host-sector) and foreign affiliate sales

[53] As documented on the GTAP website, the GTAP 8.0 database has some problems with tariff rates, particularly for China. The tariff rate has been fixed by a later version 8.1. However, using the GTAP 8.0 database is unlikely to cause a problem here. That is because, what this study uses is the GTAP SAM table only, which shows no difference between the two versions.

(home-host-sector) (Fukui & Lakatos, 2012; Lakatos et al., 2011). The FDI stock data are used to split the capital account of the GTAP SAM table into three capital accounts, including one domestic capital account and two FDI accounts with FDI being differentiated by home region. The foreign affiliate sales data are used to split the outputs in each sector into the outputs of domestic firms and foreign firms.

Using input-output ratios of the GTAP data, the inputs of intermediates and factors can be derived for the production activity accounts of domestic and foreign firms. The input-output ratios for foreign firms have been adjusted to reflect the fact that multinationals from developed countries usually outsource labor-intensive tasks, while FDI from developing countries is usually very low. Thus, the capital-output ratio of foreign firms is assumed to be lower while the labor-output ratio is higher than the counterparts in the GTAP data.

Apart from the extensions in capital and production activity accounts, the GTAP SAM table is further extended in terms of firms' supplying markets. In the FHFDI model, the industrial aggregate output of each firm type is sold to three markets, one domestic market and two export markets. For instance, XD_{ij}^{s} is the output of domestic firms in sector s region i and sold to market j, and j stands for the three regions in the model (China, PTN and ROW). The inputs that used to produce XD_{ij}^{s} are also indexed in supply market j. Thus, we need to split the production activity accounts further into three markets. According to the GTAP SAM table, firms in PTN and ROW have one more export market, which is the intra-regional export market. However, the FHFDI model does not differentiate domestic market from intra-regional export market. To be consistent with the model, I converted intra-regional trade to domestic commodities of PTN and ROW. The detailed documentation about the construction of my SAM table is presented in Appendix B.

Table 9 reports some major parameters used in the model, most of which are drawn from Zhai (2008). The markup ratios are set equal to 25% for the pro-fragmentation manufacturing sector ($m1$), 20% for the other manufacturing sector ($m2$), and 30% for the services sectors. Given that markup ratio is equal to $\frac{\sigma}{\sigma-1}$, the elasticity of substitution among varieties is 5.0 for $m1$, 6.0 for $m2$, and 4.3 for $s1$ and $s2$. With the markup ratios and substitution elasticity, the shape parameters of the Pareto distribution of productivity

can be calibrated based on the assumption of Zhai (2008) that the profit ratio (expressed in shape parameter) in total markup is estimated to be 64.5%.

The last column of Table 9 displays substitution elasticity between inputs in production. They are drawn from the value added elasticity of the GTAP model. In each sector of my model, the same substitution elasticity is applied in all layers of the production tree and the same elasticity is applied in the production activity of domestic firms and foreign firms.[54]

Table 9 Major parameters in the model

Sectors	Markup Ratio	Elasticity of Substitution	Shape Parameter	Elasticity of Substitution between inputs
a				0.50
m1	25%	5.0	6.2	1.26
m2	20%	6.0	7.75	1.26
s1	30%	4.3	5.17	1.68
s2	30%	4.3	5.17	1.35

Source: Zhai (2008) and the GTAP model.

With data and key parameters, we are ready to calibrate the model. Before calibrating the most important part of the model, productivity thresholds, we need the mass of potential firms and shares of active firms in each market. I assume the mass of potential firms, N, is proportional to sectoral output. Based on the data of firm number and output in manufacturing and services industries of China, I set the ratio of the mass of potential firms to output to 0.1 in the two manufacturing sectors and 0.3 in the two services sectors.

Next, I calibrate the shares of active firms in every market based on three assumptions. First, the extensive margin takes account of 60% of the difference in export values across regions. Second, 60% of potential firms produce and sell in the domestic market. Third, 10% of potential firms invest abroad, produce and sell in the host market. The first two assumptions follow the Zhai model and the third one is given by the author.

With the first assumption, we have the proportions of exporters in the total numbers of active firms within each firm type:

[54] Without a more reliable source of elasticity of transformation, this is the most reliable that I could find.

$$\left(\frac{PD_{ij}^{ss}*QD_{ij}^{ss}}{PD_{ii}^{ss}*QD_{ii}^{ss}}\right)^{0.6}=\frac{1-G(\varphi D_{ij}^{ss^*})}{1-G(\varphi D_{ii}^{ss^*})},\ \left(\frac{PF_{gij}^{ss}*QF_{gij}^{ss}}{PF_{gii}^{ss}*QF_{gii}^{ss}}\right)^{0.6}=\frac{1-G(\varphi F_{gij}^{ss\ ^*})}{1-G(\varphi F_{gii}^{ss\ ^*})} \qquad \text{Eq.(41)}$$

where ss stands for the sectors with heterogeneous firms as before. With the second and third assumptions, we can get the share of non-exporters within domestic firms, $1-G\left(\varphi D_{ii}^{ss^*}\right)=0.6$ and the share of non-exporters within foreign firms, $1-G\left(\varphi F_{gii}^{ss\ ^*}\right)=0.1$. $PD_{ij}^{ss}*QD_{ij}^{ss}$ represents exports of commodity ss from region i to region j produced by domestic firms, while $PD_{ii}^{ss}*QD_{ii}^{ss}$ represents sales of domestic firms to domestic market. Both exports and sales data are available from the SAM table. As a result, I can derive the shares of exporters to market j within domestic firms, $1-G(\varphi D_{ij}^{ss^*})$. Similarly, $PF_{gij}^{ss}*QF_{gij}^{ss}$ and $PF_{gii}^{ss}*QF_{gii}^{ss}$ represents sales of foreign firms in export market j and local market i, and I can derive the share of exporters to market j, $1-G(\varphi F_{gij}^{ss\ ^*})$.

Since $G(\varphi)=1-\varphi^{-\gamma}$, the productivity thresholds can be derived from the shares of exporters within each firm type following:

$$\varphi D_{ij}^{ss^*}=1-G(\varphi D_{ij}^{ss^*})^{-\frac{1}{\gamma^{ss}}},\ \varphi F_{gij}^{ss\ ^*}=1-G(\varphi F_{gij}^{ss\ ^*})^{-\frac{1}{\gamma^{ss}}} \qquad \textbf{Eq.(42)}$$

Then, the industry aggregate productivity can be derived by following Eq.(25).

Drawn from the findings of Oyamada (2014), I can calibrate the fixed trading costs of individual firms, FF_{gij}^{ss}, with given firm numbers. The calibration of fixed trading costs of foreign firms follows Eq.(43), which is derived from the demand equations, the price functions, average productivity functions and productivity threshold functions. The fixed costs of domestic firms can be derived following the same method.

$$PF_{gij}^{ss}*QF_{gij}^{ss}=\left(1+v_j^{ss}\right)(1+t_{ij}^{ss})\sigma^{ss}\frac{\gamma^{ss}}{\gamma^{ss}-\sigma^{ss}+1}\frac{1}{1+v_j^{ss}\sigma^{ss}}MF_{gij}^{ss}ff_{gij}^{ss}$$

Eq.(43)

The industry revenue from production activities should equal the sum of fixed trading costs, production variable costs and profits. But the SAM table does not have accounts reflecting fixed trading costs and profits (FP). Following the approach of Hosoe, Gasawa, and Hashimoto (2010), the input cells in production activity accounts of the SAM table are

presumed to contain FP. Therefore, to derive the net initial equilibrium values of inputs in variable costs, we must subtract from the input values of the SAM table the amount of the FP supposed to be included in these cells. In the calculation of FP contained in each of these cells, we assume that it is in proportion to the amount of input value in each cell, respectively.

The net initial equilibrium value of inputs (after subtracting FP) is computed as follows, with labor input in foreign firms as an example:

$$LF_{gij}^{ss} = SAMFL_{gij}^{ss} - SFL_{gij}^{ss}(FF_{gij}^{ss} + \Pi F_{gij}^{ss}) \qquad \textbf{Eq.(44)}$$

where LF_{gij}^{ss} is the labor input in value added of foreign firms from home region g, operating in host region i, sold in region j in sector ss, $SAMFL_{gij}^{ss}$ is the original labor input drawn from the SAM table and SFL_{gij}^{ss} is the share of labor in total inputs of labor, FDI and intermediate goods. The following equation shows the calculation of SFL_{gij}^{ss} together with the shares of capital and intermediate goods, which have been used in equations (32, 34, 37):

$$SFL_{gij}^{ss} = \frac{SAMFL_{gij}^{ss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}},$$

$$SFK_{gij}^{ss} = \frac{SAMFK_{gij}^{ss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}}, \qquad \textbf{Eq.(45)}$$

$$SFI_{gij}^{sss} = \frac{SAMFI_{gij}^{sss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}}$$

For domestic firms,

$$SDI_{ij}^{sss} = \frac{SAMDI_{ij}^{sss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}},$$

$$SDK_{ij}^{ss} = \frac{SAMDK_{ij}^{ss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}}, \qquad \textbf{Eq.(46)}$$

$$SDL_{ij}^{ss} = \frac{SAMDL_{ij}^{ss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}}$$

where SDI_{ij}^{sss} is the share of intermediate good s in total inputs of labor, domestic capital and intermediate goods in domestic firms located in sector ss, SDK_{ij}^{ss} is the share of domestic capital and SDL_{ij}^{ss} is the share of labor.

Last but not least, we need to calibrate the marginal budget and minimal consumption parameters in the household demand function. To calibrate the marginal budget, we need income elasticity of demand for each good, η_j^s, which can be drawn from the GTAP database of behavioral parameters (Table 10). Saving is regarded as a consumption good, and its income elasticity of demand is assumed to be the average of the five commodities in each region.

Table 10 Income elasticity of demand

	a	m1	m2	s1	s2	Saving
China	0.84	0.91	0.91	0.99	1.25	0.98
PTN	0.77	0.94	0.94	1.04	1.21	0.98
ROW	0.74	0.95	0.95	1.02	1.23	0.98

Note: The parameters are derived from the GTAP table of income elasticity of demand for 10 commodity aggregates following a simple average approach.

To calibrate the marginal budget on each commodity, we also need the budget share of each commodity, which can be derived from the SAM table. Then, the marginal budget can be derived as:

$$\beta_j^s = \frac{\eta_j^s SB_j^s}{\sum_c \eta_j^c SB_j^c + \eta_j^{sav} SB_j^{sav}}, \beta_j^{sav} = \frac{\eta_j^{sav} SB_j^{sav}}{\sum_c \eta_j^c SB_j^c + \eta_j^{sav} SB_j^{sav}} \qquad \textbf{Eq.(47)}$$

where β_j^s and β_j^{sav} are the marginal budget on commodity s and saving and SB_j^s and SB_j^{sav} are budget shares.

To calibrate the minimal consumption on each commodity of household, we need another parameter, Frisch parameter. It is defined as minus the reciprocal of the marginal utility of income, or the money flexibility. Following the GTAP model, the Frisch parameter is assumed to be the minus of the average of the substitution elasticity of variety, $Fr = -\sum_s \sigma^s/5$.

Then, we can calculate the minimal consumption as:

$$B_j^s = QH_j^s + \frac{\beta_j^s}{PQ_j^s}\frac{YH_j}{Fr}, B_j^{sav} = HSAV_j + \frac{\beta_j^{sav}}{PQ_j^{sav}}\frac{YH_j}{Fr} \qquad \textbf{Eq.(48)}$$

where B_j^s and B_j^{sav} are minimal consumption on commodity s and saving; QH_j^s and $HSAV_j$are the consumptions at the base year; $PQ_j^{sav}$is the price of saving, which is defined as the average of commodity prices and $YH_j$is the household income in region j.

5.5. Model Tests and Results

5.5.1. Model Tests

The FHFDI model was rendered in the GAMS language. Programming a complex new model like FHFDI in GAMS is not an easy task, and errors are hardly avoided. I employ a number of strategies to prevent errors and to make errors apparent. First is to replicate the initial equilibrium of the SAM table. This test is to check the correctness of calibration process and to check the existence of unique equilibrium of the model. The FHFDI model can pass this test by returning the initial equilibrium of the SAM table. Second is the price homogeneity test. It is a property of neoclassical models that agents respond to changes in relative prices, but not to changes in the absolute level of prices. In this test, I shock the numeraire, that is, the wage of labor, by 10%, and simulation shows that all prices and flows increased by 10% while real variables remain unchanged.

