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Structural Estimation of Variety Gains from Trade Integration in Asia

by

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Abstract

The present paper studies variety gains from trade integration in Asia. Applying a heterogenous firm model we simulate trade integration in Asia in three different scenarios (CIFTA, ASEAN+3, and ASEAN+6). The paper makes three contributions to the literature. First, in addition to traditional gains from specialisation, we also account for gains arising from increased number of different varieties. Second, we explicitly account for differences in trade gains between variable and fixed trade cost reduction. Third, using a unique set of firm-level panel data we estimate the underlying trade model's structural parameters econometrically. We find that the gains from trade integration are substantial. Reducing trade barriers by 15 percent induces trade growth up to 60 percent, which due to the additional extensive margin is more than in trade models with representative firms. Similarly, due due additional welfare gains from variety growth, the gains from trade are up to 17 percent higher than in models with homogenous products.

Keywords: Variety gains, extensive margin, trade integration, Asia, heterogenous firms.

JEL classification: F12, F14, R12, R23.

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1 Introduction

The economic emergence of the world's most populous nations China and India is contributing to fundamental shifts in global economic relations. Due to its large size and very dynamic growth, the fostered regional integration in Southeast Asia is transforming the economic landscape not only in Asia but also of the whole world.[1] Production networks and supply chains - initially formed by global international corporations and later by emerging Southeast Asian multinational firms - were the basis for trade integration. In addition, the East and South Asian governments have embarked on policy initiatives for institutional integration through bilateral and multilateral free trade agreements (FTAs). For example, the Association of Southeast Asian Nations (ASEAN) is emerging as an integration hub for the FTA activity in East and South Asia. Following China, Japan, and Korea, who already made formal economic ties with ASEAN, more recently also India and Australia are joining in this bandwagon move toward Free Trade Area in Southeast Asia.

Today Southeast Asia is at the forefront of FTA activity in Asia, with over 100 FTA initiatives at various stages equivalent to about half of Asia's total FTA initiatives. Moreover, Southeast Asia makes up two thirds of FTAs under negotiation in Asia (*Kawai* and *Wignaraja* 2007). A prominent example of the ongoing trade liberalisation efforts in Southeast Asia is the envisaged China-India Free Trade Agreement (CIFTA), which is currently under negotiation. Other important currently negotiated trade liberalisation agreements are ASEAN+3 (FTA between ASEAN, China, Japan and Korea) and ASEAN+6 (FTA between ASEAN, Australia, China, India, Japan, Korea and New Zealand (*Kawai* and *Wignaraja* 2007).

Trade integration in general and, due to low initial integration (which is rapidly growing) Southeast Asia in particular, has the potential to raise incomes and welfare of trading partners, and through input-output linkages, in the whole Asia. The sources of gains from trade are multiple. For example, in the classical trade literature, such as *Heckscher-Ohlin* and *Ricardo*, the gains from trade arise from specialisation in production, the division of labour, economies of scale, 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). A more recent strand of trade literature (*Hillberry* and *McDaniel* 2002; *Kehoe* and *Ruhl* 2003; *Hummels* and *Klenow* 2005; *Broda* and *Weinstein* 2006, *Helpman et al* 2008, *Melitz* and *Ottaviano* 2008) argues that the classical models of trade underestimate the aggregate gains from trade, as not all sources of gains are accounted for. According to *Kehoe* (2005), the applied general equilibrium models commonly used in trade policy analysis typically fail along two dimensions: they do not allow trade policy to affect aggregate productivity, and they do not allow trade

[1] Throughout the study when referring to Asia (Asia-7) we mean the ten ASEAN members (Brunei, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam), Australia, China, India, Japan, Korea and New Zealand.

liberalisation to induce trade growth along the extensive margin. The presence of the extensive margin of trade has important implication for evaluating the welfare effects of trade liberalisation. In trade models with national product differentiation (*Armington* 1969), the simulated welfare changes of trade liberalisation are dominated by the terms-of-trade effects associated with the intensive export growth, i.e. expanding export quantity but lower export price of each variety. However, as noted by *Hummels* and *Klenow* (2005), if export expansion is based on the extensive margin or high quality, such adverse terms-of-trade effects are no longer a necessary consequence.

While the empirical literature has demonstrated the relevance of within-industry productivity heterogeneity and trade growth via the extensive margin (*Roberts* and *Tybout* 1997), a sound theoretical framework that formalises the insights from the empirical literature has been lacking until recently.[2] The recently emerged class of trade models with heterogeneous firms and fixed trade costs (*Melitz* 2003) offer a useful framework for addressing the *Kehoe*'s critique. In heterogeneous firms models trade policy changes affect industry productivity by shifting market share away from low-productivity non-exporters, and toward high productivity exporters. Trade models with heterogeneous firms also emphasize trade growth along the extensive margin, and provides a mechanism by which such trade growth can be linked to policy changes. More precisely, trade policy may directly affect the extensive margin. For example, the number of traded varieties increases when trade costs fall and vice versa. The threshold for import penetration falls and more foreign firms find it profitable to enter the foreign market. The effect of changes in trade costs on the number of domestic varieties is not clear, because there are two mechanisms by which the distribution of operational firms in a given country changes with trade. First, 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, bid up the input price. Thus, the second effect acts to induce exit of firms with low productivity, which reduces the domestic variety. On net, however, consumers will likely benefit from lost domestic varieties because factor returns increase and the remaining domestic varieties are less expensive. More productive firms optimally price lower, so eliminating low productivity firms depresses the average price.

With respect to trade growth along the extensive margin, China is a particularly interesting case to study, as in China trade liberalisation takes places simultaneously with transformation from central planning to a (state controlled) market economy. During the Communist China the central planners believed strongly in the economies of scale (*Yao* and *Yueh* 2006). In combination with very low openness to international trade and absence of price signals coming from consumer preferences, the number of produced commodities and different varieties of each product was rather limited. Hence, under the central planning the number of goods and varieties pro-

[2] While some policy estimates did include ad hoc productivity adjustments (e.g. *Anderson et al* 2005), these attempts did not typically specify the mechanism by which trade policy is meant to induce productivity growth.

duced and sold was in China politically 'corrected' downward compared to a free market equilibrium.

