

Kancs, D'Artis

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### Variety Gains of Trade Integration in a Heterogeneous Firm Model

*d'Artis Kancs*



**Katholieke Universiteit Leuven**

LICOS Centre for Institutions and Economic Performance  
Huis De Dorlodot  
Deberiotstraat 34 – mailbox 3511  
B-3000 Leuven  
BELGIUM

TEL: +32-(0)16 32 65 98

FAX: +32-(0)16 32 65 99

<http://www.econ.kuleuven.be/licos>

# Variety Gains of Trade Integration in a Heterogenous Firm Model\*

d'Artis Kanacs<sup>†</sup>

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## Abstract

The present paper studies the variety gains of regional integration in Asia. Applying a heterogenous firm model we are able to assess the gains arising from the increased product and consumer choice, which is not possible in trade models with representative firms. We analyse the impacts of the ongoing trade liberalisation in South East Asia in three scenarios: CIFTA, ASEAN+3, and ASEAN+6. We find that the gains from trade integration are substantial, particularly in the multilateral liberalisation scenario ASEAN+6. A multilateral reduction of fixed and variable trade barriers by 15 percent results in a trade growth of 34 percent, which due to the additional extensive margin of trade, is larger than in trade models with representative firms. Similarly, due to the additional gains from variety growth, the welfare gains of trade integration in Asia are up to 9 percent higher than trade models with representative firms would predict.

**Keywords:** Variety gains, trade integration, Asia, heterogenous firms.

**JEL classification:** C68, F12, F14, F17, R12, R23.

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<sup>†</sup>European Commission (DG Joint Research Centre), Catholic University of Leuven (LICOS), and Economics and Econometrics Research Institute (EERI). Correspondence Address: European Commission, DG JRC, B-1049 Brussels, Belgium. E-mail: d'artis.kanacs@ec.europa.eu.

# 1 Introduction

The 15th ASEAN Summit and the 12th ASEAN+3 Summit, which took place in Thailand in October 2009, ended with a memorandum for a closer economic integration with the aim of establishing a Free Trade Area in South East Asia, and a far-reaching goal of establishing an ASEAN Economic Community by 2015.<sup>1</sup> Already now, with over 100 free trade agreements (FTA) initiatives in South East Asia, which is equivalent to about half of Asia's total FTA initiatives, the South East Asia makes up two thirds of all FTAs under negotiation in Asia, among which the ASEAN is emerging as an integration hub for the FTA activity in South East Asia (*ARIC* 2010). A prominent example of the ongoing trade liberalisation efforts in South East Asia is the ASEAN-Australia-New Zealand Free Trade Area (AANZFTA), which entered into force on 1 January 2010. Following China, Japan, and Korea, who already made formal economic ties with ASEAN (ASEAN+3), more recently also India is joining in this bandwagon of FTA move in South East Asia (ASEAN+6 and China-India Free Trade Agreement (CIFTA)).

Due to dynamic economic growth and low initial level of integration (which however is rapidly increasing), the trade integration in South East Asia has the potential to significantly raise the incomes and welfare of trading partners, and through input-output linkages, in the whole Asia. The benefits of trade integration are multiple, as are their sources. For example, in the classical trade literature, such as *Heckscher-Ohlin* and *Ricardo*, the gains of trade arise from specialisation in production, the division of labour, and the relative availability of factor resources; a resulting increase in total output possibilities; and trade through markets from sale of one type of output for other, relatively more highly valued (*Samuelson* 1962).

In the recent models with heterogeneous firms, trade liberalisation has additional positive effects on productivity, income and welfare (*Melitz* 2003; *Bernard et al* 2003; *Hillberry and McDaniel* 2002; *Kehoe and Ruhl* 2003; *Hummels and Klenow* 2005; *Broda and Weinstein* 2006, *Helpman et al* 2008). First, in trade models with heterogeneous firms, trade policy affects industry productivity by shifting market share away from low-productivity non-exporters toward high productivity exporters. This increases the aggregate industry productivity. For example, *Amiti and Konings* (2007) estimate the effects of trade liberalisation on plant productivity. In contrast to previous studies, they distinguish between productivity gains arising from lower

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<sup>1</sup>Throughout the study when referring to South East Asia (Asia-7) we mean the ten members of the Association of South East Asian Nations (ASEAN): Brunei, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam plus Australia, China, India, Japan, Korea and New Zealand.

tariffs on final goods relative to those on intermediate inputs. *Amiti* and *Konings* find that a 10 percentage point fall in output tariffs increases productivity by about 1%, whereas an equivalent fall in input tariffs leads to a 3% productivity gain for all firms and an 11% productivity gain for importing firms. *Konings* and *Vandenbussche* (2008) use EU firm-level panel data to estimate the effect of anti-dumping protection on the productivity of EU domestic firms in import-competing industries. They find that firms with relatively low initial productivity - laggard firms - have productivity gains during anti-dumping protection, while firms with high initial productivity - frontier firms - experience productivity losses. While the productivity of the average firm is moderately improved during anti-dumping protection, productivity remains below that of firms never involved in anti-dumping cases, thus questioning the desirability of protection. Second, trade models with heterogeneous firms allow for trade growth also along the extensive margin, and provide a mechanism by which such trade growth can be linked to policy changes. When due to trade liberalisation trade costs fall, the number of traded varieties increases, and vice versa. The threshold for import penetration falls and more foreign firms find it profitable to enter the foreign market. Theoretically, the effect of changes in trade costs on the number of domestic varieties is ambiguous, because there are two mechanisms by which the distribution of operational firms in a given country changes with trade integration. On the one hand, the number of exporting firms increases and the profits of all exporting firms increase, which induces entry of new firms. The increased activity of these firms, however, bids up the input price. Thus, the latter effect acts to induce exit of firms with low productivity, which reduces the domestic variety. Empirically, however, consumers usually benefit despite the lost domestic varieties. The third source of the 'new' gains of trade is due to economies of scale. More productive firms optimally price lower, so eliminating low productivity firms depresses the average price. As a result, factor returns increase and the remaining domestic varieties are less expensive. In the present study we focus on the second channel through which trade liberalisation gives rise to welfare gains - increasing consumer choices.

The present paper studies how trade liberalisation in South East Asia may affect consumer welfare through a larger choice of available goods and varieties. For this purpose, we adopt a trade model with heterogeneous firms, which allows us to assess not only the size of the integration-induced trade growth, but also to decompose the aggregate trade growth and welfare gains into quantity (intensive) margin and variety/quality (extensive) margin (section 2). In section 3 we use structurally estimated parameters and GTAP endowment data to empirically implement the theoretical trade model, and simulate the regional integration in Asia. We study the im-

pact of trade liberalisation on variety growth in three integration scenarios: CIFTA, ASEAN+3 and ASEAN+6, within each of which three types of trade cost (variable, fixed, and both variable and fixed) reductions are examined. Based on the obtained simulation results, we quantify the welfare gains arising from variety growth (section 4). The obtained results allow us to draw policy conclusions and sketch avenues for future research.

## 2 Theoretical framework

### 2.1 The setup

In order to study the variety gains of trade integration, in addition to the aggregate trade growth, the quantity (intensive) and variety (extensive) margins of trade need to be identified. There are several approaches for decomposing the aggregate trade flows. The most straightforward is to use firm-level data for prices, quantities and the number of shipments (*Broda and Weinstein 2006*). Unfortunately, such micro-data are not available for the South East Asian economies. In absence of firm-level trade data, a different approach is required, which would allow us to infer differential changes in the extensive and intensive margins of trade growth from the aggregate trade data.<sup>2</sup> If all firms from each country would export each good to every country and the set of exporting firms and exported goods would not change as a result of trade integration, we could use the canonical *Krugman's* (1980) monopolistic competition model of trade. However, according to the *COMTRADE* (2010) trade data, both types of trade flows can be observed in Asia: positive trade flows for some products and some country pairs and zero trade flows for other products and other country pairs. Thus, the *Krugman's* monopolistic competition model is not suitable for analysing the structure of trade growth in Asia, where both types of trade flows are present.

Recognising the limitations arising from neglecting the heterogeneity of firms and the presence of fixed costs of exporting, the canonical *Krugman's* (1980) model was extended by *Melitz* (2003), who endogenises the set of the exporting firms, the exported products and the destination countries. *Melitz* assumes that firms are heterogeneous according to their productivity and that only the most productive firms export their goods to foreign markets, whereas the set of exporters depends on the export market and trade cost characteristics.

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<sup>2</sup> Given that we are interested in decomposing export volume into only two components (extensive and intensive margins), we need to identify only one of them. The other trade margin can then be calculated as a residual from aggregate trade flows, which are available in foreign trade data for Asia.

Although, based on the same monopolistic competition framework, the *Melitz's* (2003) model differs from the canonical *Krugman's* (1980) model along several dimensions. In the context of the present study, the two most important are data requirements and the underlying assumptions. Obviously, the *Melitz's* model is more data demanding, as it explicitly accounts for firm heterogeneity and fixed trade costs. This implies that additional data about the distribution of firm productivity and the export market entry costs is required.

On the other hand, the necessary assumptions are less limiting (more general) in the *Melitz's* model. First, the *Melitz's* model relaxes the assumption of firm homogeneity, which has been often rejected in empirical trade literature. Firm-level heterogeneity finds strong support in empirical studies relying on firm-level data (*Bernard and Jensen* 1999). They find that those producers that export their goods abroad differ from non-exporters along several dimensions: exporters tend to have higher productivity, higher levels of output, and use more capital and labour inputs. Second, the assumption of zero market entry costs, which is relaxed in the *Melitz's* model, has been often rejected in empirical studies. E.g. *Evenett and Venables* (2002) find strong evidence of fixed market entry costs associated with exporting abroad.

Taking into account these considerations, we base our study on *Kancs* (2007) and *Chaney* (2008), who propose empirically solvable versions of the canonical *Melitz's* trade model with heterogeneous firms. As in *Melitz* (2003), the selection among exporters and non-exporters is based on the assumptions that firms are heterogeneous and the foreign market entry is associated with fixed costs, implying that less productive firms may not be able to generate enough revenue abroad to cover the entry cost. Thus, in the underlying trade model, exporters are only a subset of domestic firms and this subset varies with characteristics of foreign markets. Following *Melitz*, we also assume two types of trade costs: variable trade cost and fixed trade cost. However, in contrast to the *Melitz's* model, which assumes that a firm has first to pay a fixed cost to survive at home and then it has to pay a fixed cost for entering the export markets, we assume that all firms have to pay only one type of fixed cost for entering any market. This adjustment, which considerably reduces the trade cost data requirements, is required to make the empirical implementation of the model feasible in the Asian emerging economies, where the paucity of data is particularly important.