The third test is global balance of database. In this test, I checked two types of balances. One is that the total output of commodities produced by each firm type (domestic firms or foreign firms) must equal the total of the demands for them. Another one is that the value of output by each industry must equal the total of production costs. This test and the price homogeneity test were performed each time the model's equations or data are changed, in order to make sure that the model can always fulfil the two conditions.

5.5.2. Simulation Scenarios

The participants in RCEP comprise ASEAN and its 6 dialogue partners. With the 6 dialogue partners, ASEAN has formed 5 FTAs, including the ASEAN-China FTA, the

ASEAN-Japan FTA, the ASEAN-Korea FTA, the ASEAN-Australia-New Zealand FTA and the ASEAN-India FTA. Based on the commitments in these FTAs, Fukunaga and Isono (2013) state that RCEP should reach a 95% tariff elimination, otherwise it will have no effect on most of its member countries. Since it is not easy to identify the 5% of products that will remain high tariffs after RCEP, this paper assumes a 95% tariff reduction on all goods. Table 11 shows that the initial tariff barriers imposed by China and PTN are already at a very low level, except the tariffs on agriculture goods of PTN.

Compared with tariff barriers, we are less certain about the achievements of RCEP in NTBs. Based on the NTBs of China and PTN, I set two scenarios to simulate possible achievements of RCEP in NTBs:

- NTBs of China and PTN are reduced to a level of the average of NTBs in Japan and Korea.
- Except sectors $s1$ and $s2$ of China, NTBs of China and PTN are reduced to a level of the average of NTBs in Japan and Korea. NTBs in sectors $s1$ and $s2$ of China are reduced by the same margin as the corresponding sectors in PTN.

The average of NTBs in Japan and Korea has been chosen as the potential achievement of RCEP because it represents the middle level of NTBs among RCEP member countries. With this target, the NTBs reductions in most sectors of China and PTN are less than 0.2, which seems to be achievable for RCEP (Table 11).

The reason that sectors $s1$ and $s2$ of China are treated differently in the two scenarios is because NTBs in these sectors are extraordinarily high relative to other sectors and sectors in PTN (Initial rates in Table 11). In the first scenario (SN1), NTBs in sectors $s1$ and $s2$ of China are assumed to be reduced to a level of the average of NTBs in Japan and Korea. Under this scenario, tariff-equivalents of NTBs of China are reduced by RCEP from 0.747 to 0.169 in sector $s1$ and from 0.766 to 0.181 in sector $s2$. This scenario represents a big step of services liberalization in China, which is termed as 'big step' for brevity in the following discussion. In the second scenario (SN2), sectors $s1$ and $s2$ of China are assumed to be reduced by the same margin as those in PTN. Under this scenario, tariff-equivalents of NTBs of China are reduced by RCEP from 0.747 to 0.553 in sector $s1$ and

from 0.766 to 0.571 in sector $s2$. This scenario is termed as 'small step' in the following part.

Table 11 Simulated reductions of tariff and NTBs in China and PTN under RCEP (Units: ratio of tariff to imports)

			Tariff Barrier			Non-tariff Barrier				
Exporter	Importer		a	m1	m2	a	m1	m2	s1	s2
CN	PTN	Initial	0.296	0.021	0.067	0.404	0.155	0.155	0.363	0.376
		Simulated	0.015	0.001	0.003	0.25	0.032	0.032	0.169	0.181
PTN	CN	Initial	0.055	0.039	0.19	0.334	0.167	0.167	**0.747**	**0.766**
		Simulated (SN1)	0.003	0.002	0.01	0.25	0.032	0.032	0.169	0.181
		Simulated (SN2)	0.003	0.002	0.01	0.25	0.032	0.032	**0.553**	**0.571**

Data source: Calculation from GTAP Database and estimation of Petri et al. (2012)

A third scenario I experiment with is a 50% reduction in fixed trading costs for firms operating on the China-PTN link. This scenario is based on the consideration that RCEP might reduce the time and costs occurred in registration, approval and operation for firms from partner countries, which could be simulated as a reduction in fixed trading costs. For domestic firms in China and PTN, only the exporters operating on the China-PTN link face a 50% reduction in fixed trading costs. Firms supplying domestic market and the ROW market face the initial fixed trading costs. Foreign firms owned by China or PTN and operating in each other's market also face a 50% reduction in fixed trading costs, no matter which market they supply.

Therefore, I have three scenarios about the potential achievements of RCEP in trade liberalization to simulate:

Scenario 1. Small step. Services barriers of China are reduced by a small margin. Services barriers of PTN are reduced to the average level of Japan and Korea. Tariff barriers on all goods are reduced by 95% by all RCEP members.

Scenario 2. Big step. Services barriers of China are reduced by a big margin. Services barriers of PTN are reduced to the average level of Japan and Korea. Tariff barriers on all goods are reduced by 95% by all RCEP members.

Scenario 3. Scenario 2, plus a 50% reduction in fixed trading costs of firms operating on the China-PTN link.

5.5.3. Simulation Results

Simulation results suggest that China can gain FDI from RCEP under all three scenarios (Figure 12). Figure 12 depicts total FDI increases at constant prices, including additional FDI increases in sector m1 from the vertical fragmentation effect, which is not captured in the CGE simulation. The econometric findings of ACFTA show that the vertical fragmentation effect can increase FDI by 26.7%. With the assumption that RCEP has a similar vertical fragmentation effect on FDI as ACFTA, US$249 million is added to the simulated FDI changes in m1 for each scenario.[55] Therefore, the FDI increase in Figure 12 refers to the total increase in FDI caused by RCEP.

The increase in FDI grows with the degree of trade liberalization, as shown in Figure 12. Under the scenario of "small step", China and its RCEP partners are simulated to reduce tariffs by 95% and to reduce NTBs to the average level of Japan and Korea, except that China adopts a small step NTBs reduction in services sectors. Total FDI would increase by US$2 billion in China, accounting for 4.8% of China's FDI. In Scenario 2, when China conducts a big step of services liberalization, FDI will increase by US$2.8 billion. The most dramatic FDI increase happens in scenario 3, that is, scenario 2 plus a 50% reduction

[55] In base scenario, sector m1 has US$933 million FDI. The FDI increase as a result of the vertical fragmentation effect is then calculated as 933*0.267, which equals 249.

in fixed trading costs for firms operating on the China-PTN link. Total FDI increase in China reaches US$4 billion in this scenario, taking 9.4% of China's FDI.

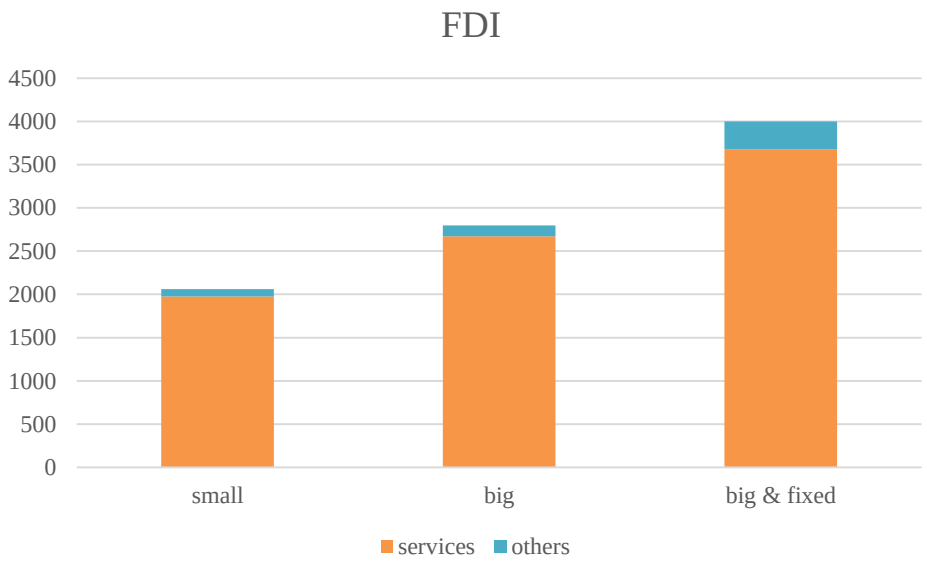

Figure 12 Real FDI changes in China under the three scenarios of RCEP, in millions of US$
Data source: Author's estimation

FDI increase is driven by growth in sales of firms that use FDI in China. Table 12 and Table 13 display the simulation results about changes in real sales of and real FDI being used by firms in China, including China domestic firms (China firms), foreign firms owned by PTN (ForFir_PTN) and foreign firms owned by ROW (ForFir_ROW). The changes in FDI shown in Table 13 does not include the additional FDI increase in sector m1 from the vertical fragmentation effect. In the three markets of the world, including the China domestic market, the PTN market and the ROW market, China firms are the main suppliers, which take a much larger share of the increased sales than foreign firms. As mentioned in Section 5.3, among China firms, joint ventures take the majority of FDI. Thus, China firms dominate in both sales and FDI in all markets. Reflected in Table 12 and Table 13, changes in the sales and FDI of China firms are the largest, compared with foreign firms.

In the domestic market, China firms will reduce sales in manufacturing sectors, while foreign firms decrease sales in all sectors with heterogeneous firms. Correspondingly, FDI being used to supply industrial goods to the domestic market will decrease. The production

contraction of firms in the domestic market could be caused by increased competition from imports. Increased imports not only squeeze the market share, but also force the least productive firms to exit. The double effects of trade liberalization make sectors with heterogeneous firms contract more than the agriculture sector, which has no exit of firms.

Apart from agriculture, services sectors s1 and s2 will experience sales increases for China firms in the domestic market too. The sales increase in services sectors, particularly in sector s2, is important for the FDI results because it leads to substantial FDI increase that dominates the increase in total FDI, as shown in Figure 12. For instance, in the scenario of "small step", sales of China firms in sector s2 grow by US$67 billion, resulting in an FDI increase of US$1.8 billion, which accounts for 89% of total FDI increase. Comparing with sector s1, in which sales of China firms increase by US$15 billion but FDI only grows by US$0.7 million, FDI is more sensitive to sales in sector s2. This corresponds to the importance of services sector s2 to FDI, as 45% of FDI flow to this sector. The sensitivity of FDI to sector s2 indicates that services liberalization could have a strong effect on FDI by affecting sales of services.

All firms expand sales to the PTN market, reflecting the trade effect of RCEP. The trade effect is particularly evident for manufacturing sectors, and the largest increase occurs to sector m2 (US$474 billion). The dramatic increase in exports of manufacturing goods reflect the comparative advantage of China. FDI changes along with sales, which increases in all sectors. Once again, joint ventures will have more FDI increase than foreign firms, with the largest increase in sector m2. Nevertheless, the total increase in FDI used for supplying PTN market is much smaller than that for the domestic market. Firms in China also increase exports to the ROW market, but the increases are lower than that to the PTN market. The increase in exports to ROW should reflect that firms in China gain competitiveness from trade liberalization through the access to more varieties of and cheaper intermediates. Accordingly, FDI being used for supplying ROW grows too.

From the scenario of "small step" to "big step", overall increases in sales and FDI grow larger, while sales reduction and FDI decrease in the domestic market become smaller. Because the change in the step consists of a change in services liberalization by China alone,

the external market faced by firms of China remains unchanged, and thus, the changes in sales and FDI are relatively small. The same as "small step", services sector s2 still dominates total FDI increase, and primarily from the FDI increase of China firms supplying the domestic market.

In the scenario of "big & fixed", the reduction in fixed trading costs in addition to reductions in trade variable costs stimulates much larger increases in sales and FDI. The reduction in fixed trading costs not only promotes more exports to partner's market, but also stimulates more sales to the domestic and ROW markets. Sales in most sectors almost double that of the scenario without reduction in fixed trading costs. However, the sales contraction of manufacturing sectors in the domestic market also become larger. Given the big increases in exports of manufactuing sectors, the contraction in domestic market could be explained as a resource diversion from the domestic sector to the more efficient export sector.

Table 14 and Table 15 show changes in sales and FDI in percentage. To some extent, the percentage change reflects the trade and FDI effects of RCEP in a clearer way than the value changes by showing big differences between domestic market and export markets. It is very clear that firms contract sales to the domestic market and expand markets to RCEP partners and ROW. In the domestic market, even if agriculture and services increase sales after RCEP, the 2~4% increases are negligible compared with the 260~1060% increases in the PTN market. The apparent sales contraction in the domestic market accompanies with FDI decrease. The FDI decrease corresponds to the plant rationalization effect defined in Chapter 3. The plant rationalization effect refers to FDI reduction as a result of trade substitution to FDI. Increased imports from PTN substitute FDI by squeezing the market share of firms using FDI.