The transition toward market economy started to relax the state control over firm-internal production decisions. As a result, the decision about the set of goods and varieties produced and the amount of each variety offered on each market started to move from the central government and the Communist party to firm level (*Yao* and *Yueh* 2006). Along with other economic reforms in the nineties, which allowed for private property, entrepreneurship and relaxed the state control of firm production decisions, the number of private firms, the set of goods and varieties each firm produces, the number of traded goods started to increase rapidly in China (*Feenstra* and *Kee* 2007). For example, 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 (*Broda* and *Weinstein* 2006).

In light of these insights, the present study examines how trade liberalisation in Asia may affect consumer welfare through a larger number of available goods and varieties in Asia and particularly in the post-Soviet China. 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 the associated welfare gains from trade into gains from quantity growth (intensive margin) and gains from variety growth (extensive margin) (section 2). Section 3 introduces the theoretical framework (*Feenstra* 1994; *Romer* 1994), which relates variety growth to welfare gains. In section 4 we use the estimated model parameters and statistical data to empirically implement the theoretical trade model and to simulate regional integration in Asia. Based on the obtained simulation results, we quantify welfare gains arising from variety growth. We study the impact of trade integration on variety growth in three scenarios: CIFTA, ASEAN+3 and ASEAN+6, which differ by the set of integrating countries. As usual, we conclude by drawing trade policy conclusions and sketching avenues for future research.

2 Theoretical framework

Assuming that consumers value variety (we do so throughout the paper), welfare gains from one unit of trade growth can be differently valuable depending on whether trade growth occurs along the intensive or along the extensive margin of trade. For example, if in addition to the growth of traded quantities, also the number of traded goods and varieties increase, then welfare gains will be larger compared to a pure 'quantity expansion' of trade. The difference in welfare gains between the two types of trade growth gives rise to variety gains of trade.

In order to quantify the variety gains, the aggregate trade growth has to be decomposed into the intensive (quantity) and extensive (variety) margins of trade. 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 is not available for the emerging economies in Asia. In absence of firm-level trade data for Asia, an 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.[3] If all firms from country o would export each good to country d and the number of exporting firms and the set of exported goods would not change, we could use the canonical *Krugman*'s (1980) monopolistic competition model of trade. However, according to the *COMTRADE* (2008) and *GTAP* (2008) trade data, both types of trade flows can be observed for 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 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 trading partner differences in the extensive margin of trade and productivity, the canonical *Krugman*'s (1980) model was extended by *Melitz* (2003), who endogenises the aggregate productivity and the set of exporting firms. *Melitz* assumes that firms in country o are heterogenous according to their productivity and that only the most productive export to country d, whereas the set of exporters depends on the export market and trade cost characteristics.

Although, based on the same underlying structure, *Melitz*'s (2003) model differs from the *Krugman*'s (1980) trade model along several dimensions. In the context of the present study, the two most important are data requirements and the underlying assumptions. Obviously, *Melitz*'s model is more data demanding, as it explicitly accounts for the intensive and extensive margins of trade. More precisely, additional information is required about the manufacturing firm distribution and export market entry costs.

On the other hand, the underlying assumptions are both fewer and less limiting in the *Melitz*'s model. First, *Melitz* relaxes the assumption of firm homogeneity. Indeed, firm-level heterogeneity finds strong support in empirical studies relying on firm-level data (e.g. *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. Similarly, the assumption of zero market entry costs, which is relaxed in the *Melitz*'s model, has been often rejected in the empirical studies. E.g. *Evenett* and *Venables* (2002) find strong evidence of fixed market entry costs associated with exporting abroad. Finally, the assumption that firms draw their productivity from

[3] 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.

a Pareto distribution also finds some 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 for 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.

2.1 The setup

Taking into account these considerations, we base our study on *Kancs* (2007) and *Chaney* (2008), which propose empirically implementable versions of the canonical *Melitz*'s trade model with heterogenous firms.[4] 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, according to the theoretical framework of the present study, exporters are only a subset of domestic firms and this subset of exporters varies with characteristics of foreign markets. Following *Melitz*, we 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 export markets, we assume that all firms have to pay only one fixed type 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 data paucity is particularly limiting.[5]

2.2 Preferences

Workers are the only consumers and have identical CES preferences over traditional and 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:

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

where σ_x is the elasticity of substitution between the manufacturing varieties and α is a consumer demand parameter determining expenditure shares, with $\sigma_x > 1$ and

[4] The present model also incorporates features of *Helpman et al* (2008).

[5] Although, the two different entry costs in the *Melitz*'s model might describe firm dynamics more precisely, they offer little additional insights in the export behaviour of firms, which is the main focus of the present study.

$\alpha_A + \alpha_x = 1$.

In order to capture the potential gains from variety, one needs to impose a specific structure on how varieties affect consumer welfare. There are many theoretical approaches of modelling the variety (e.g., *Hotelling* 1929, *Lancaster* 1975, *Spence* 1976, *Dixit* and *Stiglitz* 1977), and 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.

Consumer prices in destination country d depend on market 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 shipping manufacturing goods from origin country o to destination country d: variable trade cost, τ_{od} and fixed trade cost, FC_{od}. As usual, the variable trade cost take an 'iceberg' form: if one unit of the differentiated manufacturing good is shipped from origin country o, only fraction $\frac{1}{\tau_{od}}$ arrives at destination d.[6] On the other hand, the fixed export entry costs do not depend on the quantity of goods sold abroad: a firm from country o wanting to export to country d, must pay fixed market entry cost FC_{od}. These costs include 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.

2.3 Technology

Goods are produced in R countries indexed $r \in \{1, .., o, .., d, ..R\}$ using only labour, L. Country r has a total labour force L_r, which is proportional to the mass of firms in r.[7] All countries have access to the same technology. There are two 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. Manufacturing goods can be

[6] Following *Samuelson* (1954), implicitly we assume that the rest melts on the way.

[7] 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), we would obtain qualitatively the same results, if trade barriers are not negligible.

traded between all countries (at a positive trade cost).