## 2.2 The model

Following *Kanacs* (2007) and *Chaney* (2008), workers are the only consumers and have identical CES preferences over traditional and horizontally differentiated (manufacturing) goods. A consumer that consumes  $C_A$  units of the homogenous good,  $x_i$  units of each variety  $i$  of the manufacturing good, and  $N$  varieties of the differentiated manufacturing good achieves total utility  $U$ :

$$U = C_A^{\alpha_A} \left( \int_0^N (x_i)^{\frac{\sigma-1}{\sigma}} dx \right)^{\frac{\sigma}{\sigma-1} \alpha_x} \quad (1)$$

where  $\sigma$  is the elasticity of substitution between the manufacturing varieties and  $\alpha$  is a consumer demand parameter determining the expenditure shares, with  $\sigma > 1$  and  $\alpha_A + \alpha_x = 1$ .

In order to capture the potential gains of variety, we impose the *Dixit-Stiglitz* structure on consumer 'love of variety'.<sup>3</sup> Manufacturing goods,  $x$ , can be traded between all countries (at a positive trade cost). Consumer prices in destination country  $d$  depend on market and trade cost characteristics: they are decreasing in market size and increasing in trade costs. In line with empirical evidence, there are two types of trade costs for selling manufacturing goods from origin country  $o$  in destination market  $d$ : variable trade cost,  $\tau_{od}$  and fixed trade cost,  $FC_{od}$ .<sup>4</sup> As usual, the variable trade cost takes the 'iceberg' form: if one unit of the differentiated manufacturing good is shipped from origin country  $o$ , only fraction  $1/\tau_{od}$  arrives at destination  $d$ .<sup>5</sup>

Both types of goods are produced in all  $R$  countries indexed  $r \in \{1, \dots, o, \dots, d, \dots, R\}$  using only labour,  $L$ . Country  $r$  has a total labour force  $L_r$ , which is proportional to the mass of firms,  $N$ .<sup>6</sup> All countries have access to the same technology. There are two

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<sup>3</sup>Generally, there are many theoretical approaches of modelling the variety (e.g., *Hotelling* 1929, *Lancaster* 1975, *Spence* 1976, *Dixit* and *Stiglitz* 1977). The assumptions underlying these models are conceptually different. In line with the mainstream in international trade, economic geography, and macroeconomics, we rely on the *Dixit-Stiglitz* framework, because only it offers the necessary prominence, tractability, and empirical implementability. Moreover, it can easily explain the key stylised facts of how the emergence of new markets and the reduction of international barriers have contributed to an increase in the number of traded goods in Asia.

<sup>4</sup>The fixed export entry costs capture foreign marketing and distribution costs, bureaucratic procedures on the border, and required changes in product characteristics to match up to the tastes of foreign consumers and government regulations. They do not depend on the quantity of goods sold abroad: a firm from country  $o$  wanting to export to country  $d$ , must pay an upfront entry cost  $FC_{od}$ .

<sup>5</sup>Following *Samuelson* (1954), implicitly we assume that the rest melts on the way.

<sup>6</sup>Implicitly, we assume that there is a group of firms proportional to the size of the country. We could remove this assumption, and allow for a free entry of firms, with an infinite set of potential firms. However, according to *Chaney* (2008), if trade barriers are not negligible, the results would be similar.



types of sectors: a traditional sector,  $A$ , and manufacturing industry,  $X$ . The 'traditional' sector produces a homogenous 'traditional' good under perfect competition, constant returns to scale with unit labour requirement. As usual, the 'traditional' sector is immobile, it serves as a numeraire in the model. Hence, its price is normalised to 1. Given that every country produces the homogenous good, which is set as a numeraire, wages are equalised to unity in every country. The manufacturing industry supplies a continuum of differentiated goods and, as usual in monopolistic competition models, each firm is a monopolist for the variety it produces.

Assuming that each manufacturing firm draws a random unit labour productivity  $\varphi$ , a firm from country  $o$  with productivity  $\varphi$  has unit cost,  $c$ , of producing manufacturing good  $x$  and selling it in country  $d$ :

$$c(x) = \frac{x}{\varphi} + FC_{od} \quad (2)$$

As usual in the monopolistic competition framework, firms are price setters for their own variety. Given that the demand functions are iso-elastic, the optimal price charged in country  $d$  by firm  $i$  from country  $o$  is a constant mark-up over the unit cost (including trade cost,  $\tau_{od}$ ):

$$p_{od}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{\tau_{od}}{\varphi} \quad (3)$$

where  $p_{od}$  is the price of a manufacturing variety produced in region  $o$  and sold in region  $d$ . The restriction  $\sigma > 1$  ensures that the output price,  $p_o$ , is always positive.

Following *Helpman et al* (2004), we assume that firms draw their productivity from a Pareto distribution with scaling parameter  $\gamma$  and that firm productivity is distributed according to  $P(\tilde{\varphi} < \varphi) = F(\varphi) = 1 - \varphi^{-\gamma}$ , with  $dF(\varphi) = \gamma^{-1} \varphi^{-\gamma-1} d\varphi$  for  $\varphi \geq 1$ . The assumption that firms draw their productivity from a Pareto distribution finds strong support in firm-level research and hence has more than analytical simplicity in its favour. Indeed, there is empirical evidence that important firm-level distributions, such as firm size, follow a Pareto distribution. In addition, *Gabaix* (1999) has shown that Pareto distributions can be generated from an aggregation of random micro-level exponential growth shocks to each of the individual units, while *Kortum* (1997) has shown that the upper tail of productivity distributions needs to be Pareto if steady-state growth paths are to be sustained. Parameter  $\gamma$  is an inverse measure of firm heterogeneity in the manufacturing sector, with  $\gamma > 2$  and  $\gamma > \sigma - 1$ .<sup>7</sup> Sectors with

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<sup>7</sup> $\ln \varphi$  has a standard deviation equal to  $\frac{1}{\gamma}$ . The assumption  $\gamma > \sigma - 1$  ensures that, in equilibrium, the size distribution of firms has a finite mean. If this assumption were violated, firms with an arbitrarily high productivity would represent an arbitrarily large fraction of all firms, and they would

lower  $\gamma$  are more heterogeneous, in sense that more output is concentrated among the largest and the most productive firms.

Profit maximising firms are willing to export to country  $d$  as long as the net profits generated from exports to country  $d$  are sufficient to cover the fixed market entry cost,  $FC_{od}$ . The profits earned by firm  $n$  in  $o$  from exporting to  $d$  are given by:

$$\pi_{od}(\varphi) = \frac{r_{od}(\varphi)}{\sigma} - FC_{od} \quad (4)$$

where  $r_{od}(\varphi)$  is firm revenue from selling in country  $d$ , and the productivity threshold,  $\bar{\varphi}_{od}$ , corresponds to productivity of the least productive firm in country  $o$ , for which the gross profits earned in country  $d$  are just enough to cover the fixed cost,  $FC_{od}$ , of entering market  $d$ :

$$\pi_{od}(\bar{\varphi}_{od}) = FC_{od} \quad (5)$$

$$\bar{\varphi}_{od} = \lambda_1 FC_{od}^{\frac{1}{\sigma-1}} (P_d^{\sigma-1} Y_d)^{\frac{-1}{\sigma-1}} \tau_{rd} \quad (6)$$

where  $Y_d$  is real income,  $P_d$  is price index in country  $d$  and  $\lambda_1$  is a constant.<sup>8</sup> We assume that trade barriers are always high enough to ensure that  $\forall i, r, \bar{\varphi}_{od} > 1$ .<sup>9</sup>

If only those firms above the productivity threshold  $\bar{\varphi}_{rd}$  from country  $o$  export to country  $d$ , then the ideal *Dixit-Stiglitz* price index,  $P_d$ , in destination country  $d$  is following:

$$P_d = \left( \sum_{r=1}^R N_r \int_{\bar{\varphi}_{rd}}^{\infty} \left( \frac{\sigma-1}{\sigma} \frac{\varphi}{\tau_{rd}} \right)^{\sigma-1} dF(\varphi) \right)^{\frac{-1}{\sigma-1}} \quad (7)$$

Substituting the productivity threshold from equation (6) into price index (7), we can solve for the general equilibrium price index,  $P_d$ :

$$P_d = \lambda_2 \left( \frac{L_d}{L} \right)^{\frac{1}{\gamma}} Y_d^{\frac{-1}{\sigma-1}} \theta_d \quad (8)$$

where  $\lambda_2$  is a constant and  $\theta_d^{-\gamma} \equiv \sum_{r=1}^R \frac{L_r}{L} \tau_{rd}^{-\gamma} FC_{rd}^{1-\frac{\gamma}{\sigma-1}}$ , with  $L \equiv \sum_{r=1}^R L_r$ .<sup>10</sup>

overshadow less productive firms. Results on selection into export markets would be degenerate. This assumption is satisfied in the data for all countries in our sample.

<sup>8</sup>  $\lambda_1 = \left( \frac{\sigma}{\alpha} \right)^{\frac{1}{\sigma-1}} \left( \frac{\sigma}{\sigma-1} \right)$ .

<sup>9</sup> This assumption finds strong support in empirical firm-level research, e.g. from the U.S. Census Bureau's Annual Survey of Manufacturers.

<sup>10</sup>  $\lambda_2 = \left( \frac{\gamma-(\sigma-1)}{\gamma} \right)^{\frac{1}{\gamma}} \left( \frac{\sigma}{\alpha} \right)^{\frac{1}{\sigma-1} - \frac{1}{\gamma}} \left( \frac{\sigma}{\sigma-1} \right)$ .

Variable  $\theta_d$  is an aggregate index of  $d$ 's remoteness from the rest of the world.<sup>11</sup> It is similar to the 'multilateral resistance variable' introduced by *Anderson* and *von Wincoop* (2003). In addition to their measure, it takes into account the impact of fixed costs and firm heterogeneity on prices.