In the PTN market, sales increase remarkably, accompanied with sharp FDI increases (92~846%). The dramatic sales increase in the PTN market clearly reflects the trade effect of RCEP. The market expansion to PTN brings substantial FDI increase, that is, the market expansion effect of RCEP on FDI. The market expansion effect also shows in the ROW market as exports and FDI increase simultaneously. A notable thing in the ROW market is

that the changes in agriculture are less than that in other sectors. This is because the agriculture sector only has trade increase in the intensive margin, but has no increase in the extensive margin. Sectors with heterogeneous firms increase trade in both intensive and extensive margins. This explains why the firm heterogeneous model can capture more trade effect and FDI effect, as well as welfare effect.

Table 12 Changes in real sales of firms in China, in millions of US$

		Small Step					Big Step					Big & Fixed				
		a	m1	m2	s1	s2	a	m1	m2	s1	s2	a	m1	m2	s1	s2
Domestic market	China firms	49,443	-30,008	-334,992	15,008	66,880	68,328	-14,198	-273,420	15,712	70,490	117,453	-36,952	-337,176	27,712	117,420
	ForFir_PTN	18	-2,557	-269	-2	-20	24	-1,896	-240	-4	-29	49	-3,242	-284	-3	-31
	ForFir_ROW	201	-26,169	-6,789	-150	-1,695	278	-22,094	-6,058	-227	-2,436	558	-30,549	-7,167	-216	-2,611
	SUM	**49,661**	**-58,735**	**-342,050**	**14,856**	**65,165**	**68,630**	**-38,188**	**-279,718**	**15,481**	**68,024**	**118,059**	**-70,743**	**-344,627**	**27,493**	**114,778**
PTN market	China firms	68,388	99,933	468,633	1,480	8,698	68,955	104,607	487,628	1,611	9,378	69,071	196,662	832,214	3,206	19,230
	ForFir_PTN	37	5,105	272	0.3	2	37	5,312	281	0.3	2	37	9,978	479	1	4
	ForFir_ROW	315	29,630	5,138	9	123	316	30,704	5,322	10	130	316	58,405	9,068	19	264
	SUM	**68,741**	**134,668**	**474,043**	**1,490**	**8,823**	**69,308**	**140,623**	**493,231**	**1,621**	**9,510**	**69,424**	**265,045**	**841,761**	**3,226**	**19,498**
ROW market	China firms	476	47,902	107,025	1,144	3,582	634	54,868	123,238	1,490	4,528	527	81,468	170,075	1,975	6,218
	ForFir_PTN	0.2	2,291	57	0.2	1	0.2	2,607	66	0.2	1	0.2	3,910	92	0.3	1
	ForFir_ROW	2	15,220	1,420	7	55	3	17,289	1,634	9	68	2	26,989	2,284	12	93
	SUM	**479**	**65,412**	**108,502**	**1,151**	**3,637**	**637**	**74,765**	**124,937**	**1,499**	**4,596**	**528**	**112,368**	**172,451**	**1,987**	**6,311**

Data Source: Author's simulation

Table 13 Changes in real FDI used by firms in China, in millions of US$

		Small						Big						Big & Fixed					
		a	m1	m2	s1	s2	SUM	a	m1	m2	s1	s2	SUM	a	m1	m2	s1	s2	SUM
Domestic market	China firms	43.1	-6	-98	0.7	1842	**1782**	60.9	-4.0	-74.9	0.9	2514	**2497**	98.7	-8.3	-105.4	1.4	3423	**3410**
	ForFir_PTN	0.1	-1.6	-0.4	0.02	0.1	**-2**	0.2	-1.1	-0.3	0.0	0.1	**-1**	0.3	-2.2	-0.4	0.0	0.2	**-2**
	ForFir_ROW	1.3	-312	-10.2	-0.2	9.1	**-312**	1.8	-327.5	-7.8	-0.2	12.4	**-321**	3.0	-292.9	-11.0	-0.3	16.8	**-284**
PTN market	China firms	27.6	9.5	117.8	0.03	81.0	**236**	28.0	10.0	122.7	0.04	88.0	**249**	28.2	16.6	191.8	0.1	159.5	**396**
	ForFir_PTN	0.1	2.6	0.5	0.001	0.005	**3**	0.1	2.7	0.5	0.001	0.005	**3**	0.1	4.5	0.8	0.001	0.005	**5**
	ForFir_ROW	0.8	28.5	12.3	0.1	0.4	**42**	0.8	26.4	12.8	0.1	0.4	**41**	0.8	67.1	20.0	0.1	0.8	**89**
ROW market	China firms	0.3	4.6	30.0	0.03	43.9	**79**	0.4	5.3	34.7	0.0	56.1	**97**	0.4	7.6	46.2	0.1	76.6	**131**
	ForFir_PTN	0.001	1.2	0.1	0.001	0.002	**1**	0.0	1.4	0.1	0.001	0.003	**2**	0.001	2.0	0.2	0.002	0.004	**2**
	ForFir_ROW	0.01	-20.3	3.1	0.1	0.2	**-17**	0.0	-22.3	3.6	0.1	0.3	**-18**	0.01	-0.003	4.8	0.1	0.4	**5**
SUM		73.3	-293.5	55.0	0.8	1976.5	**1812**	92.2	-309.2	91.3	0.9	2671.7	**2547**	131.4	-205.7	146.9	1.5	3678	**3752**

Data Source: Author's simulation

Table 14 Changes in real sales of firms in China, in percentage

		Small					Big					Big & Fixed				
		a	m1	m2	s1	s2	a	m1	m2	s1	s2	a	m1	m2	s1	s2
Domestic market	China firms	4	-5	-11	4	2	5	-2	-9	4	2	9	-6	-11	7	4
	ForFir_PTN	2	-7	-14	-3	-3	3	-5	-13	-4	-4	7	-9	-15	-3	-5
	ForFir_ROW	2	-10	-14	-4	-3	3	-8	-13	-6	-4	7	-11	-15	-6	-5
PTN market	China firms	399	281	597	297	280	403	294	621	323	301	403	553	1060	642	618
	ForFir_PTN	393	270	570	272	260	394	281	590	289	275	393	528	1006	572	557
	ForFir_ROW	393	260	570	266	260	394	269	590	281	275	393	512	1006	552	557
ROW market	China firms	4	44	48	30	29	5	51	56	39	37	4	75	77	51	51
	ForFir_PTN	3	40	43	22	23	4	46	49	28	28	2	69	69	37	38
	ForFir_ROW	3	36	43	20	23	4	41	49	25	28	2	65	69	33	38

Data source: Author's simulation

Table 15 Changes in real FDI used by firms in China, in percentage

		Small					Big					Big & Fixed				
		a	m1	m2	s1	s2	a	m1	m2	s1	s2	a	m1	m2	s1	s2
Domestic market	China firms	5	-7	-9	5	5	7	-5	-7	6	6	11	-9	-10	9	9
	ForFir_PTN	5	-7	-9	5	5	7	-5	-7	6	6	11	-9	-10	9	9
	ForFir_ROW	5	-46	-9	-1	5	7	-49	-7	-1	6	11	-43	-10	-1	9
PTN market	China firms	404	232	520	251	241	410	243	542	276	262	413	406	846	484	475
	ForFir_PTN	404	232	520	275	245	409	243	541	300	270	412	406	846	500	485
	ForFir_ROW	404	92	520	232	241	410	85	542	250	262	413	216	846	429	475
ROW market	China firms	5	36	46	28	29	7	42	54	38	37	6	60	71	49	51
	ForFir_PTN	5	36	46	31	28	7	42	54	39	36	7	60	71	50	50
	ForFir_ROW	5	-21	46	22	29	7	-23	54	29	37	7	-0.004	71	35	51

Data source: Author's estimation

Last but not least, RCEP could bring welfare gains to its member countries, but would cause welfare loss to ROW (Figure 13). The magnitude of welfare changes grows with the degree of trade liberalization. In Scenario 1, “small step”, China can gain US$82.4 billion. The gain grows to US$96.5 billion under the scenario of a big step services liberalization. Similar to FDI changes, the most dramatic welfare increase in China happens in Scenario 3. China would gain US$154.2 billion, which takes 1.6% of China’s GDP and 5% of its GNI. The welfare gains of PTN are larger than that of China, around US$200~300 billion. The loss of ROW is smaller than the combined gain of China and PTN for each scenario, indicating that the world total welfare increases after RCEP.

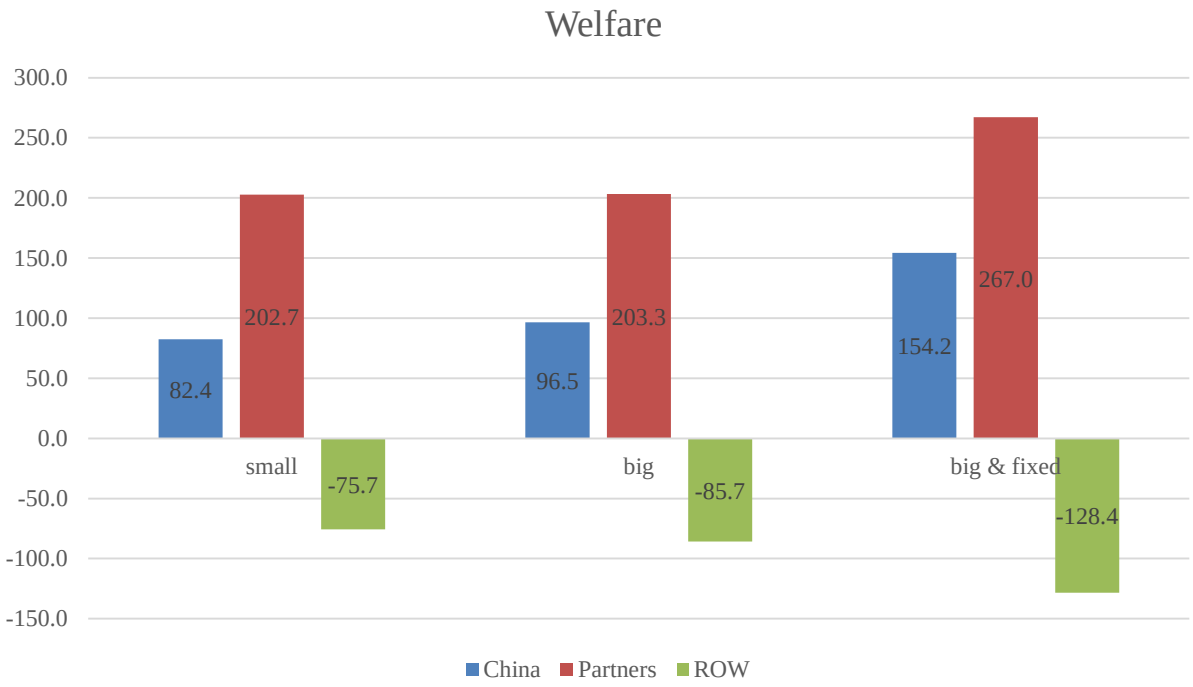

Figure 13 Welfare changes in the three regions, in billions of US$.
Data Source: Author’s estimation

In sum, FHFDI model finds that FDI would increase in China after the formation of RCEP. The FDI increase grows with the degree of trade liberalization. In each scenario, the dominant FDI increase comes from services sector s2, corresponding to the importance of services to FDI. The sensitivity of FDI to services suggests that services liberalization could affect FDI in a more significant way than tariff reduction. In addition, simulation results demonstrate the market expansion and plant rationalization effect of RCEP through the

relation between sales and FDI. Finally, the welfare results show that both China and PTN can gain from RCEP, but ROW would lose welfare.

5.6. Summary

This chapter extends the econometric studies about ACFTA in the Chapter 3 & 4 to a CGE study about RCEP. The extension has shifted the focus from tariff reduction to services liberalization in analyzing the FDI impacts of FTA. Simulation results show that, the same as ACFTA, RCEP would encourage FDI to China. The increase in FDI grows with the degree of trade liberalization between China and its partners. Services dominate FDI increases, corresponding to the importance of services to FDI. The results indicate that services liberalization has more significant effect on FDI than tariff reduction.

Apart from the findings about the FDI impact of RCEP, another contribution of this study lies in the building of FHFDI model. The FHFDI model applies the Melitz model and its extension by Helpman et al. (2004). It is the first time to introduce FDI to a firm heterogeneity CGE framework. The model is built on Zhai (2008) and extends the Zhai model in several ways. The most important extension is to introduce FDI and separate foreign firms from each economy. Through examining the production activities of foreign firms, I find the market expansion and plant rationalization effects of RCEP. The second innovation of the FHFDI model lies in the incorporation of NTBs and the special treatment of services barriers. Services barriers are modelled as tax equivalents that raise costs and create rents. That treatment enables the model to simulate the real economy in a better way. The third extension of the Zhai model is to add a capital allocation block. Capitals are allocated among sectors, regions and firms following a rule of chasing the highest return activities. Finally, I construct a SAM table with foreign firms being separated from domestic firms and FDI being separated from domestic capital. Foreign firms and FDI are differentiated by both home and host region.