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

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

As usual in the monopolistic competition framework, firms are price setters for their own variety. Given that 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 the transportation cost, τ_{od}):

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

where p_{od} is price of manufacturing variety produced in region o and sold in region d. A 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 γ and that firm productivity is distributed according to $P(\tilde{\varphi} < \varphi) = F(\varphi) = 1 - \varphi^{-\gamma}$, with $dF(\varphi) = \gamma^{-\gamma}\varphi d\varphi$ for $\varphi \geq 1$. Parameter γ is an inverse measure of firm heterogeneity in the manufacturing sector, with $\gamma > 2$ and $\gamma > \sigma - 1$.[8] Sectors with lower γ are more heterogeneous, in sense that more output is concentrated among the largest and 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 then given by:

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

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 gross profits earned in country d are just enough to cover the fixed cost, FC_{od}, of entering market d:

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

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

[8] $\ln\varphi$ 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 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.

where Y_d is real income, P_d is price index in country d and λ_1 is a constant.[9] We assume that trade barriers are always high enough to ensure that $\forall\ i,\ r,\ \bar{\varphi}_{od} > 1$.[10]

2.4 Price index

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:

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

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

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

where λ_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 $L \equiv \sum_{r=1}^{R} L_r$.[11] Variable θ_d is an aggregate index of d's remoteness from the rest of the world.[12] 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.

2.5 Trade

Using the general equilibrium price index derived in the previous section 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 strategies of all other firms and all consumers as given. A 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. A strategy for a 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

[9] $\lambda_1 = \left(\frac{\sigma}{\alpha}\right)^{\frac{1}{\sigma-1}} \left(\frac{\sigma}{\sigma-1}\right)$.

[10] This assumption finds strong support in empirical firm-level research, e.g. from the U.S. Census Bureau's Annual Survey of Manufacturers.

[11] $\lambda_2 = \left(\frac{\gamma-(\sigma-1)}{\gamma}\right)^{\frac{1}{\gamma}} \left(\frac{\sigma}{\alpha}\right)^{\frac{1}{\sigma-1}-\frac{1}{\gamma}} \left(\frac{\sigma}{\sigma-1}\right)$.

[12] 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, θ_d is a weighted average of bilateral trade costs.

is characterised by a set of prices and quantities that correspond to a fixed point of the best response graph of each agent.

By plugging 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:

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

where λ_3 is a constant.[13] According to equation (9), the selection among exporting firms and non-exporting firms takes place because of difference in firm productivities, φ, 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 from equation (9) we can derive the number of o's firms exporting to d, which is positively related to the the extensive margin of trade:

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

Because of the selection that takes place among exporters, according to equation (10) the set of firms exporting to country d only depends on country d's characteristics and trade costs. Countries that are expensive for exporting firms to enter (FC_{od} large), far away (τ_{od} large), or which have a small market (L_d low), attract only the most productive exporters. If country d is far away from its trading partners (θ_d large), it is harder for exporting firms to compete, implying that only the most productive firms from country o are able to enter market d. The number of firms, N_{od}, reacts to changes in unit trade costs, τ_{od}, with an elasticity of γ, and to changes in the size of origin and destination countries, L_r, with elasticity 1, which is close to the values recovered from the firm-level trade data (e.g. *Anderson* and *von Wincoop* 2003).

According to the definition of E_{od}, the second channel of adjustment in aggregate exports comes from individual firm exports, which is the intensive margin of trade. Given the optimal pricing strategy of firms and the optimal demand strategy of consumers, we can derive exports from origin country o to destination country d for firm with productivity φ:

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

[13] $\lambda_3 = \left(\frac{\sigma}{\alpha}\frac{\gamma}{\gamma-(\sigma-1)}\right)^{\frac{1}{\gamma}}$.

Plugging the optimal price from equation (3) and the general equilibrium price index from equation (8) into the demand function (11), we can rewrite firm exports in terms of market export characteristics and firm productivity, φ:

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

where λ_4 is a constant.[14] According to equation (12), firm exports are determined by d's relative size, L_d, bilateral trade barriers, FC_{od} and τ_{od}, and d's remoteness from the rest of the world, θ_d. Individual firm exports depend on transportation cost, τ_{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:

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

According to equation (13), fixed trade costs, FC_{od}, have a large impact on the average size of exporters. An increase in fixed cost has no impact on the exports of an individual firm, but it forces less productive firms to exit the export market, as only the most productive and largest firms survive. Therefore, the average size of exporting firms increases in fixed export market entry cost, FC_{od}. On the other hand, neither variable trade costs nor the export market size 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 and exactly offsets the increase in the size of each existing exporter.

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

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

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

[14] $\lambda_4 = \alpha \left(\frac{\gamma-(\sigma-1)}{\gamma}\right)^{\frac{\sigma-1}{\gamma}} \left(\frac{\sigma}{\alpha}\right)^{1-\frac{\sigma-1}{\gamma}}$.

equations (10) and (13) into equation (14), the aggregate exports, E_{od}, from origin country o to destination country d can be expressed as:

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

According to equation (15), the aggregate exports from o to d depend on the relative size of countries, L_r/L, the destination country d's multilateral resistance, θ_d, and bilateral transport costs (both fixed and variable) among 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.

3 Variety gains from trade growth

Trade liberalisation always generates a welfare gain in trade models. In addition to the classical gains from trade, such as specialisation, the underlying heterogenous firm model introduces three additional channels through which the trade liberalisation gives rise to welfare gains. The first is the *Dixit-Stiglitz* "love-of-variety effect", i.e. the welfare gains from the entry of firms and the associated increase in variety, because usually trade liberalisation increases the number of exporting firms. This leads to 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 channel is the productivity gains from intra-industry resource reallocation. This is a unique channel in firm heterogeneity model, as productivity is taken as given both in the *Armington*'s (1969) model and *Krugman*'s (1979) new trade model. The third channel is the scale effect. Increased import competition drives out the inefficient domestic producers and results in less producing firms. Due to increasing 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.

In the present study we examine the first channel through which trade liberalisation gives rise to welfare gains - increasing consumer choices.[15] The magnitude of

[15] 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

consumer gains is determined by the interaction of two forces: the decreased number of domestic firms, and the increased number of foreign exporters. The less domestic firms supplied to domestic markets causes negative variety effect for domestic consumers. However, this effect is typically dominated by the increased number of new foreign exporters, thereby domestic consumers still enjoy greater product variety.

Depending on the data availability, variety gains can be computed in several ways by imposing different assumptions.[16] The *Romer*'s (1994) approach is the least data demanding, but it also imposes the strongest assumptions. *Feenstra*'s (1994) methodology is less restrictive and therefore more often used in recent 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 Southeast Asia, in the present study we follow the *Romer*'s (1994) approach.