Using the general equilibrium price index (8), we can solve for firm level and aggregate exports. As usual in the monopolistic competition framework, we assume that each firm in every country chooses a strategy, taking the strategies of all other firms and all consumers as given. The strategy for a firm is both a subset of countries, where to sell its output and prices to set for its goods in each market. The strategy for the consumer is the quantity to consume of each variety of every good available domestically, given its price. Given optimal strategies of firms and consumers in every country, we can compute a global trade equilibrium, which is characterised by a set of prices and quantities that correspond to a fixed point of the best response graph of each agent.

By substituting the general equilibrium price index from equation (8) into equation (6), we obtain productivity threshold,  $\bar{\varphi}_{od}$ , above which firms from  $o$  are productive enough to export to  $d$ :

$$\bar{\varphi}_{od} = \lambda_3 \left( \frac{L_d}{L} \right)^{-\frac{1}{\gamma}} \frac{\tau_{od}}{\theta_d} FC_{od}^{\frac{1}{\sigma-1}} \quad (9)$$

where  $\lambda_3$  is a constant.<sup>12</sup> According to equation (9), the selection among exporting firms and non-exporting firms takes place because of differences in firm productivities,  $\varphi$ , and the destination market specific fixed costs,  $FC$ , implying that less productive firms may not be able to generate enough revenue abroad to cover the fixed costs of entering foreign market(s).

Using the productivity threshold (9), we can derive the number of  $o$ 's firms exporting to  $d$ , which is positively related to the extensive margin of trade:

$$N_{od} = L_o P_d(\varphi > \bar{\varphi}_{od}) = \alpha \frac{\gamma - (\sigma - 1)}{\gamma \sigma} \frac{L_o L_d}{L} \left( \frac{\tau_{od}}{\theta_d} \right)^{-\gamma} FC_{od}^{-\frac{\gamma}{\sigma-1}} \quad (10)$$

According to the definition of  $E_{od}$ , the second channel of adjustment in aggregate exports comes from individual firm exports, the intensive margin of trade. Given the optimal pricing strategy of firms and the optimal demand strategy of consumers,

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<sup>11</sup> A simple way to interpret this aggregate index is to look at a symmetrical case: when  $\tau_{rd} = \tau_d$  and  $FC_{od} = FC_d$  for all  $d$ 's,  $\theta_d \equiv \tau_d FC_d^{\frac{1}{\sigma-1} - \frac{1}{\gamma}}$ . In asymmetric cases,  $\theta_d$  is a weighted average of bilateral trade costs.

<sup>12</sup>  $\lambda_3 = \left( \frac{\sigma}{\alpha} \frac{\gamma}{\gamma - (\sigma - 1)} \right)^{\frac{1}{\gamma}}$ .

we can derive exports from origin country  $o$  to destination country  $d$  for firm with productivity  $\varphi$ :

$$e_{od}(\varphi) = p_{od}(\varphi) x_{od}(\varphi) = \alpha Y_d \left( \frac{p_{od}(\varphi)}{P_d} \right)^{1-\sigma} \quad (11)$$

Substituting the firm-level price (3) and the general equilibrium price index (8) into the demand function (11), we can rewrite firm exports in terms of market export characteristics and firm productivity,  $\varphi$ :

$$e_{od}(\varphi \mid \varphi > \bar{\varphi}_{od}) = \lambda_4 \left( \frac{L_d}{L} \right)^{\frac{\sigma-1}{\gamma}} \left( \frac{\tau_{od}}{\theta_d} \right)^{1-\sigma} \varphi^{\sigma-1} \quad (12)$$

where  $\lambda_4$  is a constant.<sup>13</sup> According to equation (12), firm exports are determined by  $d$ 's relative size,  $L_d$ , bilateral trade barriers,  $FC_{od}$  and  $\tau_{od}$ , and  $d$ 's remoteness from the rest of the world,  $\theta_d$ . Individual firm exports depend on transportation cost,  $\tau_{od}$ , with elasticity  $1 - \sigma$  and on the size of the destination market,  $L_d$ , with elasticity  $\frac{\sigma-1}{\gamma}$ , which is less than one, because of the impact of market size and price competition.

Integrating over all productivities above the exporting productivity threshold, we obtain the average exports per exporting firm,  $\tilde{e}_{od}$ , which in our model is the intensive margin of trade:

$$\tilde{e}_{od}(e_{od}(\varphi) \mid \varphi > \bar{\varphi}_{od}) = \frac{\int_{\bar{\varphi}_{od}}^{\infty} e_{od}(\varphi) dF(\varphi)}{\int_{\bar{\varphi}_{od}}^{\infty} dF(\varphi)} = \frac{\gamma\sigma}{\gamma - (\sigma - 1)} FC_{od} \quad (13)$$

According to equation (13), fixed trade costs,  $FC_{od}$ , have a large impact on the average size of exporters. Although, an increase in fixed cost has no impact on the exports of an individual firm, it forces less productive firms to exit the export market, as only the most productive and largest firms survive. As a result, the average size of exporting firms increases. On the other hand, neither the variable trade cost nor export market characteristics affect the average size of exporters. The reason is that the entry of smaller and less productive firms in response to lower trade costs or larger foreign demand pulls down the average size of exports, which exactly offsets the increase in the size of each existing exporter.

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<sup>13</sup>  $\lambda_4 = \alpha \left( \frac{\gamma - (\sigma - 1)}{\gamma} \right)^{\frac{\sigma-1}{\gamma}} \left( \frac{\sigma}{\alpha} \right)^{1 - \frac{\sigma-1}{\gamma}}$ .

The aggregate exports (*f.o.b.*) from origin country  $o$  to destination country  $d$  is product of the number of exporting firms and the average export size per firm with average productivity above  $\bar{\varphi}_{od}$ :

$$E_{od} = \underbrace{\tilde{e}_{od}(\tilde{\varphi}_{od})}_{\text{Intensive}} \underbrace{N_{od}(\cdot)}_{\text{Extensive}} \quad (14)$$

where  $N_{od}$  is the number of exporting firms (the extensive margin of trade) and  $\tilde{e}_{od}$  is the average value per shipment (the intensive margin of trade). Substituting equations (10) and (13) into (14), the aggregate exports,  $E_{od}$ , from  $o$  to  $d$  can be expressed as:

$$E_{od} = \underbrace{\frac{\gamma\sigma}{\gamma - (\sigma - 1)} FC_{od}}_{\text{Intensive margin}} \underbrace{\alpha^{\frac{\gamma - (\sigma - 1)}{\gamma\sigma}} \frac{L_o L_d}{L} \left(\frac{\tau_{od}}{\theta_d}\right)^{-\gamma} FC_{od}^{-\frac{\gamma}{\sigma - 1}}}_{\text{Extensive margin}} \quad (15)$$

Note that the elasticity of exports,  $E_{od}$ , with respect to variable trade barriers,  $\gamma$ , is larger than in trade models with representative firms, and larger than the elasticity for each individual firm (both equal to  $\sigma - 1$ ). An increase in variable costs not only causes a reduction in the size of exports of each exporter, but it also forces some exporters to pull out. In equation (15) the extensive margin comes on top of the intensive margin and amplifies the impact of variable costs.

### 2.3 Welfare gains of variety growth

According to the *Dixit-Stiglitz* preferences given in equation (1), consumer utility is increasing in the amount of each good (variety) consumed and the number of goods (varieties).<sup>14</sup> Assume that quantities,  $x_i$ , are optimally chosen to minimise  $\sum_{i \in I} p_i x_i$  subject to achieving  $f(x_i, d_i) = 1$ . The solution to this minimisation problem yields the corresponding minimum unit cost function:

$$c(p_i, d_i) = \left( \sum_{i \in I} d_i p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (16)$$

where  $d_i$  is the taste or quality parameter for variety  $i$ .<sup>15</sup> According to equation

<sup>14</sup>In order to emphasise the role of varieties, in this section we make several adjustments in the notation. First, given that variety growth can only be estimated if the number of varieties is finite, we return to a discrete set of varieties and firms. Second, given that all variables refer to a single country (in the case of imports - destination country  $d$ ), in this section we replace the location subscripts,  $o$  and  $d$ , by time reference,  $t$ .

<sup>15</sup>The underlying concept is similar to *Armington* (1969), with the key difference that instead of goods, in *Armington* goods/varieties are differentiated by their country of origin.

(16), the minimum unit cost is decreasing in the number of consumed varieties, and in the taste for a particular variety. The unit cost is increasing in price,  $p_i$ , and the elasticity of substitution,  $\sigma$ , between different varieties.

Differentiating (16) yields expenditure shares,  $s_i$ , which are implied by taste parameter,  $d_i$ :

$$\begin{aligned} s_i &= \partial \ln c(p_i, d_i) / \partial \ln p_i \\ &= c(p_i, d_i)^{1-\sigma} d_i p_i^{1-\sigma} \end{aligned} \quad (17)$$

Assume that there are two periods,  $t-1$  (before trade liberalisation) and  $t$  (after trade liberalisation), and that the quantity vectors  $x_{it}$  and  $x_{it-1}$  are the cost-minimising bundles of  $i$ 's varieties given the prices of all varieties,  $p_{it}$  and  $p_{it-1}$ . The cost-of-living price index,  $CPI$ , can then be defined as the ratio of minimum unit costs of the two periods:

$$CPI(p_{it}, p_{it-1}, x_{it}, x_{it-1}) = \frac{c_t(p_{it}, d_{it})}{c_{t-1}(p_{it-1}, d_{it})} \quad (18)$$

The economic approach to index numbers (*Diewert* 1976) shows that certain cost-of-living price indexes, known as *exact* indexes, are equal to the ratio of expenditures needed to obtain a fixed level of utility at two different prices. I.e., *Diewert* defines a price index formula whose weights are functions of the expenditure shares  $s_{it}$  and  $s_{it-1}$  as *exact*, if it equals the ratio of unit costs.<sup>16</sup> For a symmetric CES unit cost function with constant tastes,  $d_{it} = d_{it-1} = d_i$ , and the same set of varieties available in both periods,  $I_t = I_{t-1} = I$ , the price index of *Sato* (1976) and *Vartia* (1976) has this property. The *Sato-Vartia* price index equals the geometric mean of the price ratios with weights  $w_{it}$ :

$$\prod_{i \in I} \left( \frac{p_{it}}{p_{it-1}} \right)^{w_{it}} = \frac{c_t(p_{it}, d_{it})}{c_{t-1}(p_{it-1}, d_{it})} \quad (19)$$

where the ideal log-change weights,  $w_{it}$ , are defined as:<sup>17</sup>

$$w_{it} = \left( \frac{s_{it} - s_{it-1}}{\ln s_{it} - \ln s_{it-1}} \right) / \sum_{i \in I} \left( \frac{s_{it} - s_{it-1}}{\ln s_{it} - \ln s_{it-1}} \right) \quad (20)$$

<sup>16</sup>The cost-of-living price index is called *exact*, because the cost-of-living price index,  $CPI$ , exactly matches changes in the minimum unit-costs,  $c$ .