The FHFDI model has three merits in interpreting FDI effects of FTA. First, it can capture more trade effects of FTA than the Armington model through capturing the extensive margin of export expansion. Considering that trade effects closely relate to the market expansion effect on FDI, the model can capture more FDI effects too. Second, the FHFDI

model allows us to shock fixed trading costs, which is another instrumental variable of FTA distinct from trade variable costs. Finally, the FHFDI model enables us to differentiate the productivity difference between foreign firms and domestic firms in a straightforward way.

Although the FHFDI model has innovated in several aspects and generated fruitful results, it has limitations. First, FHFDI is a comparative static model. A comparative static framework restricts the ability of FHFDI to capture capital accumulation along with time. In addition, given that capital owners usually make investment decisions based on future returns, a dynamic model would be better to model FDI movements. Second, FHFDI is a relatively highly aggregated model with 3 regions, 3 factors of production and 5 sectors. While this aggregation allows me to focus on the important policy issue of RCEP and services liberalization, it may not be able to reflect what actually happened in an exact way. Because of these limitations, the FDI impacts of RCEP from FHFDI should be interpreted as experimental results rather than prediction.

Chapter 6 Conclusion

In this thesis I investigated the correlations between FTAs and FDI. Two FTAs involving China and ASEAN have been studied and I have a particular interest in their effects on China. One is the bilateral FTA between ASEAN and China, ACFTA. With the 2005 free trade agreement on trade in goods as the main achievements, it is found that ACFTA has a significant and positive FDI impact. Another FTA being studied in the thesis is RCEP, which is a region-wide FTA among 16 countries that aims to liberalize both trade in goods and services to a high extent. Simulations from a CGE model show that RCEP would encourage FDI to China. Thus, both studies of the two FTAs find positive correlations between trade liberalization and FDI.

Trade liberalization can affect FDI through three effects. First is the vertical fragmentation effect. Reduction in trade costs of intermediate goods facilitates multinationals to split production process into different countries to take advantage of each. Thus, vertical FDI would increase after FTA. Second is the market expansion effect. The preferential access to partners' markets expands domestic market to partners', increasing the attractiveness of member countries to market-seeking FDI. Third is the plant rationalization effect. Reduction in trade costs encourages firms to choose trade rather than FDI to supply partner's market. Thus, trade substitution may decrease FDI.

6.1. The Study of ACFTA

The overall effect of ACFTA is significantly positive, suggesting that the two FDI-promoting effects (the vertical fragmentation and market expansion effects) dominate. The finding is based on an econometric model which is grounded in the knowledge-capital theory and incorporates third country effects. The knowledge-capital theory differentiates horizontal and vertical FDI, while the capture of third country effects aims to explain more complex FDI such as export platform and complex vertical FDI. The adoption of this model is based on the fact that both China and ASEAN have actively participated in East Asian production value chain, and thus, all these types of FDI should exist in the region, which is confirmed by empirical findings.

Based on the results of overall effect of ACFTA, I conducted another study about ACFTA with an aim to detect the two FDI-promoting effects. The reason of detecting the two effects is to explore the mechanism of how ACFTA is affecting FDI. A better understanding about ACFTA would provide more policy implications. Based on the definitions of the two effects, I adopted an FDI industry model to detect them by using China's data. The definition of vertical fragmentation effect suggests that it would mainly affect the pro-fragmentation sectors, while the definition of market expansion effect indicates that it would dominantly affect export-increasing sectors. I examined sectoral data of total trade and trade in intermediate goods between China and ASEAN in order to find the pro-fragmentation and export-increasing sectors. The pro-fragmentation sectors include machinery and electrical goods as over 90% of trade in intermediate goods concentrates in these sectors. A close examination of trade in intermediate goods shows a switch from goods that used to be traded freely to goods that used to be blocked, demonstrating the effect of ACFTA on component trade. The study of total trade finds that textile, metal products, furniture and CE&S articles show significant export increases, which is disproportionately larger than the increases in other sectors. They are the most significant export-increasing sectors. Results from the FDI industry model show that both of the pro-fragmentation sectors and the export-increasing sectors have received extra FDI in association with ACFTA. That means ACFTA positively impacts on FDI through both of the two positive effects.

Based on the results about ACFTA, I draw a conclusion that the facilitation of production value chain is as important for FDI as the preferential access to partners' markets, at least for China. These two aspects of FTA can bring in FDI and benefit the economy. Sectors participating in the production value chain and sectors in which China possesses international competitiveness are the big beneficiaries from the FDI effect of trade liberalization. A policy implication is that binding FTAs with economies in the same production network or big economies tend to bring more benefits.

6.2. The Study of RCEP

The study of ACFTA mainly captures the effect of trade liberalization on goods, while the impact of services liberalization has not been captured. This gap is filled by the study of RCEP. RCEP is a comprehensive FTA with a target of deep liberalization of trade in goods and services. I built a CGE model (the FHFDI model) to experiment with the potential effects of RCEP on FDI. The FHFDI model introduces FDI to the firm heterogeneity CGE framework of Zhai (2008). To introduce FDI, I source capital to home region and differentiate firms by owners. Capital from foreign regions forms FDI, which would be used by joint ventures and foreign invested firms. Foreign firms are known as more productive than domestic firms. The productivity difference can be well captured by the firm heterogeneity model. The firm heterogeneity theory explains the high productivity of foreign firms by assuming that they face higher fixed costs when investing and operating away from home country.

The FHFDI model captures export platform FDI. Among foreign firms, the more productive ones export while the less productive firms only serve the local market. On the one hand, trade liberalization tends to increase exports of foreign firms by allowing more foreign firms to supply the export market (extensive margin) and through the increase in quantity of existing varieties (intensive margin). The market expansion of foreign firms drives up FDI demand. On the other hand, increased imports and trade substitution would weed out the least productive foreign firms, decreasing FDI. These are the market expansion and plant rationalization effects.

Another innovation of the FHFDI model is in terms of services barriers. Services liberalization is a main point in the study of RCEP, which is handled carefully in the model. Based on literature and empirical evidence, services barriers are modelled as tax equivalents that raise costs to imported services and generate rents to all firms in the market. In such a treatment, services liberalization not only lowers the prices of imported services, but also reduces the prices of domestic services. The prices of imports drop because of reductions in trade costs and reductions in rent-creating distortion of services barriers. The prices of domestic services drop solely because of the reduction in the rent-creating

distortion. The direct price effect of trade liberalization on domestic services amplifies the total price effect of the FTA on member countries.

Simulation results show that RCEP could encourage FDI to China, and services dominate the FDI increase. With a 95% reduction in tariff barriers, a small step of services liberalization in China would increase FDI by US$2 billion, while a big step of services liberalization can generate more FDI increases. A big step services liberalization plus a 50% reduction in fixed trading costs would generate an increase of US$4 billion FDI to China, with US$3.68 billion flowing to services. The welfare gains of China from the three scenarios of RCEP are US$82 billion, 97 billion and 154 billion, accounting for 0.9~1.6% of its GDP.

The RCEP study has practical significance at this time when RCEP is under negotiation. China would benefit from RCEP in terms of FDI and welfare. Big step of services liberalization tends to generate more benefits. If RCEP can reduce fixed trading costs among member countries, then the gains of China would be even bigger. Therefore, member countries, especially China, should work for an agreement that greatly facilitates services trade and improves business environments (so as to reduce fixed trading costs).

6.3. Limitations and Further Study

The study of ACFTA could be extended to capture the effects of the 2010 investment agreement and the supplemental protocols of the trade agreements. These agreements should have deepened trade liberalization and facilitated bilateral investment, and thus, the total effect of all ACFTA agreements might be stronger. Another extension of the ACFTA study is to explore the individual effects of ACFTA on different ASEAN states when detailed FDI data are available. ASEAN's economy is smaller than China's. According to common sense, their gains from ACFTA should be substantial, particularly from the preferential access to the China market. In addition, ASEAN states are different from each other, and ACFTA would affect them differently.

For the CGE study of RCEP, there are even more extensions that could be done in future. One extension is to relax the assumptions of the FHFDI model, such as allowing free entry

and exit of firms and including sunk costs. Some assumptions need more solid empirical background. When more evidence is available, these assumptions could be modified to reflect the real economy in a more accurate way. Additionally, the model could be used to simulate trade, FDI and welfare effects of various economic integration arrangements. With a detailed treatment of foreign firms and FDI, the model could be used to explore economic effects of FDI-stimulating policies. Finally, the CGE study could be extended from a comparative static model to a dynamic model, and extended to a more disaggregated model.

Overall, this thesis has provided a thorough examination of the FDI effects of ACFTA and RCEP. Both ACFTA and RCEP are found to be able to promote FDI to member countries. While the econometric finding for ACFTA suggests a significant FDI effect of trade liberalization in goods, the CGE simulation results of RCEP show that the effect of services liberalization is likely to be much stronger. It is hoped that this research has provided an insight into the policy implication of the proliferation of FTAs from an FDI perspective and could stimulate countries to place greater emphasis on liberalization of services.

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Appendices

A. Data

A.1. FDI home and host countries in the bilateral FDI stock database, and other countries that constitute the third countries.

FDI home country		**FDI host country**	**Other**
Australia	New Zealand	China	Bulgaria
Austria	Norway	Indonesia	Costa Rica
Belgium	Poland	Malaysia	Cyprus
Canada	Portugal	Philippines	Latvia
Czech Republic	Spain	Singapore	Luxembourg
Denmark	Sweden	Thailand	Macao SAR, China
Finland	Switzerland	Viet Nam	Malta
France	Taiwan		Mexico
Germany	Turkey		Morocco
Greece	USA		Panama
Hong Kong	UK		Peru
Hungary	China		Romania
Iceland	Indonesia		Russian Federation
Ireland	Malaysia		Slovenia
Italy	Philippines		South Africa
Japan	Singapore		Sri Lanka
Korea	Thailand		Uruguay
Netherlands	Viet Nam		

A.2. Data Sources for control variables

Distance data are drawn from CEPII. Real GDP data at 2005 US dollars are available from the World Bank's World Development Indicators.[56] The same database provides gross capital formation data at 2005 US dollars, total labor force, and ratio of labor force with tertiary education. I estimate a country's capital stock by the perpetual inventory method as outlined in Baltagi et al. (2007). Choosing 1992 as the initial year, I estimate $K_{1992} =$

[56] The World Bank does not report data for Taiwan. The data for Taiwan are complemented by National Statistics of Taiwan.

$2\sum_{t=1990}^{1994} I_t$, where $I_t$denotes investment in year t. Assuming a depreciation rate (δ) of 7%, the annual capital stocks can be calculated by the perpetual inventory method based on annual investment data ($K_t = (1-\delta)K_{t-1} + I_t$). A country's skilled (unskilled) labor endowment is measured by total labor force times the ratio (one minus the ratio) of labor force with tertiary education. The political risk indices are taken from International Country Risk Guide.

A.3. The 30 sectors in China's manufacturing industry

Group I	Furniture manufacturing	Metal product
	Textile	Culture, educational and sports articles
Group II	Petroleum processing and product	Non-metal mineral products
Group III	Wood and wood product	Leathers and related products
	Artwork and other manufacturing	Transport equipment
Group IV	Food processing	Beverage manufacturing
	Garments & footwear	Papermaking and paper products
Pro-fragmentation sectors	Electronic and telecommunications	Electrical equipment and machinery
	General machinery	Special machinery
Others	Plastic products	Medical and pharmaceutical products
	Chemical materials and products	Measuring instruments and machinery
	Food manufacturing	Printing and recorded pressing
	Rubber	Smelting and pressing of non-ferrous metals
	Chemical fibbers	Smelting and pressing of ferrous metals
	Tobacco	Recycling and disposal of waste

B. The SAM table

In Chapter 5, the SAM table used for simulation with the FHFDI model is based on the GTAP data. The FHFDI model separates foreign firms and defines market-specific outputs for each firm type. To be consistent with the FHFDI model, I first split the total outputs in the GTAP data into outputs of domestic firms and foreign firms. The outputs of foreign firms are specific to the home region of foreign firms, which are drawn from the three-dimension global foreign affiliate sales database (home-host-sector). Second, the outputs of each firm are further allocated into three markets as each firm can supply all three regions of the world. The allocation of outputs to the three markets is based on the share of each market in total sales drawn from the GTAP data. Therefore, in a region, the production activity accounts are extended from 5 accounts (5 sectors) to 45 accounts (3 firms $\times$ 3 markets $\times$ 5 sectors).