3.1 Consumer preferences for variety

According to the *Dixit-Stiglitz* preferences given in equation (1), consumer utility is increasing in the amount of each good consumed and the number of consumed manufacturing goods.[17] Hence, the sub-utility derived from the consumption of manufacturing good x_i can be expressed as:

$$U_{gt} = \left(\sum_{i \in I_{gt}} d_{git}^{\frac{1}{\sigma_g}} x_{git}^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}} \tag{16}$$

where I_g is the set of varieties of good, g, available to consumers at time t and the varieties, i, of good g, are identified with their country of origin and $\sigma_g > 1$ is the elasticity of substitution between varieties of good g. Assume that the quantities, $\mathbf{x}_{gt}$, are optimally chosen to minimise $\sum_{i \in I_g} p_{git} x_{git}$ subject to achieving $f(\mathbf{x}_{gt}, \mathbf{d}_{gt}) = 1$. The solution to this minimisation problem yields the corresponding minimum unit cost function:

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.

[16] 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.

[17] In order to emphasise the role of varieties, in this section we make several adjustments in the notation. First, we consider a more general case with i varieties and g horizontally differentiated manufacturing goods. Second, 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. Third, given that all variables refer to a single country (in the case of imports destination d), in this section we drop the flow subscripts o and d. Instead, we introduce a time reference, t.

$$c_{gt}\left(\mathbf{p}_{gt},\mathbf{d}_{gt}\right)=\left(\sum_{i\in I_{gt}}d_{git}p_{git}^{1-\sigma_g}\right)^{\frac{1}{1-\sigma_g}} \tag{17}$$

where p_{git} is price, x_{git} is quantity and d_{git} is taste or quality parameter for good g's variety i.[18] According to equation (17) the minimum unit cost is decreasing in the number of consumed varieties, in the tastes for particular variety. The unit cost is increasing in price, p_{gi}, and elasticity of substitution, σ_g, between varieties of good g.

Differentiating (17) provides the expenditure shares, s_{git}, implied by the taste parameters $\mathbf{d}_{gt}$:

$$\begin{aligned} s_{git} &= \partial \ln c\left(\mathbf{p}_{gt},\mathbf{d}_{gt}\right)/\partial \ln p_{git} \\ &= c\left(\mathbf{p}_{gt},\mathbf{d}_{gt}\right)^{1-\sigma_g} d_{git}p_{git}^{1-\sigma_g} \end{aligned} \tag{18}$$

3.2 The exact price index

Assume that there are two periods, $t-1$ (before trade liberalisation) and t (after trade liberalisation), and assume that the quantity vectors $\mathbf{x}_{gt}$ and $\mathbf{x}_{gt-1}$ are the cost-minimising bundles of good g's varieties given the prices of all varieties, $\mathbf{p}_{gt}$ and $\mathbf{p}_{gt-1}$. As usual, we define the cost-of-living price index, CPI_g, as the ratio of minimum unit costs of two periods:

$$CPI_g\left(\mathbf{p}_{gt},\mathbf{p}_{gt-1},\mathbf{x}_{gt},\mathbf{x}_{gt-1}\right)=\frac{c_{gt}\left(\mathbf{p}_{gt},\mathbf{d}_{gt}\right)}{c_{gt-1}\left(\mathbf{p}_{gt-1},\mathbf{d}_{gt}\right)} \tag{19}$$

The economic approach to index numbers (e.g. *Diewert* 1976) shows that certain cost-of-living price indexes, known as *exact* indexes, equal the ratio of expenditures needed to obtain a fixed level of utility at two different prices. More precisely, *Diewert* (1976) defines a price index formula whose weights are functions of the expenditure shares s_{git-1} and s_{git} as *exact*, if it equals the ratio of unit costs.[19]

For the CES unit cost function with constant tastes, $d_{git}=d_{git-1}=d_{gi}$, and constant set of available product varieties available in both periods, $I_{gt}=I_{gt-1}=I_g$, 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_{git}:

$$\prod_{i\in I_g}\left(\frac{p_{git}}{p_{git-1}}\right)^{w_{git}}=\frac{c_{gt}\left(\mathbf{p}_{gt},\mathbf{d}_{gt}\right)}{c_{gt-1}\left(\mathbf{p}_{gt-1},\mathbf{d}_{gt}\right)} \tag{20}$$

[18] The underlying concept is similar to *Armington* (1969), with the key difference that instead of goods, here varieties are differentiated by their country of origin.

[19] The cost-of-living price index is called *exact*, because the cost-of-living price index, CPI_g, exactly matches changes in the minimum unit-costs, c_g.

where the ideal log-change weights, w_{git}, are defined as:[20]

$$w_{git} = \left(\frac{s_{git} - s_{git-1}}{\ln s_{git} - \ln s_{git-1}} \right) / \sum_{i \in I_g} \left(\frac{s_{git} - s_{git-1}}{\ln s_{git} - \ln s_{git-1}} \right) \tag{21}$$

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

$$s_{git} = \frac{p_{git} x_{git}}{\sum_{i \in I_g} p_{git} x_{git}} \tag{22}$$

An important assumption of the *exact* price index in (20) is that it requires that all varieties are available in both periods, i.e., the set of available varieties does not change. However, if e.g. trade liberalisation changes the set of traded goods, neglecting the emergence of new varieties (the disappearance of old), can significantly overestimate (underestimate) the true price index.

3.3 Trade liberalisation and variety growth

Following *Krugman* (1980), most of the monopolistic competition models assume that consumer preferences are symmetric, i.e. $d_{gi} = 1 \forall i \in I_g$.[21] This implies that all varieties i of good g are equally priced at p_g. In the case of a symmetric CES the minimum unit cost function (17) simplifies to

$$c_{gt}^K (I_{gt}) = N_{gt}^{\frac{1}{1-\sigma_g}} p_{gt} \tag{23}$$

$$c_{gt}^K (I_{gt}) = p_{gt} N_{gt}^{\frac{1}{1-\sigma_g}} \tag{24}$$

The minimum unit cost function in (23) implies that for a given p_{gt}, an increase in the number of locally available varieties, N_{gt}, e.g. through more sources of imports, reduces the minimum cost, c_{gt}^K, required to achieve a given level of utility. Alternatively, a raise in variety increases utility that can be achieved at cost, c_{gt}^K. Note that in the underlying trade model from section 2 N_{gt} is equal to the last term on the right hand side in equations (14) and (15).

Analogously to (19), the ratio of minimum unit costs can be measured by the cost-of-living price index, CPI_g^K:

$$CPI_g^K (\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g) = \frac{c_{gt}^K (I_{gt})}{c_{gt-1}^K (I_{gt-1})} \tag{25}$$

[20]According to *Sato* (1976) and *Vartia* (1976), w_{git} captures 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.