<sup>17</sup>According to *Sato* (1976) and *Vartia* (1976),  $w_{it}$  capture the share of differences in cost shares over time normalised by the difference in logarithmic cost shares over time in the aggregate differences in cost shares over time normalised by the difference in logarithmic cost shares over time.

with the corresponding expenditure share,  $s_{it}$ , on each variety

$$s_{it} = \frac{p_{it}x_{it}}{\sum_{i \in I} p_{it}x_{it}} \quad (21)$$

An important assumption of the *exact* price index in (19) is that all varieties are available in both periods, i.e., the set of available varieties does not change. If, however, if e.g. trade liberalisation changes the set of traded goods, then neglecting the emergence of new varieties (the disappearance of old) would overestimate (underestimate) the true cost-of-living price index.

Following *Krugman* (1980), we assume that firms and consumer preferences are symmetric, i.e.  $d_i = 1 \forall i \in I$ . This implies that all varieties in each market (country) are equally priced at  $p$ . In the case of symmetric CES preferences, the minimum unit cost function (16) simplifies to:

$$c_t(I_t) = (N_t p_{it}^{1-\sigma})^{\frac{1}{1-\sigma}} \quad (22)$$

The minimum unit cost function (22) implies that for a given price,  $p_t$ , an increase in the number of available varieties,  $N_t$ , e.g. through more sources of imports, reduces the minimum cost,  $c_t$ , which is required to achieve the same level of utility. Alternatively, a rise in variety increases utility that can be achieved at cost,  $c_t$ .

Analogously to (18), the cost-of-living price index,  $CPI$ , is equal to the ratio of minimum unit costs in two periods:

$$CPI(p_{it}, p_{it-1}, x_{it}, x_{it-1}, I) = \frac{c_t(I_t)}{c_{t-1}(I_{t-1})} \quad (23)$$

Given that firms are symmetric, all varieties have the same price, hence, there is no need for weights. As above, this *Krugman*-type price index in (23) with constant and symmetric varieties does not consider new (and disappearing) varieties and, therefore, will not capture the fall in minimum costs, or equivalently the rise in utility. Consumers would only gain from falling prices of imported varieties.<sup>18</sup>

Depending on the data availability, variety gains can be assessed in several ways by imposing different assumptions on consumer preferences.<sup>19</sup> The *Romer's* (1994) approach is the least data demanding, but it also imposes the strongest assumptions.

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<sup>18</sup>In the *Krugman's* model the key source of price reductions is increasing returns to scale. As tariffs are reduced between two countries, some firms exit the market and the remaining firms expand their output and lower their average costs through economies of scale. The reduction in average costs also leads to a reduction in prices in the zero-profit equilibrium.

<sup>19</sup>Applying the same concept, variety growth and the associated welfare gains can be measured not only for imports, but also for exports, and either comparing a country (set of countries) across time or comparing countries at a point of time.

*Feenstra's* (1994) methodology is less restrictive and therefore more often used in empirical work. *Broda and Weinstein's* (2006) approach is the most rigorous, but also the most data demanding. Recognising the firm-level trade data limitations for South East Asia, in the present study we follow the *Romer's* (1994) approach.

*Romer* (1994) extends the canonical *Krugman's* model by allowing for the set of goods and varieties to change between periods. Due to fixed costs of accessing foreign markets, the number of varieties can rise with declining tariffs. According to *Romer*, in order to account for variety growth, the conventional cost-of-living price index, *CPI*, needs to be multiplied by the ratio of available varieties in the two periods:

$$CPI(p_{it}, p_{it-1}, x_{it}, x_{it-1}, I) = \frac{p_t}{p_{t-1}} \left( \frac{N_t}{N_{t-1}} \right)^{\frac{1}{\sigma-1}} \quad (24)$$

As in *Krugman* (1980), all varieties of the same good are symmetric (the same price and quantity) also in (24), implying that the extensive import margin equals to the number of varieties and hence firms ( $I_t = N_t$ ). An increase in the number of varieties,  $N_t$ , in period  $t$  compared to the number of varieties available in period  $t-1$  reduces the *Romer*-type cost-of-living price index compared to the conventional (*Krugman*) cost-of-living price index. In other words, increasing the number of varieties (firms),  $N$ , will lower the ratio of old to new varieties,  $N_{t-1}/N_t$ , and hence the *Romer* cost-of-living price index.

The introduction of new goods in the market increases consumer's 'standard of living' and therefore reduces the cost of maintaining a consumer's well-being. Comparing the *Romer*-type cost-of-living price index (24) to the conventional (*Krugman*-type) cost-of-living price index (23), we note that in addition to the expenditure ratios in the two periods (which under symmetric varieties/firms are equal to price ratios), equation (24) contains an additional term,  $(N_t/N_{t-1})^{\frac{1}{\sigma-1}}$ , which is an inverse measure of product variety and is defined as follows:

$$\begin{aligned} N_t &= \frac{\sum_{i \in I} p_{it} x_{it}}{\sum_{i \in I_t} p_{it} x_{it}} = 1 - \frac{\sum_{i \in I_t, i \notin I} p_{it} x_{it}}{\sum_{i \in I_t} p_{it} x_{it}} \\ N_{t-1} &= \frac{\sum_{i \in I} p_{it-1} x_{it-1}}{\sum_{i \in I_{t-1}} p_{it-1} x_{it-1}} = 1 - \frac{\sum_{i \in I_{t-1}, i \notin I} p_{it-1} x_{it-1}}{\sum_{i \in I_{t-1}} p_{it-1} x_{it-1}} \end{aligned} \quad (25)$$

*Feenstra* (1994) shows that changes in the *Romer*-type cost-of-living price index (24) are equal to the welfare gains of variety growth,  $\Delta W$ :



$$\Delta W = \alpha_t Y_t \left( \frac{N_t}{N_{t-1}} \right)^{\frac{1}{\sigma-1}} \quad (26)$$

According to equation (26), welfare gains of variety growth depend on four variables: traded goods (e.g. imports, domestic sales) share in consumer expenditure,  $\alpha_t Y_t$ , the fraction of expenditure on the varieties that are available in both periods relative to the entire set of varieties available in periods  $t$  and  $t - 1$ ,  $N_t$  and  $N_{t-1}$ , and the elasticity of substitution between varieties,  $\sigma$ .

### 3 Simulating the trade integration in South East Asia

#### 3.1 Empirical specification

In order to quantify the variety gains arising of trade integration in Asia, we employ the heterogenous firm model outlined in section 2, which allows us to derive closed form solutions for the total export volume, the extensive margin of trade, and welfare gains of variety growth. Collecting terms in equation (15), the aggregate exports from  $o$  to  $d$  can be expressed as:

$$E_{od} = \alpha \frac{L_o L_d}{L} \left( \frac{\hat{\theta}_d}{\tau_{od}} \right)^{\hat{\gamma}} FC_{od}^{1 - \frac{\hat{\gamma}}{\hat{\sigma} - 1}} \quad (27)$$

According to equation (27), the aggregate exports from  $o$  to  $d$  depend on the relative size of countries,  $L_o/L$ , the destination country  $d$ 's multilateral resistance,  $\theta_d$ , and bilateral trade costs (both variable,  $\tau_{od}$ , and fixed,  $FC_{od}$ ) between the trading partners. In contrast to trade models with representative firms, the aggregate exports,  $E_{od}$ , may grow both due to changes in average value,  $e_{od}$ , per shipment (intensive margin of trade) or due to changes in the number of shipments,  $N_{od}$ , (extensive margin of trade) both of which may vary across destinations and co-vary with trade costs.

The extensive margin of trade,  $N_{od}$ , which is derived in equation (10), is equal to:

$$N_{od} = \frac{\hat{\gamma} - (\hat{\sigma} - 1)}{\hat{\gamma} \hat{\sigma}} \alpha \frac{L_o L_d}{L} \left( \frac{\hat{\theta}_d}{\tau_{od}} \right)^{\hat{\gamma}} FC_{od}^{-\frac{\hat{\gamma}}{\hat{\sigma} - 1}} \quad (28)$$

Because of selection that takes place among exporters, in equation (28) the set of firms exporting to country  $d$  only depends on  $d$ 's characteristics and trade costs. Countries that are expensive for exporting firms to enter ( $FC_{od}$  large), far away ( $\tau_{od}$  large), or which have a small market ( $L_d$  low), attract only the most productive

exporters. If country  $d$  is far away from other trading partners ( $\theta_d$  large), it is easier for exporting firms to compete, implying that more firms from country  $o$  will serve market  $d$ . The number of firms,  $N_{od}$ , reacts to changes in unit trade costs,  $\tau_{od}$ , with the elasticity  $\gamma$ , and to changes in the size of origin and destination countries,  $L_r$ , with the elasticity 1, which is close to the values recovered from the firm-level trade data (e.g. *Anderson and von Wincoop* 2003).

According to equation (26), the welfare gains of variety growth can be calculated as:

$$\Delta W = \alpha_{dt} E_{dt} \left( \frac{N_{odt}}{N_{odt-1}} \right)^{\frac{1}{\sigma-1}} \quad (29)$$

Equation (29) states that the gains of variety growth are increasing in traded goods share in income as, *ceteris paribus*, consumers care more about variety growth in sectors that occupy a large share of consumption than in small sectors. Welfare gains are also increasing in the number of new varieties. The more new varieties are available, the larger is consumer choice and the bigger are welfare gains of variety growth. gains of variety are decreasing in the elasticity of substitution between varieties. If different varieties of traded goods are perfectly substitutable, then having two varieties of that good will have no impact on welfare.