Accordingly, the inputs of intermediate goods and factors in each sector are split into the 9 activity accounts (3 firms $\times$ 3 markets) based on sectoral input-output ratios of the GTAP data. The ratios of capital-output and labor-output have been adjusted for foreign firms in order to reflect the fact that multinationals usually outsource labor-intensive work. For foreign firms, the capital-output ratio is lower while the labor-output ratio is higher than their counterparts in the GTAP data. The capital-output ratio is drawn from the survey data of US majority-owned nonbank foreign affiliates in 2007 (Barefoot & Jr., 2009). The data show that the capital-output ratio of US foreign affiliates is 5% on average. To obtain the sectoral capital-output ratio, I adjusted the 5% by the sectoral ratios of the GTAP data, because there are no sectoral capital inputs in the survey. With the sectoral capital-output ratios, the capital inputs of foreign firms in each sector can be calculated. The calculated capital inputs might be higher than the FDI from home region as given by the global FDI stock database (home-host-sector). In that case, the FDI stock data substitute the calculated capital inputs. The calculated capital becomes real inputs when the calculated capital inputs are lower than the FDI stock data. The excess FDI that cannot be exhausted by foreign firms is allocated to domestic firms. The labor-output ratio is raised for foreign firms to a level that the SAM table is balanced.

In terms of supply, I separated sales into three markets in order to be consistent with the production activity accounts. Then, the sales to domestic market are aggregated with imports from different regions and produced by different firms to compose the aggregated supply for domestic demand. There are 5 demand accounts and 30 export accounts (2 export markets $\times 3$ types of firms $\times 5$ sectors).

The last adjustment to the GTAP data is in terms of intra-regional trade. Since the FHFDI model does not differentiate between domestic commodities and intra-regional imports, I added the intra-regional exports to domestic commodities and meanwhile removed intra-regional imports, and thus, converting intra-regional trade to domestic commodities. In sum, the SAM table has 152 accounts for each economy, which are more than three times of those in the GTAP data (50).

C. Equations and Variables

Equation Expression.

Variables are in capital letters. D and F are used to indicate domestic and foreign firms. A parenthesis after a variable or parameter containing letters like i, j, s, c indicates regions and sectors. Regions are denoted with i, j and g. Sector and commodity are denoted with s, ss, c and a, with a for agriculture particularly and ss for sectors with heterogeneous firms. In contexts where two regional indicators are required, the first refers to the origin of a trade flow or investment and the second to the destination (or host). In contexts where three regional indicators are required, the first refers to the home region of foreign firms, the second to the host region, and the third to the destination of a trade flow from foreign firms, i.e.:

$XF(g, i, j, s)$ Output of foreign firms in sector s, sourced capital from home region g, produced in host region i, sold to the market j

In contexts where two commodity indicators are used, the first refers to the producing industry of a commodity and the second to the consuming industry, i.e.:

$INTCF(c,g,i,j,s)$ Intermediate input of commodity c in production of s of foreign firm sourced capital from region g, operating in i and exporting to j

At the end of each function, the perpendicular symbol '$\perp$' shows the corresponding relationships between variables and equations.

C.1. Capital Allocation

$$A(g) = (\sum_{s} \alpha a(g,s)^{\frac{1}{\sigma 1}} AK(g,s)^{\frac{\sigma 1-1}{\sigma 1}})^{\frac{\sigma 1}{\sigma 1-1}} \qquad \perp AK(g,s)(1)$$

$$\sum_{s} AK(g,s) * \frac{1}{RK(g,s)} = \overline{W(g)} \qquad \perp AK(g,s)(2)$$

$$\frac{AK(g,s)}{A(g)} = \alpha a(g,s)\left(\frac{RK(g,s)}{R(g)}\right)^{\sigma 1}, s \neq a \qquad \perp AK(g,s)(3)^{57}$$

$$AK(g,s) = [\alpha D(g,s)^{\frac{1}{\sigma 2}} AD(g,s)^{\frac{\sigma 2-1}{\sigma 2}} + \alpha F(g,s)^{\frac{1}{\sigma 2}} AF(g,s)^{\frac{\sigma 2-1}{\sigma 2}}]^{\frac{\sigma 2}{\sigma 2-1}} \qquad \perp AD(g,s)(4)$$

$$\frac{AD(g,s)}{AF(g,s)} = \frac{\alpha d(g,s)}{\alpha f(g,s)}(\frac{RD(g,s)}{RF(g,s)})^{\sigma 2} \qquad \perp AF(g,s)(5)$$

$$AD(g,s)\frac{1}{RD(g,s)} + AF(g,s)\frac{1}{RF(g,s)} = AK(g,s)\frac{1}{RK(g,s)} \qquad \perp RK(g,s)(6)$$

$$AF(g,s) = (\sum_{i} \alpha fdi(g,i,s)^{\frac{1}{\sigma 3}} AFDI(g,i,s)^{\frac{\sigma 3-1}{\sigma 3}})^{\frac{\sigma 3}{\sigma 3-1}}, g \neq i \qquad \perp AFDI(g,i,s)(7)$$

$$\frac{AFDI(g,i,s)}{AFDI(g,h,s)} = \frac{\alpha fdi(g,i,s)}{\alpha fdi(g,h,s)}(\frac{RFDI(g,i,s)}{RFDI(g,h,s)})^{\sigma 3}, g \neq i \neq h \qquad \perp AFDI(g,i,s)(8)$$

$$\sum_{i} AFDI(g,i,s)\frac{1}{RFDI(g,i,s)} = AF(g,s)\frac{1}{RF(g,s)}, g \neq i \qquad \perp RF(g,s)(9)$$

$$AFDID(g,i,s) = \alpha N(g,i,s)AFDI(g,i,s), g \neq i \qquad \perp AFDID(g,i,s)(10)$$

$$AFDIF(g,i,s) = \alpha FA(g,i,s)AFDI(g,i,s), g \neq i \qquad \perp AFDIF(g,i,s)(11)$$

[57] This equation sets s ≠ a in order to equalize the number of equation with the number of variables. With s ≠ a, the equation group (3) has 12 equations (3 regions ×4 sectors). Together with the 3 equations in (1), there are 15 equations which correspond to 15 variables of AK(g, s).

$$AFDID(g,i,s)\frac{1}{RFDID(g,i,s)}+AFDIF(g,i,s)\frac{1}{RFDIF(g,i,s)} = AFDI(g,i,s)\frac{1}{RFDI(g,i,s)}, g \neq i \quad \perp RFDI(g,i,s) \text{(12)}$$

$$RFDID(g,i,s) = \frac{WFDID(g,i,s)}{PA(i)}, g \neq i \quad \perp RFDID(g,i,s) \text{(13)}$$

$$RFDIF(g,i,s) = \frac{WFDIF(g,i,s)}{PA(i)}, g \neq i \quad \perp RFDIF(g,i,s) \text{(14)}$$

$$RD(g,s) = \frac{WDK(g,s)}{PA(g)} \quad \perp RD(g,i,s) \text{(15)}$$

$$PA(i) = \frac{EINV(i)}{\sum_s \overline{QINV(J,s)}} \quad \perp PA(i) \text{(16)}$$

$$AFDID(g,i,s) = QFDID(g,i,s) * PA(i), g \neq i \quad \perp WFDID(g,i,s) \text{(17)}$$

$$AFDIF(g,i,s) = QFDIF(g,i,s) * PA(i), g \neq i \quad \perp WFDIF(g,i,s) \text{(18)}$$

$$AD(g,s) = QDK(g,s) * PA(g) \quad \perp WDK(g,s) \text{(19)}$$

$$QFDID(g,i,s) = \sum_j QFDIDJ(g,i,j,s), g \neq i \quad \perp QFDID(g,i,s) \text{(20)}$$

$$QFDIF(g,i,s) = \sum_j QFDIFJ(g,i,j,s), g \neq i \quad \perp QFDIF(g,i,s) \text{(21)}$$

$$QDK(i,s) = \sum_j QDKJ(i,j,s) \quad \perp QDK(i,s) \text{(22)}$$

C.2. Production

C.2.1. Domestic Firm

$$\Pi D(i,j,ss) = \frac{PD(i,j,ss)QD(i,j,ss)}{(1+t(i,j,ss))}\frac{1+v(i,j,ss)\sigma(ss)}{\sigma(ss)}\frac{\sigma(ss)-1}{\gamma(ss)(1+v(i,j,ss))} \quad \perp \Pi D(i,j,ss) \text{(23)}$$

$$\Pi F(g,i,j,ss) = \frac{PF(g,i,j,ss)QF(g,i,j,ss)}{(1+t(i,j,ss))}\frac{1+v(i,j,ss)\sigma(ss)}{\sigma(ss)}\frac{\sigma(ss)-1}{\gamma(ss)(1+v(i,j,ss))}, i \neq g \quad \perp \Pi F(g,i,j,ss) \text{(24)}$$

$$PD(i,j,ss) = \big(1+v(j,ss)\big)\frac{\sigma(ss)}{\sigma(ss)-1}\frac{\big(1+t(i,j,ss)\big)\tau(i,j,ss)CD(i,j,ss)}{\widetilde{\varphi D}(i,j,ss)}[\overline{N(\iota,ss)}(1 - G(\varphi D(i,j,ss)^{*}))]^{1/1-\sigma(ss)} \quad \perp XD(i,j,ss)\ (25)^{58}$$

$$PD(i,j,a) = \big(1+t(i,j,a)\big)\tau(i,j,a)CD(i,j,a) \quad \perp XD(i,j,a)\ (26)$$

$$\widetilde{\varphi D}(i,j,ss) = \varphi D^{*}(i,j,ss)\left(\frac{\gamma(ss)}{\gamma(ss)-\sigma(ss)+1}\right)^{1/\sigma(ss)-1} \quad \perp \widetilde{\varphi D}(i,j,ss)\ (27)$$

$$\varphi D^{*}(i,j,ss) = \frac{\tau(i,j,ss)CD(i,j,ss)}{\sigma(ss)-1} * \left(\frac{PQ(j,ss)}{\sigma(ss)\big(1+v(i,j,ss)\big)\big(1+t(i,j,ss)\big)}\right)^{\frac{\sigma(ss)}{1-\sigma(ss)}} * \left(\frac{\overline{FD(\iota,j,ss)}}{Q(j,ss)[1+v(i,j,ss)\sigma(ss)]\theta(i,j,ss)\theta D(i,j,ss)}\right)^{1/\sigma(ss)-1} \quad \perp \varphi D^{*}(i,j,ss)\ (28)$$

$$XD(i,j,s) = \omega D(i,j,s)\,[\delta 1(i,j,s)^{1/\sigma'(s)} * VAD(i,j,s)^{\sigma'(s)-1/\sigma'(s)} + \delta 2(i,j,s)^{1/\sigma'(s)} * INTD(i,j,s)^{\sigma'(s)-1/\sigma'(s)}]^{\sigma'(s)/\sigma'(s)-1} \quad \perp VAD(i,j,s)\ (29)$$

$$\frac{PVAD(i,j,s)}{PINTD(i,j,s)} = \left(\frac{\delta 1(i,j,s)}{\delta 2(i,j,s))}\frac{INTD(i,j,s)}{VAD(i,j,s)}\right)^{1/\sigma'(s)} \quad \perp INTD(i,j,s)\ (30)$$

$$CD(i,j,s) = \frac{1}{\omega D(i,j,s)}(\delta 1(i,j,s)PVAD(i,j,s)^{1-\sigma'(s)} + \delta 2(i,j,s)PINTD(i,j,s)^{1-\sigma'(s)})^{1/1-\sigma'(s)} \quad \perp CD(i,j,s)\ (31)$$

$$INTCD(c,i,j,s) = \alpha cs(c,i,j,s)INTD(i,j,s) \quad \perp INTCD(c,i,j,s)\ (32)$$

$$PINTD(i,j,s) = \sum_{c}\alpha cs(c,i,j,s)PQ(i,c) \quad \perp PINTD(i,j,s)\ (33)$$

$$VAD(i,j,ss) = \omega VAD(i,j,ss)[\delta va1(i,j,ss)^{1/\sigma'(ss)}LD(i,j,ss)^{\sigma'(ss)-1/\sigma'(ss)} + \delta va2(i,j,ss)^{1/\sigma'(ss)} * KD(i,j,ss)^{\sigma'(ss)-1/\sigma'(ss)}]^{\sigma'(ss)/\sigma'(ss)-1} \quad \perp LD(i,j,ss)\ (34)$$

$$\frac{WL(i)}{WKD(i,j,ss)} = \left(\frac{\delta va1(i,j,ss)}{\delta va2(i,j,ss)}\frac{KD(i,j,ss)}{LD(i,j,ss)}\right)^{1/\sigma'(ss)} \quad \perp KD(i,j,ss)\ (35)$$

$$PVAD(i,j,ss) = \frac{1}{\omega VAD(i,j,ss)}[\delta va1(i,j,ss)\big(WL(i)\big)^{1-\sigma'(ss)} + \delta va2(i,j,ss)WKD(i,j,ss)^{1-\sigma'(ss)}]^{1/1-\sigma'(ss)} \quad \perp PVAD(i,j,ss)\ (36)$$