[21]See Appendix 8.1 for the case of asymmetric CES preferences.

Substituting equation (23) into (25) we obtain the CES price index as a price ratio of p in both periods:

$$CPI_g^K\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g\right) = \frac{p_{gt}}{p_{gt-1}} \tag{26}$$

Given that all suppliers are symmetric, all varieties have the same price and there is no need for weights. As above, this *Krugman*-type price index in (26) 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. Hence, the canonical *Krugman*'s (1980) model predicts that a decrease in tariffs will not change the number of available varieties although consumers will gain from the falling prices of imported varieties.[22]

Romer (1994) presents a simple extension of the canonical *Krugman*'s model to allow for fixed costs of accessing foreign markets so that the number of available varieties rises with declining tariffs. According to *Romer*, in order to account for variety growth, the conventional exact price index, CPI_g^K, needs to be multiplied by the ratio of available varieties in the two periods:

$$P_g^R\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g\right) = CPI_g^K\left(\frac{N_{gt}}{N_{gt-1}}\right)^{\frac{1}{\sigma_g-1}} \tag{27}$$

$$P_g^R\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g\right) = \frac{p_{gt}}{p_{gt-1}}\left(\frac{N_{gt}}{N_{gt-1}}\right)^{\frac{1}{\sigma_g-1}} \tag{28}$$

As in *Krugman* (1980), all varieties of the same good are symmetric (the same price and quantity) also in (27), implying that the extensive import margin equals the number of varieties imported. An increase in the number of varieties, N_{gt}, in period t compared to the number of varieties, N_{gt-1}, available in period $t-1$ leads directly to a fall in the exact price index, P_g^R, relative to the conventional price index, CPI_g^K. In other words, increasing the number of varieties (source countries), N_g, for good g will lower the ratio of old to new varieties, N_{gt-1}/N_{gt}, and hence the price index, P_g^R.

The downside of the *Romer*'s (1994) approach is that price index in (27) can yield substantial bias (which are different from 20). For example, if new varieties represent only a small share of the total expenditure in a good, then a simple count of varieties will grossly overestimate the true impact of new varieties.

3.4 Welfare gains from variety growth

The introduction of new goods in the market increases consumer 'standard of living' and therefore should reduce the cost of maintaining a consumer's well-being. Thus,

[22] 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.

an increase in the variety of goods available for consumption reduces the value of a cost-of-living price index. In this section we outline the conceptual framework, which will be used for calculating the gains from variety from the cost-of-living price index that takes variety growth into account (which we derived in the previous sections). Comparing equation (27) to a conventional cost-of-living price index, we note that in addition to expenditure ratios in the two periods, equation (27) contains an additional term on the RHS, $(N_{gt}/N_{gt-1})^{\frac{1}{\sigma_g-1}}$, which is an inverse measure of product variety and is defined as follows:

$$
\begin{aligned}
N_{gt} &= \frac{\sum_{i\in I_g} p_{git}x_{git}}{\sum_{i\in I_{gt}} p_{git}x_{git}} = 1 - \frac{\sum_{i\in I_{gt}, i\notin I} p_{git}x_{git}}{\sum_{i\in I_{gt}} p_{git}x_{git}} \\
N_{gt-1} &= \frac{\sum_{i\in I_g} p_{git-1}x_{git-1}}{\sum_{i\in I_{gt-1}} p_{git-1}x_{git-1}} = 1 - \frac{\sum_{i\in I_{gt-1}, i\notin I} p_{git-1}x_{git-1}}{\sum_{i\in I_{gt-1}} p_{git-1}x_{git-1}}
\end{aligned}
$$

Feenstra (1994) has mapped out that the bias term is proportional to variety growth between the two periods and hence can be used to calculated welfare gains from variety growth:

$$\triangle W = m_{gt}\left(\frac{N_{gt}}{N_{gt-1}}\right)^{\frac{1}{\sigma_g-1}} \tag{29}$$

In the case of variety growth through trade liberalisation m_{gt} is import share in GDP. According to equation (29), welfare gains from variety growth depend on four variables: import share in GDP, m_{gt}, 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_{gt} and N_{gt-1}, and the elasticity of substitution between varieties, σ_g.

Equation (29) states that the gains from variety growth are increasing in the import share in GDP 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 imported, the larger is consumer choice and the bigger are welfare gains from variety. On the other hand, gains from variety are decreasing in the elasticity of substitution between varieties. If varieties of a particular good are perfectly substitutable, then having two varieties of that good will have no impact on welfare. For example, most consumers care about the price and grade of their fuel, but not which oil field it came from.

4 Simulating trade liberalisation in Asia

4.1 Base run

In order to simulate the trade liberalisation in Asia, we employ the theoretical trade model presented in section 2, which allows us to derive closed form solutions for the total export volume, and the intensive and extensive margins of trade. Collecting terms in equation (15), the aggregate exports from o to d can be expressed as:

$$E_{od} = \alpha \frac{L_o L_d}{L} \left(\frac{\hat{\theta}_d}{\tau_{od}} \right)^{\hat{\gamma}} FC_{od}^{1-\frac{\hat{\gamma}}{\hat{\sigma}-1}} \tag{30}$$

The extensive margin of trade, N_{od}, can be derived from equation (10):

$$N_{od} = \frac{\hat{\gamma} - (\hat{\sigma} - 1)}{\hat{\gamma}\hat{\sigma}} \alpha \frac{L_o L_d}{L} \left(\frac{\hat{\theta}_d}{\tau_{od}} \right)^{\hat{\gamma}} FC_{od}^{-\frac{\hat{\gamma}}{\hat{\sigma}-1}} \tag{31}$$

Similarly, the intensive margin of trade, $\tilde{e}_{od}$, can be derived from equation (13):

$$\tilde{e}_{od} = \frac{\hat{\gamma}\hat{\sigma}}{\hat{\gamma} - (\hat{\sigma} - 1)} FC_{od} \tag{32}$$

The three trade equations (30, 31 and 32) will be used for simulating the impacts of trade liberalisation in Asia and for decomposing the aggregate trade growth.