### 3.2 Data and parameters

In order to perform numerical simulations of trade integration in South East Asia, the base year data for the total labour force,  $L$ , labour force in each country,  $L_r$ , and the expenditure share,  $\alpha$ , are required for each country. Both the labour force and the expenditure share of traded goods are drawn from the GTAP v7 data base. Given that the GTAP v7 data base is constructed for 2004, we choose it as a base year for the simulation analysis.

In addition to country level macro data, the estimates for three types of parameters are required: the heterogeneity of firms, the elasticity of substitution and the barriers of trade. In order to obtain an estimate of firm heterogeneity, we follow *Helpman, Melitz and Yeaple* (2004) and *Chaney* (2008), and construct a measure of firm heterogeneity by looking directly at the distribution of firm size in each Asia-7 economy. The size distribution of national firms is shaped by the distribution of productivity shocks and the degree of competition. However, the link between the productivity distribution and the size distribution will be more or less distorted by the accessibility of foreign markets.

A firm receiving a random productivity shock,  $\tilde{\varphi}$ , has the total sales,  $S_i(\tilde{\varphi})$ , which are equal to  $S_i(\tilde{\varphi}) = \sum_{r=1}^N p_{od}(\tilde{\varphi}) x_{od}(\tilde{\varphi})$ . In large and closed economies, most firms serve only the domestic market, and the exporting firms sell only a small fraction of their output abroad (*Bernard et al* 2003).<sup>20</sup> Thus, the access to foreign markets has only a limited impact on the size distribution of firms within a country. Hence, when looking at the entire distribution of firm sizes for Asian economies, in most cases we can straightforwardly assume that the size of a firm is almost entirely determined by the size of the domestic market:<sup>21</sup>  $S_i(\tilde{\varphi}) \approx p_o(\tilde{\varphi}) x_o(\tilde{\varphi}) = \lambda_o \tilde{\varphi}^{\sigma-1}$  with  $\lambda_o$  a country  $o$ 's specific term common to all  $o$ 's firms.<sup>22</sup> The probability that a firm has a size (measured by sales) larger than  $S$  is equal to:

$$\begin{aligned} P_o(\tilde{S} > S) &\approx P\left(\tilde{\varphi} > \left(\frac{S}{\lambda_o}\right)^{\frac{1}{\sigma-1}}\right) \\ P_o(\tilde{S} > S) &\approx \lambda_o^{\frac{\gamma}{\sigma-1}} S^{-\frac{\gamma}{\sigma-1}} \end{aligned} \quad (30)$$

If empirically we have  $N$  (large) draws from this distribution, we can estimate the coefficient  $\gamma/(\sigma-1)$  by looking at the rank-size relationship. We order firms according to their size, the largest firm first. Since there are  $i$  out of  $N$  firms, that are larger than the  $i$ -th firm,  $i/N$  is an estimator of the probability that a firm has a size larger than  $Size_i$ . For a firm  $i$ :

$$\ln\left(\frac{Rank_i}{N}\right) \approx \ln\left(P(\tilde{S} > Size_i)\right) = a - \frac{\gamma}{\sigma-1} \ln(Size_i) \quad (31)$$

Estimating equation (31) with OLS provides us with an estimator of  $\gamma/(\sigma-1)$ , the scaling coefficient of the size distribution in country  $o$ .

In order to measure the heterogeneity of firms using the distribution of firm size within a country, we use the data from the Oriana data base, which is compiled and maintained by the *Bureau van Dijk*, on the distribution of sales Asian companies. Following the guidance of the underlying heterogenous firm trade model, we restrict the sample to the domestic firms only and exclude all affiliates of foreign firms. Due

<sup>20</sup>For example, *Bernard et al* (2003) report that only 21% of the USA's manufacturing plants export. Even though those plants are large and account for more than 60% of the USA manufacturing sector, the vast majority of exporting firms sell no more than 10% of their output abroad.

<sup>21</sup>In the case of small and integrated economies, a selection process between firms will magnify the impact of productivity differences between firms. More productive firms are able to capture a larger market and they are also able to reach more countries. Hence, they sell more than less productive firms for two reasons: (i) because they can charge lower prices and capture a larger demand in each market; and (ii) because they have access to more markets.

<sup>22</sup> $\lambda_o = \alpha \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} P_o^{\sigma-1} L_o$ .

to selection issues, the rank-size scaling of firms is an appropriate description of the scaling of large firms, but is not accurate for small firms. Therefore, we restrict the estimation to the largest firms in the sample. Given that a 33% threshold provides the best information for estimating the shape of the Pareto distribution of firm size at the lowest cost in terms of departure from the Pareto scaling, we restrict the sample to the 33% largest firms in each country. Despite the exclusion of affiliates of foreign firms and small firms from the sample, the large number of observations available in the Oriana data base (more than one million for Asia-7) allows us to obtain robust and reliable heterogeneity measures for every Asia-7 economy.

Table 1: The estimates of firm heterogeneity for Asia-7

	Asean	Austr	China	India	Japan	Korea	New Z
$\gamma_r$	5.902 <sup>†††</sup>	6.928 <sup>†††</sup>	6.063 <sup>†††</sup>	5.880 <sup>†††</sup>	5.153 <sup>†††</sup>	5.234 <sup>†††</sup>	6.396 <sup>††</sup>
	(0.367)	(0.423)	(0.274)	(0.843)	(0.482)	(0.485)	(1.076)

Notes: Estimates based on equation (31) and Oriana firm level data. White-corrected standard errors are in parenthesis. \*significant at 10% level, \*\*significant at 5% level, and \*\*\*significant at 1% level.

Table 1 reports the estimates of the firm heterogeneity,  $\gamma_r$ . The estimated index of firm distribution,  $\gamma_r$ , is inversely related to firm heterogeneity, implying that countries with lower  $\gamma_r$  are more heterogeneous, in sense that more output is concentrated among the largest and most productive firms. According to our estimates, the highest firm heterogeneity (measured by productivity) in Japan and Korea (5.153 and 5.234, respectively). In contrast, firms are most homogenous in Australia and New Zealand, where the estimates of  $\gamma_r$  are 6.928 and 6.396, respectively (Table 1). The unweighted average value of the shape parameter in productivity distribution,  $\gamma_r$ , is 5.936, which is in line with *Zhai* (2008), who uses the shape parameter in productivity distribution between 5.17 and 7.75.

The second type of parameter estimates we require are the elasticities of substitution. According to the underlying heterogeneous firm trade model, the elasticity of substitution is a demand concept. Therefore, a proper estimation must be able to estimate the demand and the supply elasticities simultaneously and distinguish between the two. Empirically, however, the simultaneity involved by market clearing makes it difficult to isolate the demand from the supply considerations. Because of this simultaneity problem, most estimates of the elasticities of substitution available in the literature are either flawed or inconsistent with our model.

In order to fulfill these conceptual requirements, we use the estimates of elasticities of substitution from *Rivas* (2010). Based on the works of *Feenstra* (1994), *Broda* and

Weinstein (2006) and Broda and Romalis (2009), and employing the panel dimensions of the data, he uses the second moments of variations in the demand and in the supply to infer the demand and the supply elasticities separately. Even though, *Rivas* does not account directly for the heterogeneity between firms, he uses the trade data at a sufficiently fine level of disaggregation to capture most of the heterogeneity. Using the price and volume data at a highly disaggregated level, the between countries variations, and assuming that the demand and the supply elasticities are constant over time, *Rivas* constructs two separate estimates for the demand and the supply elasticities. His estimation strategy is robust to many different specifications of the underlying structure of the economy. More importantly, it is consistent with the underlying heterogenous firm trade model where, due to the selection that takes place between the exporting firms, the demand and the supply elasticities differ.

Table 2 reports the estimates of the elasticity of substitution,  $\sigma_r$ . The average magnitude of the estimated elasticity of substitution,  $\sigma_r$ , is 4.501, which is in line with *Zhai* (2008) - the closest model to ours - who uses the elasticities of substitution between 4.30 and 6.00. The highest elasticity of substitution is estimated for Asean (4.531), the lowest for Australia (4.459). The elasticities of substitution reported in Table 2 is between the estimated industry-level estimates, which range from 1.22 (*Ronald-Holst et al.* 1992), 3.41 (*Davis* 1993), 4.83 (*Gallaway et al* 2000) and calibrated Armington elasticities of substitution employed in CGE models, which range up to 12.0 (*Ruhl* 2003).

Table 2: The estimates of the elasticity of substitution for Asia-7

	Asean	Austr	China	India	Japan	Korea	New Z
$\sigma_r$	4.531 <sup>†††</sup>	4.459 <sup>††</sup>	4.508 <sup>†††</sup>	4.503 <sup>†††</sup>	4.531 <sup>†††</sup>	4.499 <sup>†††</sup>	4.479 <sup>††</sup>
	(0.422)	(0.664)	(0.121)	(0.807)	(0.228)	(0.448)	(1.341)

Notes: White-corrected standard errors are in parenthesis. \*significant at 10% level, \*\*significant at 5% level, and \*\*\*significant at 1% level. Source: *Rivas* (2010).

The variation in the magnitude of the elasticity of substitution is due to differences in the underlying conceptual frameworks, which also cause different impact of trade liberalisation on the gains of trade. In the underlying heterogenous firm trade model the elasticity of substitution has opposite effects on each margin of trade. A higher elasticity makes the intensive margin more sensitive to changes in trade barriers, whereas it makes the extensive margin less sensitive. When trade barriers decrease, new and less productive firms enter the export market, attracted by the potential for higher profits. When the elasticity of substitution is high, low productivity is a

severe disadvantage. These less productive firms can only capture a small market share. The impact of those new entrants on aggregate trade is small. On the other hand, when the elasticity is low, each firm is sheltered from competition. The new entrants capture a large market share. The impact of those new entrants on aggregate trade is large. Hence, the elasticity of substitution magnifies the sensitivity of the intensive margin to changes in trade barriers, whereas it dampens the sensitivity of the extensive margin. The net impact of the elasticity of substitution may be either positive or negative. In contrast, in trade models with representative firms the impact is always positive: trade barriers have a strong impact on trade flows when the elasticity of substitution between goods is high and vice versa.