[58] $1-G(\varphi)=\varphi^{-\gamma}$

$$VAD(i,j,a) = \omega VAD(i,j,a)\Big[\delta va1(i,j,a)^{1/\sigma\prime(a)} LD(i,j,a)^{(\sigma\prime(a)-1)/\sigma\prime(a)} + \delta va2(i,j,a)^{1/\sigma\prime(a)} * LKD(i,j,a)^{(\sigma\prime(a)-1)/\sigma\prime(a)}\Big]^{\sigma\prime(a)/(\sigma\prime(a)-1)} \quad \perp LD(i,j,a) \quad (37)$$

$$\frac{WL(i)}{PLKD(i,j,a)} = \left(\frac{\delta va1(i,j,a)}{\delta va2(i,j,a)}\frac{LKD(i,j,a)}{LD(i,j,a)}\right)^{1/\sigma\prime(a)} \quad \perp LKD(i,j,a) \quad (38)$$

$$PVAD(i,j,a) = \frac{1}{\omega VAD(i,j,a)}[\delta va1(i,j,a)WL(i)^{1-\sigma\prime(a)} + \delta va2(i,j,a)PLKD(i,j,a)^{1-\sigma\prime(a)}]^{1/(1-\sigma\prime(a))} \quad \perp PVAD(i,j,a) \quad (39)$$

$$LKD(i,j,a) = \omega LKD(i,j,a)\Big[\delta lk1(i,j,a)^{1/\sigma\prime(a)} LND(i,j,a)^{(\sigma\prime(a)-1)/\sigma\prime(a)} + \delta lk2(i,j,a)^{1/\sigma\prime(a)} KD(i,j,a)^{(\sigma\prime(a)-1)/\sigma\prime(a)}\Big]^{\sigma\prime(a)/(\sigma\prime(a)-1)} \quad \perp LND(i,j,a) \quad (40)$$

$$\frac{WLAN(i)}{WKD(i,j,a)} = \left(\frac{\delta lk1(i,j,a)}{\delta lk2(i,j,a)}\frac{KD(i,j,a)}{LND(i,j,a)}\right)^{1/\sigma\prime(a)} \quad \perp KD(i,j,a) \quad (41)$$

$$PLKD(i,j,a) = \frac{1}{\omega LKD(i,j,a)}[\delta lk1(i,j,a)WLAN(i)^{1-\sigma\prime(a)} + \delta lk2(i,j,a)WKD(i,j,a)^{1-\sigma\prime(a)}]^{1/(1-\sigma\prime(a))} \quad \perp PLKD(i,j,a) \quad (42)$$

$$KD(i,j,s) = \omega KD(i,j,s)\Big[\delta k1(i,j,s)^{1/\sigma\prime(s)} QDKJ(i,j,s)^{(\sigma\prime(s)-1)/\sigma\prime(s)} + \delta k2(i,j,s)^{1/\sigma\prime(s)} QFKD(i,j,s)^{(\sigma\prime(s)-1)/\sigma\prime(s)}\Big]^{\sigma\prime(s)/(\sigma\prime(s)-1)} \quad \perp QDKJ(i,j,s) \quad (43)$$

$$\frac{WDK(i,s)}{WFKD(i,j,s)} = \left(\frac{\delta k1(i,j,s)}{\delta k2(i,j,s)}\frac{QFKD(i,j,s)}{QDKJ(i,j,s)}\right)^{1/\sigma\prime(s)} \quad \perp QFKD(i,j,s) \quad (44)$$

$$WKD(i,j,s) = \frac{1}{\omega KD(i,j,s)}[\delta k1(i,j,s)WDK(i,s)^{1-\sigma'(s)} + \delta k2(i,j,s)WFKD(i,j,s)^{1-\sigma'(s)}]^{1/(1-\sigma\prime(s))} \quad \perp WKD(i,j,s) \quad (45)$$

$$QFDIDJ(g,i,j,s) = \delta fk(g,i,j,s)QFKD(i,j,s), g \neq i \quad \perp QFDIDJ(g,i,j,s) \quad (46)$$

$$WFKD(i,j,s) = \sum_g \delta fk(g,i,j,s)WFDID(g,i,s), g \neq i \quad \perp WFKD(i,j,s) \quad (47)$$

C.2.2. Foreign Firms

$$PF(g,i,j,ss) = \big(1 + v(i,j,ss)\big)\frac{\sigma(ss)}{\sigma(ss)-1}\frac{(1+t(i,j,ss))\tau(i,j,ss)CF(g,i,j,ss)}{\widetilde{\varphi F}(g,i,j,ss)}[\overline{N(g,ss)}(1 - G(\varphi F(g,i,j,ss)^{*}))]^{1/1-\sigma(ss)} \quad \perp XF(g,i,j,ss) \quad (48)$$

$$PF(g,i,j,a) = \big(1 + t(i,j,a)\big)\tau(i,j,a)CF(g,i,j,a) \quad \perp XF(g,i,j,a) \quad (49)$$

$$\widetilde{\varphi F}(g,i,j,ss) = \varphi F^{*}(g,i,j,ss)\left(\frac{\gamma(ss)}{\gamma(ss)-\sigma(ss)+1}\right)^{1/\sigma(ss)-1} \quad \perp \widetilde{\varphi F}(g,i,j,ss) \quad (50)$$

$$\varphi F^{*}(g,i,j,ss) = \frac{\tau(i,j,ss)CF(g,i,j,ss)}{\sigma(ss)-1} * \left(\frac{PQ(j,ss)}{\sigma(ss)\big(1+v(i,j,ss)\big)\big(1+t(i,j,ss)\big)}\right)^{\frac{\sigma(ss)}{1-\sigma(ss)}} * \left(\frac{\overline{FF(g,i,j,ss)}}{Q(j,ss)\big(1+v(i,j,ss)\sigma(ss)\big)\theta(i,j,ss)\theta FS(i,j,ss)\theta F(g,i,j,ss)}\right)^{1/\sigma(ss)-1} \quad \perp \varphi F^{*}(g,i,j,ss) \quad (51)$$

$$XF(g,i,j,s) = \omega F(g,i,j,s)\,[\delta F1(g,i,j,s)^{1/\sigma'(s)}\,VAF(g,i,j,s)^{\sigma'(s)-1/\sigma'(s)} + \delta F2(g,i,j,s)^{1/\sigma'(s)} * INTF(g,i,j,s)^{\sigma'(s)-1/\sigma'(s)}]^{\sigma'(s)/\sigma'(s)-1} \quad \perp VAF(g,i,j,s) \quad (52)$$

$$\frac{PVAF(g,i,j,s)}{PINTF(g,i,j,s)} = \left(\frac{\delta F1(g,i,j,s)}{\delta F2(g,i,j,s)}\frac{INTF(g,i,j,s)}{VAF(g,i,j,s)}\right)^{1/\sigma'(s)} \quad \perp INTF(g,i,j,s) \quad (53)$$

$$CF(g,i,j,s) = \frac{1}{\omega F(g,i,j,s)}(\delta F1(g,i,j,s)PVAF(g,i,j,s)^{1-\sigma'(s)} + \delta F2(g,i,j,s)PINTF(g,i,j,s)^{1-\sigma'(s)})^{1/1-\sigma'(s)} \quad \perp CF(g,i,j,s) \quad (54)$$

$$INTCF(c,g,i,j,s) = \alpha csf(c,g,i,j,s)INTF(g,i,j,s) \quad \perp INTCF(c,g,i,j,s) \quad (55)$$

$$PINTF(g,i,j,s) = \sum_{c}\alpha csf(c,g,i,j,s)PQ(i,c) \quad \perp PINTF(g,i,j,s) \quad (56)$$

$$VAF(g,i,j,ss) = \omega VAF(g,i,j,ss)[\delta vaF1(g,i,j,ss)^{1/\sigma'(ss)}LF(g,i,j,ss)^{\sigma'(ss)-1/\sigma'(ss)} + \delta vaF2(g,i,j,ss)^{1/\sigma'(ss)}QFDIFJ(g,i,j,ss)^{\sigma'(ss)-1/\sigma'(ss)}]^{\sigma'(ss)/\sigma'(ss)-1} \quad \perp LF(g,i,j,ss) \quad (57)$$

$$\frac{WL(i)}{WFDIF(g,i,s)} = \left(\frac{\delta vaF1(g,i,j,ss)}{\delta vaF2(g,i,j,ss)}\frac{QFDIFJ(g,i,j,ss)}{LF(g,i,j,ss)}\right)^{1/\sigma'(ss)} \quad \perp QFDIFJ(g,i,j,ss) \quad (58)$$

$$PVAF(g,i,j,ss) = \frac{1}{\omega VAF(g,i,j,ss)}[\delta vaF1(g,i,j,ss)WL(i)^{1-\sigma'(ss)} + \delta vaF2(g,i,j,ss) * WFDIF(g,i,ss)^{1-\sigma'(ss)}]^{1/1-\sigma'(ss)} \perp PVAF(g,i,j,ss) \quad (59)$$

$$VAF(g,i,j,a) = \omega VAF(g,i,j,a)[\delta vaF1(g,i,j,a)^{1/\sigma'(a)} LF(g,i,j,a)^{\sigma'(a)-1/\sigma'(a)} + \delta vaF2(g,i,j,a)^{1/\sigma'(a)} LKF(g,i,j,a)^{\sigma'(a)-1/\sigma'(a)}]^{\sigma'(a)/\sigma'(a)-1} \perp LF(g,i,j,a) \quad (60)$$

$$\frac{WL(i)}{PLKF(g,i,j,a)} = (\frac{\delta vaF1(g,i,j,a)}{\delta vaF2(g,i,j,a)}\frac{LKF(g,i,j,a)}{LF(g,i,j,a)})^{1/\sigma'(a)} \perp LKF(g,i,j,a) \quad (61)$$

$$PVAF(g,i,j,a) = \frac{1}{\omega VAF(g,i,j,a)}[\delta vaF1(g,i,j,a)WL(i)^{1-\sigma'(a)} + \delta vaF2(g,i,j,a)PLKF(g,i,j,a)^{1-\sigma'(a)}]^{1/1-\sigma'(a)} \perp PVAF(g,i,j,a) \quad (62)$$

$$LKF(g,i,j,a) = \omega LKF(g,i,j,a)\Big[\delta lkF1(g,i,j,a)^{1/\sigma'(a)} LNF(g,i,j,a)^{\sigma'(a)-1/\sigma'(a)} + \delta lkF2(g,i,j,a)^{1/\sigma'(a)} QFDIFJ(g,i,j,a)^{\sigma'(a)-1/\sigma'(a)}\Big]^{\sigma'(a)/\sigma'(a)-1} \perp LNF(g,i,j,a) \quad (63)$$

$$\frac{WLAN(i)}{WFDIF(g,i,a)} = (\frac{\delta lkF1(g,i,j,a)}{\delta lkF2(g,i,j,a)}\frac{QFDIFJ(g,i,j,a)}{LNF(g,i,j,a)})^{1/\sigma'(a)} \perp QFDIFJ(g,i,j,a) \quad (64)$$

$$PLKF(g,i,j,a) = \frac{1}{\omega LKF(g,i,j,a)}[\delta lkF1(g,i,j,a)WLAN(i,a)^{1-\sigma'(a)} + \delta lkF2(g,i,j,a) * WFDIF(g,i,a)^{1-\sigma'(a)}]^{1/1-\sigma'(a)} \perp PLKF(g,i,j,a) \quad (65)$$