The obtained results from the three trade equations can be further used to calculate welfare gains from variety, which in our model is equal to the number of firms, N, serving the particular market. According to equation (29), welfare gains from variety growth can be calculated as follows:

$$\triangle W = E_{odt} \left(\frac{N_{odt}}{N_{odt-1}} \right)^{\frac{1}{\sigma-1}} \tag{33}$$

In order to perform numerical simulations, all right hand side variables in equations (30) - (33) - the total labour force, L, labour force by country, L_o - are assigned numerical base year (2004) values.[23] As above, labour force and expenditure share of traded manufactured goods are drawn from the GTAP v7 data base.

The underlying structural parameters are estimated econometrically (*Kancs* 2009). Table 1 reports estimates of the two key parameters - the elasticity of substitution, σ_o, and firm heterogeneity, γ_o. According to Table 1, on average, the magnitude of the elasticity of substitution, σ_o, is 4.501. The highest elasticity of substitution is estimated for Asean (4.531), the lowest for Australia (4.459). The average magnitude of firm competition, γ_o, which is inversely related to firm heterogeneity, is 5.936.

[23] Note that, in contrast to parameter estimation in section 4, the calibration of the model requires only one cross section - the base year.

Countries with lower γ are more heterogeneous, in the sense that more output is concentrated among the largest and most productive firms. Hence, according to Table 1, firm heterogeneity measured by their productivity is the highest in Japan and Korea (5.153 and 5.234, respectively). In contrast, firms are the most homogenous in Australia and New Zealand, where the estimates of γ are 6.928 and 6.396, respectively.

Table 1: Structural parameter estimates

	Asean	Austr	China	India	Japan	Korea	New Z
γ_o	$5.902^{\dagger\dagger\dagger}$	$6.928^{\dagger\dagger\dagger}$	$6.063^{\dagger\dagger\dagger}$	$5.880^{\dagger\dagger\dagger}$	$5.153^{\dagger\dagger\dagger}$	$5.234^{\dagger\dagger\dagger}$	$6.396^{\dagger\dagger}$
	(0.367)	(0.423)	(0.274)	(0.843)	(0.482)	(0.485)	(1.076)
σ_o	$4.531^{\dagger\dagger\dagger}$	$4.459^{\dagger\dagger}$	$4.508^{\dagger\dagger\dagger}$	$4.503^{\dagger\dagger\dagger}$	$4.531^{\dagger\dagger\dagger}$	$4.499^{\dagger\dagger\dagger}$	$4.479^{\dagger\dagger}$
	(0.422)	(0.664)	(0.121)	(0.807)	(0.228)	(0.448)	(1.341)

Source: Kancs (2009). Notes: White-corrected standard errors are in parenthesis. *significant at 10% level, **significant at 5% level, and ***significant at 1% level.

Comparing these estimating to literature we note that there is a wide variation in the estimated elasticities in the literature, where they range from 0.02 - 1.22 (*Ronald-Holst et al.* 1992), 3.41 (*Davis* 1993), 0.52 - 4.83 (*Gallaway et al* 2000) to Armington elasticities of substitution employed in CGE models of trade (6.0 - 12.0). Hence, the magnitude of the estimated elasticities of substitution is between the estimated industry-level elasticities of substitution and the calibrated Armington elasticities of substitution. These differences are due to different specification of the gravity model and due to the fact that we estimate firm level trade. Given that *Kancs* (2009) does not estimate the elasticities by sector, the cross-country variation is lower than in the literature.

Solving the system of four equations (30) - (33) numerically yields predicted aggregate trade flows for the base run: the extensive margin and intensive margins of trade, and welfare gains from variety, E_{od}^{br}, N_{od}^{br}, $\tilde{e}_{od}^{br}$, W_{d}^{br}. The obtained base run values are reported in Tables 2 and 3. Table 2 reports the bilateral trade flows, domestic sales and imports in value terms (Billion Dollars), which are obtained from equation (30). First column reports exporting countries, first row - importing countries. For example, the number 0.3 in second row, third column means that in the base year Asean exported 0.3 Billion Dollar worth goods to Australia. Diagonal elements report exports/imports to domestic markets (local sales). Off-diagonal elements report exports/imports with other Asian countries. Note that in the model we do not impose bilateral trade balance. We only impose income (gross trade) balance, according to which total sales (domestic sales + exports) must be equal to total consumption (domestic demand + imports).

Comparing the predicted trade flows, E_{od}^{br}, with the observed trade flows, E_{od}^{dat},

Table 2: Predicted base run trade flows for Asia-7, Billion Dollars

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Asean	198.2	0.3	20.3	21.3	2.1	0.5	0.0	242.7
Australia	0.3	0.3	0.1	0.0	0.1	0.0	0.0	0.8
China	20.5	0.1	230.8	43.9	43.4	16.4	0.0	355.2
India	22.3	0.1	40.5	367.0	3.3	0.8	0.0	433.9
Japan	1.3	0.0	45.7	1.5	110.8	1.6	0.0	160.9
Korea	0.1	0.0	17.8	0.2	1.2	7.9	0.0	27.3
New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total trade	242.7	0.8	355.2	433.9	160.9	27.3	0.0	1220.9
Domestic	198.2	0.3	230.8	367.0	110.8	7.9	0.0	915.1
Imports	44.5	0.5	124.4	66.9	50.1	19.4	0.0	305.8

Notes: Simulated trade flows based on equations (30) - (33), estimated parameters and GTAP v7 macro data. For model assumptions see section 2. Total = total demand (column sum), Local = domestic demand for domestically produced goods (diagonal elements), Imports are domestically consumed foreign goods (off-diagonal elements).

we note that: (i) the predicted trade pattern does not match the observed trade exactly;[24] (ii) on average, the estimated trade flows are slightly lower than those observed for 2004 in the data; and (iii) the overall model's performance is very good. The slight downward bias of predicted trade flows is not sizeable (on average 3.4%). Nevertheless, it has implications for interpreting the simulation results. Given that the simulation model tend to underestimate trade flows, trade may also be under-predicted in the trade liberalisation scenarios.

The only country, where the simulation model's performance is rather weak, is New Zealand (column 8, row 8 in Table 2). The weak model's performance for New Zealand can be explained by the fact that, New Zealand is far away from all Asian trading partners (except for Australia) and, in terms of labour force and GDP, it is very small compared to 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 offset the trade cost effect. As a result, the predicted trade values reported in column 8 and row 8 of Table 2 are close to zero, i.e. they are very small. Similar trade patterns are also predicted in the trade liberalisation scenarios, which not always can be interpreted in an economically meaningful way. Although, it would be more than

[24] There are several reasons why the predicted trade flows do not match exactly the observed in the data: parameter estimation error (due to high level of aggregation and the imposed restrictions), market imperfections, differences between model's assumptions and Asian economies, trade balance, which was not in equilibrium in the base year, omitted variable bias (in reality foreign trade is driven by many more variables than those included in the model), etc. In order to ensure that the predicted trade matches exactly the observed trade one could, for example, calibrate one or more parameters (instead of estimating), as is usually done in CGE models.