The third type of the required parameter estimates are the trade barriers. A consistent estimation of trade costs, which were in line with the underlying heterogeneous firm model, faces two complications. First, part of the trade costs are not directly observable and/or measurable (e.g. time costs, bureaucratic procedures on the border). As a result, neither the indirect measures of trade barriers which are commonly used in the literature, such as the bilateral geographical distance between two trading partners, the fact of sharing a common border, and the fact of sharing a common language, nor the direct measures of trade costs, such as freight and tariff data, can capture all trade barriers the exporting firms face. Second, according to the underlying heterogeneous firm trade model and firm level evidence (*Bernard et al* 2003), trade barriers contain a variable (per unit), trade cost component and a fixed trade cost component. Given that both affect trade flows in the same direction (negatively) and part of them are not directly observable and/or measurable, is impossible to distinguish between the two.

In line with these conceptual requirements, we use the trade barriers estimates of *Rivas* (2010). He follows the approach of trade freeness proposed by *Head and Mayer* (2004), which measures the easiness with which two countries participate in reciprocal trade. By calculating the cif/fob ratios from the bilateral trade data, *Rivas* is able to infer the international trade barriers. The main advantage of the implied trade cost approach is that it does not require to arbitrarily assume a specific functional form and estimation method, does not need to select/exclude explanatory variables, and by construction it accounts for the unobservable component of trade costs. A downside of the imputed measure of trade freeness is that it imposes certain regularity conditions, such as symmetric bilateral trade costs and zero internal trade costs. In the context of our study, particularly the assumption of zero internal trade costs is critical because, due to the large geographic size of several Asian countries, one cannot straightforwardly assume negligible trade costs for inter-regional trade within

these economies. The assumption of zero internal trade cost might be particularly critical for geographically large countries, because internal trade costs increase with the size of the country. Consequently, when positive trade costs are assumed only for cross-border transactions, the trade freeness would be underestimated, suggesting lower levels of trade integration than actually observed. As a result, the estimated trade freeness would be biased downward for geographically large countries, such as China and India.

In order to address the country size bias, *Rivas* (2010) develops a two-step estimator for China, India and for the intra-ASEAN trade. In the first step he estimates the trade freeness for China and India at the provincial level and intra-ASEAN at the national level, by assuming frictionless intra-provincial/intra-ASEAN trade. Using the obtained intra-provincial/intra-ASEAN trade freeness estimates, he then calculates a weighted average index of internal trade freeness for China, India and ASEAN. In a second step, using the internal trade freeness estimates he estimates the international openness to trade for each country pair.

Table 3: Bilateral trade freeness estimates for Asia-7 in 2004

	Asean	Austr	China	India	Japan	Korea	New Z
Asean	-	0.298	0.234	0.251	0.295	0.288	0.315
Australia	0.298	-	0.320	0.324	0.408	0.403	0.454
China	0.234	0.320	-	0.327	0.250	0.303	0.246
India	0.251	0.324	0.327	-	0.205	0.208	0.199
Japan	0.295	0.408	0.250	0.205	-	0.404	0.395
Korea	0.288	0.403	0.303	0.208	0.404	-	0.357
New Zealand	0.315	0.454	0.246	0.199	0.395	0.357	-

Notes: Higher freeness of trade = lower trade costs. Two-step trade freeness estimates from *Rivas* (2010).

*Rivas's* (2010) estimates of the bilateral trade freeness for Asia-7 are reported in Table 3. Note that the reported trade freeness estimates are inversely related to trade costs: a higher freeness of trade imply lower trade costs. According to the bilateral trade freeness estimates reported in Table 3, we note that the general level of trade integration in Asia is rather low, and there is a sizeable variation in the bilateral trade freeness between the trading pairs. *Rivas* estimates the highest average trade openness for Australia (0.368), followed by New Zealand, Korea and Japan (0.328, 0.327 and 0.326, respectively). The lowest average trade freeness he estimates for India (0.252), followed by China and Asean (both 0.280). Table 3 also suggests a substantial variation between the trading partners. For example, for Australia it

varies between 0.298 (Asean) to 0.454 (New Zealand).

In addition to the aggregate estimates of trade barriers, the underlying heterogeneous firm trade model requires also the estimates of variable and fixed trade costs. The share of variable and fixed trade costs in the total trade costs cannot be estimated based on aggregate trade data. Therefore, given that for all other variables in the model we have data and for all other parameters estimates, this share can be unequally identified by calibrating the model. We calibrate the ratio of variable to fixed trade costs such that the model exactly reproduces the GTAP v7 bilateral trade data for 2004.

### 3.3 Base run and scenarios

Solving the derived trade model numerically yields the aggregate trade, the extensive margin of trade, and the welfare gains of variety growth,  $E_{od}^{br}$ ,  $N_{od}^{br}$ ,  $W_d^{br}$ , respectively, for the base run. Given that the share of variable/fixed trade costs in total trade costs is calibrated, we are able to exactly replicated the bilateral GTAP trade data for Asia-7 for 2004. The only country, where our model's performance is unsatisfactory, is New Zealand.<sup>23</sup> The rather weak model's performance for New Zealand can be explained by the fact that, New Zealand is very far away from all its Asia-7 trading partners (except for Australia) and, in terms of the labour force and the GDP, it is very small compared to the rest of Asia-7. Although, part of the New Zealand's remoteness to its trading partners is captured in the multilateral trade resistance variable, it does not fully represent the true New Zealand's remoteness and economy's size. As a result, the predicted trade flows are very small (close to zero) for New Zealand in our model. Based on these base run results for New Zealand, it would be more than natural to exclude New Zealand from further simulations. However, we leave it in the sample, in order to clearly show the limitations of our model.

Breaking down the base run results by the extensive margin,  $N_{od}$ , and the intensive margin,  $e_{od}$ , we note that, on average, two thirds of trade takes place along the intensive margin and one third along the extensive margin, which is in line with previous studies on trade integration in heterogeneous firm framework (*Hillberry and McDaniel* 2002; *Kehoe and Ruhl* 2003; *Hummels and Klenow* 2005; *Broda and Weinstein* 2006; *Kanacs* 2007; *Blonigen and Soderbery* 2009; *Feenstra* 2009). Due to the fixed export market entry costs (which are considerably lower in the domestic market), the extensive margin is notably lower for exports (average 7.9%) than for

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<sup>23</sup>Unsatisfactory model's performance means that we are not able to reproduce the New Zealand's bilateral trade data with the Asia-7 trading partners within a plausible range of the calibrated ratio of variable to fixed trade costs.



domestic sales (average 47.6%). As usual, the base run values,  $br$ , will be used as a counterfactual in the following comparative static analysis of trade integration in Asia.

Table 4: Summary of the analysed FTA scenarios in Asia-7

	Asean	Austr	China	India	Japan	Korea	New Z
CIFTA- $\Delta\tau_{od}$			+	+			
CIFTA- $\Delta F_{od}$			+	+			
CIFTA- $\Delta\phi_{od}$			+	+			
ASEAN+3- $\Delta\tau_{od}$	+		+		+	+	
ASEAN+3- $\Delta F_{od}$	+		+		+	+	
ASEAN+3- $\Delta\phi_{od}$	+		+		+	+	
ASEAN+6- $\Delta\tau_{od}$	+	+	+	+	+	+	+
ASEAN+6- $\Delta F_{od}$	+	+	+	+	+	+	+
ASEAN+6- $\Delta\phi_{od}$	+	+	+	+	+	+	+

Notes: Scenarios based on Kawai and Wignaraja (2007) and *ARIC* (2010) data base on FTAs in Asia.  $\Delta\tau_{od}$  = variable trade cost reduction,  $\Delta F_{od}$  = fixed trade cost reduction,  $\Delta\phi_{od}$  = variable and fixed trade cost reduction.

The potential impacts of trade integration in Asia are studied in three trade liberalisation scenarios (two regional and one global - Asia-7): FTA between China and India (CIFTA), FTA between ASEAN, China, Japan and Korea (ASEAN+3), and FTA between ASEAN, Australia, China, India, Japan, Korea and New Zealand (ASEAN+6).<sup>24</sup> A summary of the three trade integration scenarios and the involved trading partners is provided in Table 4.

Generally, the trade integration can take different forms. For example, as a result of an FTA, the exporting firms might have to pay lower import tariffs, the administrative hurdles are lower/less, or the border controls are abolished. All these measures lower the trade costs and hence facilitate the bilateral trade. However, depending on which type of trade costs are reduced - variable, fixed or both - the trade liberalisation can have different implications on trade growth and welfare. This implies that designing integration scenarios, which are trade cost specific, is data demanding and requires not only bilateral country-pair specific trade cost data, but also the shares of variable and fixed trade cost reductions. Unfortunately, such data are not available for Asia-7.<sup>25</sup> Therefore, we simulate trade integration in Asia by hypothetically re-

<sup>24</sup> According to *Bandara* and *Yu* (2003); *Kawai* and *Wignaraja* (2007), the three selected FTAs are among the most often discussed FTAs involving China and India.

<sup>25</sup> Though, the *ARIC* data base on FTAs in Asia provides some of the relevant information required for decomposing the tariff and non-tariff trade barrier reductions into variable and fixed trade cost

ducing variable trade costs, fixed trade costs and both fixed and variable trade costs in 5% steps up to 15%, which according to *Rivas's* (2010) estimates, is the potential impact of FTA on trade barriers in Asia-7.

### 3.4 Simulation results

We reduce the trade costs to their post-integration values according to Table 4 and calculate the *fta* equilibrium values for  $N_{od}^{fta}$ ,  $\tilde{e}_{od}^{fta}$  and  $E_{od}^{fta}$ . Subtracting the *fta* equilibrium values from the *br* equilibrium values yields trade growth,  $\Delta E_{od}$ , changes in the extensive margin,  $\Delta N_{od}$ , the intensive margin of trade,  $\Delta \tilde{e}_{od}$ , and welfare gains/losses from increasing/decreasing variety,  $\Delta W_d$ . The results for the trade liberalisation simulations are reported in Tables 5-13.