C.3. Demand and Government

$$Q(j,s) = \left[\sum_i (\theta(i,j,s)^{1/\sigma(s)} Z(i,j,s)^{(\sigma(s)-1)/\sigma(s)}\right]^{\sigma(s)/(\sigma(s)-1)} \perp Z(i,j,s) \quad (66)$$

$$PQ(j,s) = [\sum_i \theta(i,j,s) * PZ(i,j,s)^{1-\sigma(s)}\ ]^{1/1-\sigma(s)} \perp PQ(j,s) \quad (67)$$

$$\frac{Z(i,j,s)}{Q(j,s)} = \theta(i,j,s)(\frac{PQ(j,s)}{PZ(i,j,s)})^{\sigma(s)}, i \neq CN \perp Z(i,j,s) \quad (68)$$[59]

[59]This equation sets $i \neq CN$ in order to equalize the number of equations with the number of variables $Z(i,j,s)$.

$$Z(i,j,s) = \left[(\theta D(i,j,s)^{1/\sigma(s)} QD(i,j,s)^{(\sigma(s)-1)/\sigma(s)} + \theta FS(i,j,s)^{1/\sigma(s)} QFS(i,j,s)^{(\sigma(s)-1)/\sigma(s)} \right]^{\sigma(s)/(\sigma(s)-1)} \perp QD(i,j,s) \quad (69)$$

$$PZ(i,j,s) = [\theta D(i,j,s) * PD(i,j,s)^{1-\sigma(s)} + \theta FS(i,j,s) * PFS(i,j,s)^{1-\sigma(s)}]^{1/1-\sigma(s)} \perp PZ(i,j,s) \quad (70)$$

$$\frac{QD(i,j,s)}{QFS(i,j,s)} = \frac{\theta D(i,j,s)}{\theta FS(i,j,s)} \left(\frac{PFS(i,j,s)}{PD(i,j,s)}\right)^{\sigma(s)} \perp QFS(i,j,s) \quad (71)$$

$$QFS(i,j,s) = \left[\sum_g (\theta F(g,i,j,s)^{1/\sigma(s)} QF(g,i,j,s)^{(\sigma(s)-1)/\sigma(s)} \right]^{\sigma(s)/(\sigma(s)-1)} \perp QFS(g,i,j,s) \quad (72)$$

$$PFS(i,j,s) = [\sum_g \theta F(g,i,j,s) * PF(g,i,j,s)^{1-\sigma(s)}]^{1/1-\sigma(s)} \perp PFS(i,j,s) \quad (73)$$

$$\frac{QF(g,i,j,s)}{QFS(i,j,s)} = \theta F(g,i,j,s) \left(\frac{PFS(i,j,s)}{PF(g,i,j,s)}\right)^{\sigma(s)}, g \neq i \perp QF(g,i,j,s) \quad (74)$$

$$\begin{aligned} YH(j) = {} & WLN(j)\overline{LN(j)} + WL(j)L(j) + \sum_s QDK(j,s)WDK(j,s) \\ & + \sum_s \sum_g [QFDID(j,g,s)WFDID(j,g,s) \\ & + QFDIF(j,g,s)WFDIF(j,g,s)] \\ & + \sum_{ss} \sum_i (SDK(j,i,ss) + SDL(j,i,ss))(FD(j,i,ss) \\ & + \Pi D(j,i,ss)) \\ & + \sum_{ss} \sum_i \sum_g (SFL(g,j,i,ss))(FF(g,j,i,ss) + \Pi F(g,j,i,ss)) \\ & + \sum_{ss} \sum_i \sum_g SFK(j,g,i,ss)(FF(j,g,i,ss) + \Pi F(j,g,i,ss)) \end{aligned} \perp YH(j) \quad (75)$$

$$\begin{aligned} PQ(j,s)QH(j,s) = {} & PQ(j,s)b(j,s) \\ & + \beta(j,s) \left[YH(j) - \sum_c PQ(j,c)b(j,c) \right. \\ & \left. - PSAV(j)b(j,sav) \right] \end{aligned} \perp QH(j,s) \quad (76)$$

$$\text{PSAV(j)} = \frac{\sum_s PQ(j,s)}{5} \perp PSAV(j) \quad (77)$$

$$PSAV(j)HSAV(j) = PSAV(j)b(j,sav) + \beta(j,sav)\left[YH(j) - \sum_s PQ(j,s)b(j,s) - PSAV(j)b(j,sav)\right] \perp HSAV(j) \quad (78)$$

$$YG(j) = \sum_s \sum_i [(tm(i,j,s) + \tau(i,j,s) - 1) * \frac{\left(PD(i,j,s)QD(i,j,s) + \sum_g PF(g,i,j,s)QF(g,i,j,s)\right)}{1 + t(i,j,s)}] \perp YG(j) \quad (79)$$ [60]

$$EG(j) = \sum_s PQ(j,s)\overline{QG(J,s)} + PQ(j,s1)\overline{TS1(J)} \perp EG(j) \quad (80)$$

$$GSAV(j) = YG(j) - EG(j) \perp GSAV(j) \quad (81)$$

$$EINV(j) = \sum_s PQ(j,s)\overline{QINV(J,s)} \perp EINV(j) \quad (82)$$

C.4. Closure

$$Q(j,s) = \sum_c \sum_i INTCD(s,j,i,c) + \left[\sum_{ss} \sum_i SDI(j,i,ss)\left(FD(j,i,ss) + \Pi D(j,i,ss)\right)\right] \Big/ PQ(j,s) + \sum_g INTCF(s,g,j,i,c) + \left[\sum_{ss} \sum_i SFI(g,j,i,ss)\left(FF(g,j,i,ss) + \Pi F(g,j,i,ss)\right)\right] \Big/ PQ(j,s) + QH(j,s) + \overline{QG(J,s)} + \overline{QINV(J,s)} + \overline{TS1(J)}, \quad TS1(j) = 0 \; if \; s \neq s1 \perp Q(j,s) \quad (83)$$

$$XD(i,j,ss) = [\overline{N(i,ss)}(1 - G(\varphi D(i,j,ss)^*)]^{1/(1-\sigma(ss))} \frac{\tau(i,j,ss)QD(i,j,ss)}{\varphi D(\widetilde{i,j,ss})} \perp PD(i,j,ss) \quad (84)$$

$$XD(i,j,a) = \tau(i,j,a)QD(i,j,a) \perp PD(i,j,a) \quad (85)$$

$$XF(g,i,j,ss) = [\overline{N(g,ss)}(1 - G(\varphi F(i,j,ss)^*)]^{1/(1-\sigma(ss))} \frac{\tau(i,j,ss)QF(g,i,j,ss)}{\varphi F(\widetilde{i,j,ss})} \perp PF(g,i,j,ss) \quad (86)$$

[60] The government income equation (79) integrates iceberg costs of imports. Similarly, the government expenditure equation (80) integrates international transportation services demand. Accordingly, the government saving equation (81) integrates saving from the international transportation services pool. This is due to the similarity in the calculation of government balance and international transportation services balance. I integrate the two balances into one group of equations to simplify computation.

$$XF(g,i,j,a) = \tau(i,j,a)QF(g,i,j,a) \qquad \perp PF(g,i,j,a) \quad (87)$$

$$\sum_j \sum_s \left(LD(i,j,s) + \sum_g LF(g,i,j,s) \right) = \overline{L(\iota)} \qquad \perp WL(i) \quad (88)$$

$$\sum_j \sum_s \left(LND(i,j,s) + \sum_g LNF(g,i,j,s) \right) = \overline{LN(\iota)} \qquad \perp WLAN(i) \quad (89)$$

$$FSAVD(i,j) = \sum_s [\frac{PD(i,j,s)QD(i,j,s)}{1+t(i,j,s)} - \frac{PD(j,i,s)QD(j,i,s)}{1+t(j,i,s)}], i \neq j \qquad \perp FSAVD(i,j) \quad (90)$$

$$FSAVF(i,j) = \sum_s \left[\sum_g \frac{PF(g,i,j,s)QF(g,i,j,s)}{1+t(i,j,s)} - \sum_h \frac{PF(h,j,i,s)QF(h,j,i,s)}{1+t(j,i,s)} \right], i \neq j, g \neq i,h \neq j \qquad \perp FSAVF(i,j) \quad (91)$$

$$\begin{aligned} FSAVK(i,j) = \sum_s & (QFDID(i,j,s)WFDID(i,j,s) + QFDIF(i,j,s)WFDIF(i,j,s) \\ & - QFDID(j,i,s)WFDID(j,i,s) - QFDIF(j,i,s)WFDIF(j,i,s)) \\ & + \sum_g \sum_{ss} SFK(i,j,g,ss)(FF(i,j,g,ss) + \Pi F(i,j,g,ss)) \\ & - \sum_g \sum_{ss} SFK(j,i,g,ss)(FF(j,i,g,ss) + \Pi F(j,i,g,ss)) \end{aligned} \qquad \perp FSAVK(i,j) \quad (92)$$

$$\begin{aligned} EINV(j) = & PSAV(j)HSAV(j) + GSAV(j) + \sum_i (FSAVD(i,j) + FSAVF(i,j) + FSAVK(i,j)) \\ & + VBIS(j) \end{aligned} \qquad \perp VBIS(j) \quad (93)$$

C.5. Variables and Parameters

C.5.1. Variables

C.5.1.1. Capital Allocation Variables

$A(g)$ Assets owned by region g

$AK(g,s)$ Assets owned by region g allocated to sector s

$RK(g,s)$ Rate of return on AK(g,s)

$AD(g,s)$ Assets owned by region g allocated to domestic market sector s

$AF(g,s)$ Assets owned by region g allocated to foreign markets sector s

$RD(g,s)$ Rate of return on $AD(g,s)$

$RF(g,s)$ Rate of return on $AF(g,s)$

$AFDI(g,i,s)$ FDI owned by region g invested in region i sector s

$RFDI(g,i,s)$ Rate of return on $AFDI(g,i,s)$

$AFDID(g,i,s)$ FDI owned by region g invested in region i sector s used by domestic firms of i

$RFDID(g,i,s)$ Rate of return on $AFDID(g,i,s)$

$AFDIF(g,i,s)$ FDI owned by region g invested in region i sector s used by foreign firms with parents in g

$RFDIF(g,i,s)$ Rate of return on $AFDIF(g,i,s)$

$PA(g)$ Asset price in region g

$WFDID(g,i,s)$ Rental price of FDI owned by region g invested in region i sector s paid by domestic firms of i

$WFDIF(g,i,s)$ Rental price of FDI owned by region g invested in region i sector s paid by foreign firms with parents in g

$WDK(g,s)$ Rental price of capital owned by region g invested in domestic market sector s paid by domestic firms

$QDK(g,s)$ Demand of domestic firms in region g sector s for domestic capital

$QFDID(g,i,s)$ Demand of domestic firms in region i sector s for FDI from home region g

$QFDIF(g,i,s)$ Demand of foreign firms in region i sector s from FDI from home region g

C.5.1.2. Production Variables

$\Pi D(i,j,ss)$ Sectoral profits of domestic firms in sector with heterogeneous firms ss operating on the $i-j$ link

$PD(i,j,s)$ Sectoral average price for commodity s produced by domestic firms operating on the $i-j$ link

$QD(i,j,s)$ Demand of market j for commodity s produced by domestic firms of region i

$\Pi F(g,i,j,ss)$ Sectoral profit of foreign firms from home region g located in region i and supplying market j (the $g-i-j$ link) in sector ss

$PF(g,i,j,s)$ Sectoral average price for commodity s produced by foreign firms on the $g-i-j$ link

$QF(g,i,j,s)$ Demand of market j for commodity s produced by foreign firms from home region g located in region i

C.5.1.2.1. Domestic firms

$\varphi D^*(i,j,ss)$ Productivity threshold for domestic firms in sector ss to operate on the $i-j$ link

$\widetilde{\varphi D}(i,j,ss)$ Average productivity of domestic firms in sector ss operating on the $i-j$ link

$XD(i,j,s)$ Output of domestic firms in sector s on the $i-j$ link

$VAD(i,j,s)$ Value added inputs of domestic firms in sector s on the $i-j$ link

$INTD(i,j,s)$ Composite intermediate inputs of domestic firms in sector s on the $i-j$ link

$PVAD(i,j,s)$ Price of $VAD(i,j,s)$

$PINTD(i,j,s)$ Price of $INTD(i,j,s)$

$CD(i,j,s)$ Marginal cost of $XD(i,j,s)$

$INTCD(c,i,j,s)$ Inputs of intermediate commodity c in the production of commodity s of domestic firms on the $i-j$ link

$LD(i,j,s)$ Labor demand of domestic firms in sector s on the $i-j$ link

$WL(i)$ Wage for labor in region i

$KD(i,j,s)$ Capital demand of domestic firms in sector s on the $i-j$ link

$WKD(i,j,s)$ Rental price of capital paid by domestic firms in sector s on the $i-j$ link