Table 3: Predicted base run trade flows for Asia-7, trade structure

	Asean	Austr	China	India	Japan	Korea	New Z	Asia-7
Domestic trade and import shares, %								
Total trade	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Domestic	81.7	41.3	65.0	84.6	68.9	29.0	0.0	75.0
Imports	18.3	58.7	35.0	15.4	31.1	71.0	100.0	25.0
Extensive margin, %								
Total trade	40.3	10.2	38.0	33.2	46.9	25.7	0.3	37.6
Domestic	47.8	20.2	55.0	37.9	63.2	57.1	0.0	47.6
Imports	7.0	3.2	6.5	7.2	11.1	12.8	0.3	7.9
Intensive margin, %								
Total trade	59.7	89.8	62.0	66.8	53.1	74.3	99.7	62.4
Domestic	52.2	79.8	45.0	62.1	36.8	42.9	100.0	52.4
Imports	93.0	96.8	93.5	92.8	88.9	87.2	99.7	92.1

Notes: Simulated trade flows based on equations (30) - (33), estimated parameters and GTAP v7 macro data. For model assumptions see section 2. E = total sales, N = extensive margin (number of firms), e = intensive margin (average exports per firm), W gains = welfare gains from variety, Total = total demand, Local = domestic demand for domestically produced goods, Imports are domestically consumed foreign goods.

naturally to exclude New Zealand from simulations, we leave it in the sample to clearly show the limitations of our model.

Table 3 breaks down the results reported in Table 2 by the extensive margin, N, the intensive margin, e, and sources of variety gains, W. These base run, br, values reported in Tables 2 and 3 will be used as a counterfactual in the following comparative static analysis of trade integration in Asia.

4.2 Simulation results: trade integration in Asia

We simulate three trade liberalisation scenarios: Free Trade Area between China and India (CIFTA), ASEAN Free Trade Area with China, Japan and Korea (ASEAN+3), ASEAN Free Trade Area with Australia, China, India, Japan, Korea and New Zealand (ASEAN+6).[25] A summary of the three trade integration scenarios in Asia and the involved trading partners is provided in Table 4.

In order to simulate the trade integration in Asia, we reduce the bilateral trade costs. Given that the underlying trade model distinguishes between two types of trade costs (variable and fixed), the empirical implementation of trade liberalisation scenarios is considerably complicated. Not only bilateral country-pair specific magni-

[25] 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.

Table 4: Summary of FTA scenarios in Asia

	CIFTA			ASEAN+3			ASEAN+6		
	$\triangle\tau_{od}$	$\triangle F_{od}$	$\triangle\phi_{od}$	$\triangle\tau_{od}$	$\triangle F_{od}$	$\triangle\phi_{od}$	$\triangle\tau_{od}$	$\triangle F_{od}$	$\triangle\phi_{od}$
Asean				+	+	+	+	+	+
Australia							+	+	+
China	+	+	+	+	+	+	+	+	+
India	+	+	+				+	+	+
Japan				+	+	+	+	+	+
Korea				+	+	+	+	+	+
New Zealand							+	+	+

Source: Authors' compilation based on Kawai and Wignaraja 2007; *ARIC* (2009) data base on FTAs in Asia. $\triangle\tau_{od}$ = variable trade cost reduction, $\triangle F_{od}$ = fixed trade cost reduction, $\triangle\phi_{od}$ = variable and fixed trade cost reduction.

tudes of trade cost reductions are required, but also values of variable and fixed trade cost reductions. Unfortunately, such data are not available for Asia.[26] Therefore, we simulate trade integration in Asia by hypothetically reducing variable trade costs, fixed trade costs and both fixed and variable trade costs in 5% steps up to 15%, which according to *ARIC* (2009) is the lower bond of FTA potential among Asia-7.

After the trade cost reduction to their post-integration values, we solve the model anew for the fta equilibrium. As a result, we obtain a set of fta equilibrium values for N_{od}^{fta}, $\tilde{e}_{od}^{fta}$ and E_{od}^{fta}. Subtracting these fta equilibrium values from the simulated base run, br, values yields the aggregate trade growth, $\triangle E_{od}$, trade growth along the extensive margin, $\triangle N_{od}$, trade growth along the intensive margin of trade, $\triangle\tilde{e}_{od}$, and welfare gains/losses from increasing/decreasing variety, $\triangle W_d$. The simulation results of trade integration in Asia are reported in Tables 5 - 13.

We start with CIFTA, which is simulated as a reduction in bilateral trade costs between China and India. Table 5 reports the results of variable trade cost reduction, CIFTA-$\triangle\tau_{od}$, Table 6 reports results of fixed trade cost reduction, CIFTA-$\triangle F_{od}$, and Table 7 reports results of both variable and fixed trade cost reduction, CIFTA-$\triangle\phi_{od}$. According to Tables 5 - 7, bilateral trade cost reduction between China and India increases bilateral trade (trade creation) in all three scenarios (5.67% and 12.49% under CIFTA-$\triangle\tau_{od}$, 1.40% and 2.62% under CIFTA-$\triangle F_{od}$, and 4.99% and 13.01% under CIFTA-$\triangle\phi_{od}$). Depending on the initial trade costs, market structure and product substitutability, trade flows either increase or decrease (trade diversion) in the five excluded Asian economies. The number of operating firms, and hence product

[26] 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 reductions, it does not cover changes in all trade barriers.

Table 5: Simulated CIFTA trade flows with reduced variable trade costs, percentage changes from the base run

CIFTA-$\triangle\tau_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

Table 6: Simulated CIFTA trade flows with reduced fixed trade costs, percentage changes from the base run

CIFTA-$\triangle F_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

varieties, decrease in CIFTA members, but in most cases increase in the non-CIFTA economies. This is due to the fact that opening markets also increases competition. Higher competition reduces prices and firm profits, which drives the least profitable firms out of the market. This effect is particularly sizeable in China, where the number of firms decrease by -23.10% and -20.32% in CIFTA-$\triangle\tau_{od}$ and CIFTA-$\triangle\phi_{od}$ scenarios, respectively. The total variety gains for Asia-7 are positive in all three scenarios (+0.96%, 0.64% and +1.54%). However, because of increased competition and less firms, they are not always positive for the two integrating economies. More precisely, under CIFTA-$\triangle\tau_{od}$ and CIFTA-$\triangle\phi_{od}$ variety gains from trade integration are negative.