Table 5: The impact of CIFTA- $\Delta\tau_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	-9.23	-9.92	5.67	12.49	-5.35	2.34	-5.42	3.59
Extensive margin	2.69	4.16	-23.10	-14.17	2.98	0.60	-4.73	-8.63
Variety gains	-8.55	-8.85	-1.95	7.69	-4.56	2.52	-6.73	0.96

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. CIFTA- $\Delta\tau_{od}$ : 15 percent reduction of variable trade costs between China and India.

Table 6: The impact of CIFTA- $\Delta F_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	-1.42	-1.61	1.40	2.62	-1.32	-0.33	-1.16	0.87
Extensive margin	0.35	0.56	-2.54	-1.19	0.39	0.00	-0.80	-0.80
Variety gains	-1.32	-1.46	0.66	2.27	-1.21	-0.33	-1.39	0.64

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. CIFTA- $\Delta F_{od}$ : 15 percent reduction of fixed trade costs between China and India.

CIFTA is simulated as a reduction in bilateral trade costs between China and India. Table 5 reports the results of variable trade cost reduction by 15%, CIFTA- $\Delta\tau_{od}$ , Table 6 reports the results of fixed trade cost reduction by 15%, CIFTA- $\Delta F_{od}$ . However, as a simulation, it does not cover changes in all trade barriers.

Table 7: The impact of CIFTA- $\Delta\phi_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	-9.84	-10.69	4.99	13.01	-5.84	2.73	-5.79	3.40
Extensive margin	2.99	4.62	-20.32	-8.97	3.34	0.75	-5.12	-6.17
Variety gains	-9.09	-9.52	-1.59	10.01	-4.96	2.95	-7.20	1.54

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. CIFTA- $\Delta\phi_{od}$ : 15 percent reduction of variable and fixed trade costs between China and India.

$\Delta F_{od}$ , and Table 7 reports the results of both variable and fixed trade cost reduction by 15%, CIFTA- $\Delta\phi_{od}$ . According to Tables 5-7, the bilateral trade cost reduction between China and India increases bilateral trade in all three CIFTA sub-scenarios (5.67% and 12.49% under CIFTA- $\Delta\tau_{od}$ , 1.40% and 2.62% under CIFTA- $\Delta F_{od}$ , and 4.99% and 13.01% under CIFTA- $\Delta\phi_{od}$ ) implying a trade creation between China and India. Depending on the initial trade costs, the market structure and the elasticity of substitution, trade flows decrease in four out of five excluded Asian economies, suggesting trade diversion. Qualitatively (in terms of signs), these results are in line with trade models with representative firms (*Ballard and Cheong 1997, Roland-Holst et al 2003*). Quantitatively, however, the results presented here are different from trade models with representative firms, as according to the underlying heterogeneous firm trade model, because of a reduction in trade barriers, not only each firm exports more, but also more firms export, which results in a higher trade growth.

The extensive margin of trade, and hence the product variety, increases in four out of five non-CIFTA economies, but decreases in both CIFTA members. The decrease in product variety in CIFTA is due to the fact that opening of markets also increases competition. Higher competition reduces prices and hence firm profits, which drives the least profitable firms out of markets. This effect is particularly sizeable in China, where the variety margin decreases by -23.10% under CIFTA- $\Delta\tau_{od}$  and -20.32% under CIFTA- $\Delta\phi_{od}$ . The variety gains for Asia-7 are positive in all three CIFTA sub-scenarios (0.96%, 0.64% and 1.54%). However, because of increased competition and fewer firms, they are ambiguous for China and India. For example, under CIFTA- $\Delta\tau_{od}$  and CIFTA- $\Delta\phi_{od}$ , the variety gains of trade integration are negative for China. These results are not directly comparable to trade models with representative firms, where both the extensive margin and variety gains are absent.

Simulation results for ASEAN+3 are reported in Tables 8-10. Similarly to CIFTA,

Table 8: The impact of ASEAN+3- $\Delta\tau_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	39.82	-16.15	19.23	-37.26	12.16	-23.20	5.31	1.34
Extensive margin	-33.98	14.69	-39.44	4.63	-30.69	-14.69	-30.75	-19.43
Variety gains	24.31	-12.76	3.34	-36.45	1.10	-26.61	-5.24	-4.72

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+3- $\Delta\tau_{od}$ : 15 percent reduction of variable trade costs between Asean, China, Japan and Korea.

Table 9: The impact of ASEAN+3- $\Delta F_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	5.87	-0.67	4.11	-1.92	0.97	-1.83	0.20	1.77
Extensive margin	-2.98	1.02	-3.51	0.48	-1.36	6.79	-3.92	-1.80
Variety gains	4.97	-0.38	3.06	-1.79	0.58	0.04	-0.95	1.24

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+3- $\Delta F_{od}$ : 15 percent reduction of fixed trade costs between Asean, China, Japan and Korea.

the aggregate trade and variety effects of trade integration between Asean, China, Japan and Korea are rather moderate - up to 5% of their benchmark values. The aggregate results, however, mask a great deal of variation between countries. Similarly to CIFTA, in terms of trade volume, ASEAN+3 is beneficial for all block members but Korea (first row in Tables 8-10) implying trade creation in ASEAN+3. Note that the integration's impact on trade volume and variety has the opposite sign in Korea both under CIFTA and ASEAN+3 scenarios. Abstracting from New Zealand (see section 3.3), the excluded countries (Australia and India) loose under all three ASEAN+3 sub-scenarios both in terms of quantity and variety.

A qualitative difference between the two trade integration scenarios is in the results reported in the last column of Tables 5-10, according to which trade integration yields variety gains under all three CIFTA sub-scenarios, but results in variety losses under ASEAN+3- $\Delta\tau_{od}$  and ASEAN+3- $\Delta\phi_{od}$ . As explained above, the opening of markets to trade increases competition, which reduces prices and firm profits. Lower profits, in turn, drive the least profitable firms out of the market. Only in Korea the competition effect is fully offset by a larger import variety (sub-scenarios ASEAN+3-

Table 10: The impact of ASEAN+3- $\Delta\phi_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	41.92	-17.39	19.84	-39.60	10.60	-27.82	5.38	0.79
Extensive margin	-32.67	16.28	-36.67	5.00	-25.97	4.42	-32.53	-17.21
Variety gains	26.88	-13.71	5.20	-38.76	1.57	-26.92	-5.89	-4.50

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+3- $\Delta\phi_{od}$ : 15 percent reduction of variable and fixed trade costs between Asean, China, Japan and Korea.

$\Delta F_{od}$  and ASEAN+3- $\Delta\phi_{od}$ ). However, given that the extensive margin declines in Korea, the positive variety effect does not lead to variety gains.

Table 11: The impact of ASEAN+6- $\Delta\tau_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	38.14	20.33	24.20	37.70	28.16	-2.29	-15.09	31.70
Extensive margin	-51.37	-61.73	-60.21	-48.27	-48.89	-37.96	16.87	-52.60
Variety gains	12.62	-8.85	-4.49	14.08	5.97	-14.76	-11.19	6.41

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+6- $\Delta\tau_{od}$ : 15 percent reduction of variable trade costs between the Asia-7 trading partners.

Tables 11-13 report the effects of multilateral trade liberalisation in Asia-7.<sup>26</sup> Compared to CIFTA and ASEAN+3, the most striking difference is in the magnitude of changes in the trade volume and the variety gains. The results reported in the last column of Tables 11-13 suggest that, depending on the type of trade cost reduction, ASEAN+6 would increase the volume and the variety gains by 6.52%-33.93% and 4.89%-8.84%, respectively. These effects are considerably larger than under CIFTA and ASEAN+3 (Tables 5-10) and trade models with representative firms. Five out of seven integrating economies in Asia benefit significantly from ASEAN+6 both in terms of the trade volume and variety.

Compared to trade models with representative firms, the adopted heterogeneous firm model predicts that the same trade barriers would have a larger impact on trade flows than in the models with representative firms (*Ballard and Cheong 1997*,

<sup>26</sup>Note that ASEAN+6 is equal to Asia-7 (Asean, Australia, China, India, Japan, Korea and New Zealand).

Table 12: The impact of ASEAN+6- $\Delta F_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	6.64	6.99	6.06	8.05	4.03	1.99	-1.26	6.52
Extensive margin	-5.43	-10.34	-6.70	-5.34	-3.82	2.12	41.90	-5.27
Variety gains	4.96	3.66	3.98	6.37	2.89	2.60	9.19	4.89

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+6- $\Delta F_{od}$ : 15 percent reduction of fixed trade costs between the Asia-7 trading partners.

Table 13: The impact of ASEAN+6- $\Delta\phi_{od}$  on Asia-7 trade, changes in %

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Total trade	40.65	20.02	25.55	41.23	28.91	-3.00	-16.41	33.93
Extensive margin	-51.95	-46.16	-59.11	-48.10	-47.10	-24.06	66.21	-51.63
Variety gains	14.28	0.35	-2.70	17.12	7.64	-10.34	-3.26	8.84

Notes: Simulation results based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data. ASEAN+6- $\Delta\phi_{od}$ : 15 percent reduction of variable and fixed trade costs between the Asia-7 trading partners.

*Roland-Holst et al 2003, Roland-Holst, Verbiest and Zhai 2008*). In addition to adjustments in the intensive margin of trade, which are captures also in *Armington* and *Krugman* type trade models, in the underlying *Melitz* type model there are important adjustments in the extensive margin too. When trade barriers decrease, not only each firm exports more but, in addition, also more firms start to export.

The cross country differences are particularly visible under ASEAN+6, which is a symmetric policy shock to all Asia-7 economies. Under all three ASEAN+6 sub-scenarios the largest winners are India and Asean, where the trade volume by 8.05%-41.23% and 6.64%-40.65%, respectively, and the variety gains increase by 6.37%-14.08% and 4.96%-14.28%, respectively. The results for Korea are small and ambiguous - depending on which type of trade costs are reduced - it would either slightly gain or slightly loose from ASEAN+6. As explained in section 3.3, our model's predictions for New Zealand cannot be interpreted in an economically meaningful way.