$LKD(i,j,a)$ Demand for land-capital composite of domestic firms in agriculture sector on the $i-j$ link

$PLKD(i,j,a)$ Price of $LKD(i,j,a)$

$LND(i,j,a)$ Land demand of domestic firms in agriculture sector on the $i-j$ link

$WLAN(i)$ Price of land in region i

$QDKJ(i,j,s)$ Demand for domestic capital of domestic firms in sector s on the $i-j$ link

$QFKD(i,j,s)$ Demand for foreign capital of domestic firms in sector s on the $i-j$ link

$QFDIDJ(g,i,j,s)$ Demand for FDI owned by region g of domestic firms in sector s on the $i-j$ link

$WFKD(i,s)$ Rental price of foreign capital paid by domestic firms in region i sector s

C.5.1.2.2. Foreign firms

$\varphi F^*(g,i,j,ss)$ Productivity threshold for foreign firms from home region g to operate on the $i-j$ link sector ss

$\widetilde{\varphi F}(g,i,j,ss)$ Average productivity of foreign firms in sector ss on the $g-i-j$ link

$XF(g,i,j,s)$ Output of foreign firms in sector s on the $g-i-j$ link

$VAF(g,i,j,s)$ Value added of foreign firms in sector s on the $g-i-j$ link

$INTF(g,i,j,s)$ Intermediate composite of foreign firms in sector s on the $g-i-j$ link

$PVAF(g,i,s)$ Price of $VAF(g,i,j,s)$

$PINTF(g,i,s)$ Price of $INTF(g,i,j,s)$

$CF(g,i,s)$ Marginal cost of $XF(g,i,j,s)$

$INTCF(c,g,i,j,s)$ Inputs of intermediate commodity c in the production of commodity s of foreign firms on the $g-i-j$ link

$LF(g,i,j,s)$ Labor demand of foreign firms in sector s on the $g-i-j$ link

$LKF(g,i,j,a)$ Demand for land-capital composite of foreign firms in agriculture sector on the $g-i-j$ link

$PLKF(g,i,a)$ Price of $LKF(g,i,j,a)$

$LNF(g,i,j,a)$ Land demand of foreign firms in agriculture sectors on the $g-i-j$ link

$QFDIFJ(g,i,j,s)$ FDI demand of foreign firms in sector s on the $g-i-j$ link

C.5.1.3. Demand and Government Variables

$Q(j,s)$ Aggregated demand for good s in region j

$PQ(j,s)$ Aggregated price of commodity s in region j

$Z(i,j,s)$ Aggregated demand of region j for good s sourced from region i

$PZ(i,j,s)$ Aggregated price for $Z(i,j,s)$

$QFS(i,j,s)$ Demand of region j for commodity s produced by foreign firms located in region i

$PFS(i,j,s)$ Price of $QFS(i,j,s)$

$YH(j)$ Household income in region j

$QH(j,s)$ Demand of household for commodity s in region j

$PSAV(j)$ Price for household saving in region j

$HSAV(j)$ Saving of household in region j

$YG(j)$ Government income in region j

$EG(j)$ Government expenditure in region j

$GSAV(i)$ Government saving in region j

$EINV(j)$ Investment in region j

C.5.1.4. Closure Variables

$FSAVD(i,j)$ Foreign saving from trade products produced by domestic firms in regions i and j

$FSAVF(i,j)$ Foreign saving from trade products produced by foreign firms of in regions i and j

$FSAVK(i,j)$ Foreign saving from investment between regions i and j

$VBIS(j)$ Virtual variable in the investment-saving equation for region j

C.5.2. Parameters

C.5.2.1. Capital Allocation Parameters

σ1 Transformation elasticity of assets among sectors

$\alpha a(g,s)$ Share of assets being allocated to sector s in total assets of region g

$\alpha D(g,s)$ Share of assets being invested in domestic market in total assets of region g allocated to sector s

$\alpha F(g,s)$ Share of assets being invested abroad in total assets of region g allocated to sector s

σ2 Transformation elasticity of assets between domestic and foreign investment

$\alpha fdi(g,j,s)$ Share of assets being invested in region j in total assets of region g sector s invested abroad

σ3 Transformation elasticity of assets being invested in different host regions

$\alpha N(g,j,s)$ Share of FDI used by domestic firms in FDI from home region g to host region j sector s

$\alpha FA(g,j,s)$ Share of FDI used by foreign firms in FDI from home region g to host region j sector s

C.5.2.2. Production Parameters

γ(ss) Shape parameter of productivity in a Pareto distribution for sector ss with heterogeneous firms

σ′(s) Elasticity of substitution among factors in sector s

$t(i,j,s)$ Tariff equivalents of trade barriers in sector s on the $i-j$ link. It equals to the sum of tariff and tax equivalents of NTBs in sectors a, $m1$, $m2$, $s1$, and equals to the cost-raising distortions of services barriers in sector $s2$

$tm(i,j,s)$ Tariff rates imposed by region j on commodity s from region i

$v(i,j,ss)$ Rent-creating distortions of services barriers in sector $s2$ being imposed by region j on imports from region i

$\tau(i,j,s)$Iceberg trade costs indicating that only a fraction of $1/\tau(i,j,s)$ can arrive when shipping one unit of good s from region i to j ($\tau(i,j,s) = 1\ for\ i = j$).

$\omega D(i,j,s)$ Scale factor for output of domestic firms in sector s on the $i-j$ link

$\delta 1(i,j,s)$ Share of value added in the output of domestic firms in sector s on the $i-j$ link

$\delta 2(i,j,s)$ Share of intermediates in the output of domestic firms in sector s on the $i-j$ link

$\alpha cs(c,i,j,s)$ Leontief share of commodity c in composite intermediate inputs for the production of s of domestic firms on the $i-j$ link

$\omega VAD(i,j,s)$ Scale factor for value added of domestic firms in sector s on the $i-j$ link

$\delta va1(i,j,ss)$ Share of labor in value added of domestic firms in sector ss on the $i-j$ link

$\delta va2(i,j,ss)$ Share of capital in value added of domestic firms in sector ss on the $i-j$ link

$\delta va1(i,j,a)$ Share of labor in value added of domestic firms in agriculture sector on the $i-j$ link

$\delta va2(i,j,a)$ Share of land-capital composite in value added of domestic firms in agriculture sector on the $i-j$ link

$\omega LKD(i,j,a)$ Scale factor for land-capital composite output of domestic firms in agriculture sector on the $i-j$ link

$\delta lk1(i,j,a)$ Share of land in land-capital composite of domestic firms in agriculture sector on the $i-j$ link

$\delta lk2(i,j,a)$ Share of capital in land-capital composite of domestic firms in agriculture sector on the $i-j$ link

$\omega KD(i,j,s)$ Scale factor for capital aggregation of domestic firms in sector s on the $i-j$ link

$\delta k1(i,j,s)$ Share of domestic capital in total capital inputs of domestic firms in sector s on the $i-j$ link

$\delta k2(i,j,s)$ Share of foreign capital in total capital inputs of domestic firms in sector s on the $i-j$ link

$\delta fk(g,i,j,s)$ Share of FDI owned by region g in the aggregate foreign capital inputs of domestic firms in sector s on the $i-j$ link

$\omega F(g,i,j,s)$ Scale factor for the outputs of foreign firms in sector s on the $g-i-j$ link

$\delta F1(g,i,j,s)$ Share of value added in the outputs of foreign firms in sector s on the $g-i-j$ link

$\delta F2(g,i,j,s)$ Share of intermediates in the outputs of foreign firms in sector s on the $g-i-j$ link

$\alpha csf(c,g,i,j,s)$ Leontief share of commodity c in composite intermediate inputs for the production of s of foreign firms on the $g-i-j$ link

$\omega VAF(g,i,j,s)$ Scale factor for value added of foreign firms in sector s on the $g-i-j$ link

$\delta vaF1(g,i,j,ss)$ Share of labor in value added of foreign firms in sector ss on the $g-i-j$ link

$\delta vaF2(g,i,j,ss)$ Share of capital in value added of foreign firms in sector ss on the $g-i-j$ link

$\delta vaF1(g,i,j,a)$ Share of labor in value added of foreign firms in agriculture sector on the $g-i-j$ link

$\delta vaF2(g,i,j,a)$ Share of land-capital composite in value added of foreign firms in agriculture sector on the $g-i-j$ link

$\omega LKF(g,i,j,a)$ Scale factor for land-capital composite of foreign firms in agriculture sector on the $g-i-j$ link

$\delta lkF1(g,i,j,a)$ Share of land in land-capital composite of foreign firms in agriculture sector on the $g-i-j$ link

$\delta lkF2(g,i,j,a)$ Share of capital in land-capital composite of foreign firms in agriculture sector on the $g-i-j$ link

C.5.2.3. Demand and Government Parameters

$\sigma(s)$ Substitution elasticity among goods in sector s

$\theta(i,j,s)$ Share of $Z(i,j,s)$ in aggregated demand $Q(j,s)$

$\theta D(i,j,s)$ Share of domestic firms' products in $Z(i,j,s)$

$\theta FS(i,j,s)$ Share of foreign firms' products in $Z(i,j,s)$

$\theta F(g,i,j,s)$ Share of products produced by foreign firms owned by region g in the composite demand for foreign firms' products

b(j,s) Compulsory demand for commodity s in region j

$\beta(j,s)$ Marginal consumption of commodity s in region j

b(j,sav) Compulsory saving in region j

$\beta(j,sav)$ Marginal consumption of saving in region j

SDL_{ij}^{ss} Share of labor in total inputs of labor, domestic capital and intermediate goods of domestic firms in sector ss on the $i-j$ link

$$SDL_{ij}^{ss} = \frac{SAMDL_{ij}^{ss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}};$$

$SAMDL_{ij}^{ss}$ Labor inputs of domestic firms in sector ss on the $i-j$ link from the SAM table

$SAMDK_{ij}^{ss}$ Capital inputs of domestic firms in sector ss on the $i-j$ link from the SAM table

$SAMDI_{ij}^{css}$ Intermediate inputs of commodity c of domestic firms in sector ss on the $i-j$ link from the SAM table

SDK_{ij}^{ss} Share of domestic capital in total inputs of labor, domestic capital and intermediate goods of domestic firms in sector ss on the $i-j$ link

$$SDK_{ij}^{ss} = \frac{SAMDK_{ij}^{ss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}};$$

SDI_{ij}^{sss} Share of intermediate good s in total inputs of labor, domestic capital and intermediate goods of domestic firms in sector ss on the $i-j$ link

$$SDI_{ij}^{sss} = \frac{SAMDI_{ij}^{sss}}{SAMDL_{ij}^{ss}+SAMDK_{ij}^{ss}+\sum_c SAMDI_{ij}^{css}};$$

SFL_{gij}^{ss} Share of labor in total inputs of foreign firms in sector ss on the $g-i-j$ link,

$$SFL_{gij}^{ss} = \frac{SAMFL_{gij}^{ss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}};$$

$SAMFL_{gij}^{ss}$ Labor inputs of foreign firms in sector ss on the $g-i-j$ link from the SAM table

$SAMFK_{gij}^{ss}$ Capital inputs of foreign firms in sector ss on the $g-i-j$ link from the SAM table

$SAMFI_{gij}^{css}$ Intermediate inputs of commodity c of foreign firms in sector ss on the $g-i-j$ link from the SAM table

SFK_{gij}^{ss} Share of FDI in total inputs of foreign firms in sector ss on the $g-i-j$ link

$$SFK_{gij}^{ss} = \frac{SAMFK_{gij}^{ss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}};$$

SFI_{gij}^{sss} share of intermediate good s in total inputs of foreign firms in sector ss on the $g-i-j$ link

$$SFI_{gij}^{sss} = \frac{SAMFI_{gij}^{sss}}{SAMFL_{gij}^{ss}+SAMFK_{gij}^{ss}+\sum_c SAMFI_{gij}^{css}};$$

C.5.3. Exogenous Variables

$W(g)$ Total assets in region g

$N(i,s)$ Total mass of potential firms in region i sector s

$FD(i,j,s)$ Fixed trading costs faced by domestic firms in sector s on the $i-j$ link

$FF(g,i,j,s)$ Fixed trading costs faced by foreign firms in sector s on the $g-i-j$ link

$L(i)$ Labor endowments in region i

$LN(i)$ Land endowments in region i

$QG(i,s)$ Government demand for commodity s in region i

$QINV(i,s)$ Investment demand for commodity s in region i

$TS1(j)$ Demand for transportation services produced in region j from the international transportation pool