These results are in line with *Feenstra* and *Kee* (2007) and *Zhai* (2008), who were among the first to adopt the heterogenous firm framework for studying the trade integration in Asia. *Feenstra* and *Kee* estimate that in 1972 China only exported 710

different goods to the United States as opposed to 10,315 in 2001. This fourteen-fold increase in the number of varieties produced a dramatic change in China's relative position: moving from the twenty-eighth most important source of varieties in 1972 to the fourth most important in 2005 and is further increasing. *Zhai* (2008) directly compares a calibrated *Armington* (1969) model with representative firms with the *Melitz* (2003) model with heterogeneous firms. *Zhai* finds that the gains of trade integration in Asia are up to two times higher when allowing for firm heterogeneity and accounting for fixed costs of exporting.<sup>27</sup>

Generally, we may conclude that the variable trade cost reduction has a considerably larger impact on trade growth than fixed trade cost reduction and hence is more efficient from a policy perspective. This is due to differences in the elasticities with respect to fixed and variable trade costs. The elasticity with respect to variable trade costs,  $\gamma$ , is larger than the elasticity with respect to fixed trade costs,  $1 - \gamma/(\sigma - 1)$ . Although, there is a sizeable variation between countries and trade integration scenarios, on average, a reduction of variable trade cost results in about 4-5 times larger trade growth than fixed trade cost reduction.

### 3.5 Robustness and sensitivity analysis

As usual, we perform robustness checks and sensitivity analysis with respect to the parameter values. The results of the sensitivity analysis for the elasticity of substitution,  $\sigma_r$ , and firm heterogeneity,  $\gamma_r$ , are reported in Table 14. Generally, the volume of trade, the number of firms and the welfare gains of variety seem to be sensitive but not over-sensitive to changes in the two key parameters of the model. A 50% changes in the values of the elasticity of substitution,  $\sigma_r$ , and firm heterogeneity,  $\gamma_r$ , results in 4.54% to 73.01% changes in the volume of trade, 39.32% to 52.44% changes in the number of firms, and 4.64% to 69.56% changes in the welfare gains of variety. Although, a misestimation of parameter values by 50% is very unlikely given the sample size of several hundreds of thousands firm level observations and given that they are line with estimates in the literature, these results provide a certain range or 'confidence interval' for interpreting the simulation results presented above.

According to the results of the sensitivity analysis reported in Table 14, +50% and -50% changes in firm heterogeneity,  $\gamma_r$ , have larger impact on the volume of

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<sup>27</sup>The presence of firm heterogeneity has also implications on country terms of trade. In *Armington* model with national product differentiation the simulated welfare changes of trade liberalisation are often dominated by negative terms-of-trade effects associated with export growth along the intensive margin, i.e. expanding export quantity but lower export price of each good. In the underlying *Melitz* model, however, if export expansion is based on the extensive margin or higher quality, such adverse terms-of-trade effects are no longer a necessary consequence.

Table 14: Sensitivity analysis results for the Asia-7, changes in %

	$\gamma_r + 50\%$	$\gamma_r - 50\%$	$\sigma_r + 50\%$	$\sigma_r - 50\%$
Total trade	-73.01	41.38	4.54	-6.74
Extensive margin	52.44	-49.85	-39.32	42.08
Variety gains	-69.56	16.09	-7.87	4.64

Notes: Sensitivity analysis results for the Asia-7 based on equations (27)-(29), estimated parameters from the ORIANA firm-level micro data and base year (2004) variables from the GTAP v7 macro data.

trade, the number of firms and the welfare gains of variety than the same changes in the elasticity of substitution between varieties,  $\sigma_r$ . The sensitivity analysis results also suggest that the two parameters affect the volume of trade and the number of firms in the opposite direction, but the welfare gains of variety in the same direction. Whereas a decrease in the heterogeneity of firms (increase in  $\gamma_r$ ) reduces the trade volume and the welfare gains of variety but increases the number of firms, an increase in the elasticity of substitution,  $\sigma_r$ , has exactly the opposite effect on the volume of trade and the number of firms. These results are both intuitive and in line with the previous literature (*Ruhl* 2003).<sup>28</sup> Given that countries with lower  $\gamma_r$  are more heterogeneous, in sense that more output is concentrated among the largest and most productive firms, an increase in  $\gamma_r$  increases the number of firms. Higher values of the elasticity of substitution,  $\sigma_r$ , imply that consumers care less about varieties (as varieties are highly substitutable), but more about the price of goods. As a result, the number of firms decreases. The welfare gains of variety is a combination of the two effects. Since changes in the volume of trade has the opposite compared to the number of firms, the percentage changes in the magnitude of the welfare gains of variety lies in between that of the volume of trade and the number of firms.

Compared to the previous literature, the sensitivity analysis results reported in Table 14 suggest that the elasticity of substitution has a different effect than in trade models with representative firms. Whereas in trade models with representative firms trade barriers have a strong impact on trade flows when the elasticity of substitution between goods is high, in our model the elasticity of substitution has no effect on the elasticity of trade flows with respect to variable trade costs, and a negative effect

<sup>28</sup> *Ruhl* (2003) incorporates firm heterogeneity à la *Melitz* in a dynamic setting in order to explain the so called elasticity puzzle: he argues that in response to high frequency transitory shocks, only the intensive margin adjusts, whereas in response to permanent shocks such as trade liberalisation, both the intensive and the extensive margin adjust. This provides an explanation for the difference between the low elasticity needed to explain the patterns of International Business Cycles, and the high elasticity needed to explain the growth of trade following a tariff reduction.



on the elasticity of trade flows with respect to fixed costs. A higher elasticity of substitution makes the intensive margin more sensitive to changes in trade barriers, whereas it makes the extensive margin less sensitive. According to the underlying heterogenous firm model, when trade barriers decrease, new and less productive firms enter the export market, attracted by the potential for higher profits. When the elasticity of substitution is high, a low productivity is a severe disadvantage. These less productive firms can only capture a small market share. The impact of those new entrants on aggregate trade is small. On the other hand, when the elasticity is low, each firm is sheltered from competition, and new entrants capture large market share.

## 4 Conclusions

The present paper studies the variety gains of trade integration in South East Asia. We extend the previous research along three dimensions. First, in addition to gains of trade in classical general equilibrium trade models, we also account for gains/losses arising from increased/decreased number of available varieties. Second, we show that, depending on the market structure and the substitutability between different varieties, the sources and size of variety gains are not only quantitatively but also qualitatively different between variable and fixed trade cost reduction. Third, we use a unique set of firm-level panel data provided by *Bureau van Dijk* to estimate the underlying trade model's structural parameters econometrically. Hence, our paper complements the previous research on trade integration in Asia in presence of firm and product heterogeneity (*Feenstra and Kee 2007, Zhai 2008*) by explicitly assessing the welfare gains of variety growth.

The underlying heterogenous firm model introduces three additional sources of gains of trade, which are not present in trade models with representative firms. The first is the *Dixit-Stiglitz* "love-of-variety effect", according to which the gains in welfare result from the entry of new firms and the associated increase in variety. This leads to a greater product variety for domestic consumers, if the losses in the number of domestic suppliers (due to fiercer competition) are more than offset by the number of new foreign exporters. The second additional source of welfare gains of trade is due to productivity gains from intra-industry resource reallocation. This is a unique channel in the heterogenous firm model, as productivity is taken as given both in the *Armington's* (1969) model of regional differentiation and *Krugman's* (1979) new trade model. The third source is the scale effect. Increased import competition drives out the inefficient domestic producers and results in less producing firms. Due to in-

creasing returns to scale, average costs usually fall, even though they are partly offset by the increased fixed exporting costs associated with a larger number of exporting firms.

Empirically, we analyse the first channel through which trade liberalisation gives rise to welfare gains - increased consumer choices.<sup>29</sup> The magnitude of the variety gains is determined by interaction of two opposite effects: a decreasing number of domestic firms, and an increasing number of foreign exporters. Less domestic firms supplying the domestic market reduce the gains of variety. However, in most of the analysed scenarios this effect is dominated by an increase in foreign exporters, thereby domestic consumers enjoy greater product variety.

We examine the potential impacts of trade integration in Asia in three different scenarios, within each of which three trade cost sub-scenarios are studied: variable trade cost, fixed trade cost, and both fixed and variable trade cost reduction. Our simulation results suggest that a multilateral trade liberalisation in Asia-7 (ASEAN+6) would increase the volume and variety of traded goods by 6.52%-33.93% and 4.89%-8.84%, respectively. In terms of trade and variety gains from multilateral trade liberalisation in Asia-7, the largest winners are India and Asean, where the volume of traded goods increases by 8.05%-41.23% and 6.64%-40.65%, respectively, and the variety gains increase by 6.37%-14.08% and 4.96%-14.28%, respectively. The gains in the regional trade integration scenarios (CIFTA and ASEAN+3) are considerably smaller than in the global trade integration scenario ASEAN+6. Both under CIFTA and ASEAN+3, the aggregate trade and variety effects of trade integration in Asia-7 are moderate - up to 5% of their benchmark values. Generally, a reduction in variable trade cost has a considerably larger impact on trade growth than fixed trade cost reduction (on average, trade growth due to reductions in variable trade costs is about 4-5 times larger than due to fixed trade cost reduction), because the elasticity of variable trade costs is larger than the elasticity of fixed trade costs.

Compared to previous studies, which mostly rely on trade models with representative firms, the underlying heterogeneous firm trade model predicts that the same

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<sup>29</sup> A related branch of this 'new' trade literature focuses on the quality differentiation of traded goods. *Hallak* (2006) attempts to identify the effect of product quality on the direction of international trade. The paper empirically investigates whether importers at a higher income level tend to buy more varieties of products from exporters with higher income as well because they tend to produce higher quality products. In a related paper *Hallak* applies his framework of product quality and uses sectoral level data to provide evidence for the Linder hypothesis according to which international trade is more intensive between countries with similar income levels than those that differ (*Hallak* 2005). *Choi, Hummels and Xiang* (2006) explore the effect of income distribution on varieties in trade, whose key insight is that consumers with higher income will buy goods with higher quality rather than buy greater quantities of goods that vary in the quality dimension.

trade barriers would have a larger impact on trade growth. In addition to the adjustments of the intensive margin of trade captured also in existing trade models with representative firms, in our model there are also important adjustments of the extensive margin. When trade barriers decrease, each firm exports more and, in addition, new firms start exporting. These results are in line with *Feenstra* and *Kee* (2007); *Zhai* (2008), who were among the first studying trade integration in Asia in a heterogenous firm framework. *Zhai* finds that the gains of trade integration are up to two times higher when allowing for firm heterogeneity and fixed costs of exporting.

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