Second, we consider simulation results for ASEAN+3, which are reported in Tables 8 - 10. Similarly to CIFTA, the aggregate trade and variety effects of trade integration between Asean, China, Japan and Korea are moderate - up to 5% of their benchmark values. The aggregate results, however, mask a great deal of variation

Table 7: Simulated CIFTA trade flows with reduced variable and fixed trade costs, percentage changes from the base run

CIFTA-$\triangle\phi_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

Table 8: Simulated ASEAN+3 trade flows with reduced variable trade costs, percentage changes from the base run

ASEAN+3-$\triangle\tau_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

between countries. Similarly to CIFTA, the results reported in Tables 8 - 10 suggest that in terms of the traded volume, ASEAN+3 is beneficial for all block members but Korea. Hence, the integration's impact on traded volume and variety has the opposite sign in Korea under both CIFTA and ASEAN+3 scenarios. Abstracting from New Zealand (see section 4.1), the excluded countries Australia and India loose under all three ASEAN+3 scenarios both in terms of market shares and available variety of goods. A further qualitative difference between CIFTA and ASEAN+3 is that whereas trade integration yields welfare gains in all three CIFTA scenarios, trade integration reduces variety gains under under ASEAN+3-$\triangle\tau_{od}$ and ASEAN+3-$\triangle\phi_{od}$. As explained above, opening markets 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 (scenarios ASEAN+3-$\triangle F_{od}$ and ASEAN+3-$\triangle\phi_{od}$). However, given that Korea looses its market share in output and production, this does not lead to variety gains.

Table 9: Simulated ASEAN+3 trade flows with reduced fixed trade costs, percentage changes from the base run

ASEAN+3-$\triangle F_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

Table 10: Simulated ASEAN+3 trade flows with reduced variable and fixed trade costs, percentage changes from the base run

ASEAN+3-$\triangle \phi_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

Finally, in Tables 11 - 13 we report effects of multilateral trade liberalisation in Asia-7. Compared to CIFTA and ASEAN+3, the most striking difference seems to be in the magnitude of changes in trade volume and variety. The results reported in the last column in Tables 11 - 13 suggest that, depending on the type of trade cost reduction, ASEAN+6 would increase the volume and variety of trade by 6.52%-33.93% and 4.89%-8.84%, respectively. These effects are considerably larger than under CIFTA and ASEAN+3 (see Tables 5 - 10). Five out of the seven integrating economies in Asia benefit significantly from trade liberalisation both in terms of the traded volume and variety. Under all three ASEAN+6 scenarios the largest winners are India and Asean, where traded volume and variety increase by 8.05%-41.23% and 6.64%-40.65%, respectively. The simulation results do not support the hypothesis that trade integration in Asia would yield particularly high welfare gains from variety in China. The results for Korea are small and ambiguous - depending on which trade costs are reduced - it may either slightly gain or slightly loose from ASEAN+6.

Table 11: Simulated ASEAN+6 trade flows with reduced variable trade costs, percentage changes from the base run

ASEAN+6-$\triangle\tau_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

Table 12: Simulated ASEAN+6 trade flows with reduced fixed trade costs, percentage changes from the base run

ASEAN+6-$\triangle F_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

As noted above, model predictions for New Zealand cannot be interpreted in an economically meaningful way.

The presented simulation results allow us to draw several conclusions about the underlying heterogenous firm framework. First, variable trade cost reduction has considerably larger impact on trade growth than fixed trade cost reduction. This is due to differences in the elasticities with respect to fixed and variable trade costs. The elasticity of variable trade costs, γ, is larger than the elasticity of fixed trade costs, $1-\gamma/(\sigma-1)$. Although, there is a sizeable variation between countries and trade integration scenarios, on average, trade growth due to reductions in variable trade costs is 4-5 times larger than due to fixed trade cost reduction.

Second, the elasticity of substitution has opposite effects on intensive and extensive 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. The reason is the following. When trade barriers decrease, new and less productive

Table 13: Simulated ASEAN+6 trade flows with reduced variable and fixed trade costs, percentage changes from the base run

ASEAN+6-$\triangle\phi_{od}$	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 (30) - (33), estimated parameters from ORIANA firm-level micro data and GTAP v7 macro data for 2004. For model assumptions see section 2. Total trade = domestic demand for domestically produced goods plus imports, Extensive margin = number of domestic and foreign firms serving the local market, Variety gains = welfare gains from variety growth.

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. The new entrants capture a large market share. This effect is best seen for Korea and is in line with *Ruhl* 2003.

Third, compared to previous literature relying on trade models with representative firms, our model with heterogeneous firms predicts that the same trade barriers will have a larger impact on trade flows than in the model with representative firms (*Ballard* and *Cheong* 1997, *Roland-Holst et al* 2003, *Roland-Holst*, *Verbiest* and *Zhai* 2008). In addition to the adjustment of the intensive margin of trade described in existing models, there are important adjustments of the extensive margin. When trade barriers decrease, each firm exports more. In addition, new firms start exporting.

5 Conclusions

The present paper studies variety gains from trade integration in Asia. Our analysis complements the previous research on trade integration in Asia in the presence of firm/product heterogeneity (*Feenstra* and *Kee* 2007, *Zhai* 2008). The present study extends previous research along three dimensions. First, in addition to conventional studies of gains from specialisation, we also account for gains/losses arising from increased/decreased number of different varieties. Second, we show that, depending on market structure and the substitutability of different varieties, the sources and size of variety gains are different between variable and fixed trade cost reduction. Third, we use a unique set of firm-level panel data (ORIANA) provided by *Bureau van Dijk* to estimate the underlying trade model's structural parameters econometrically.

Applying a heterogenous firm model à la *Kancs* (2007) and *Chaney* (2008), we simulate trade integration in Asia in three different scenarios, in each of which we reduce variable trade costs, fixed trade cost, and fixed and variable trade costs. Our simulation results suggest that the multilateral trade liberalisation (ASEAN+6) would increase the volume and variety of trade by 6.52%-33.93% and 4.89%-8.84%, respectively. The largest winners from multilateral trade liberalisation in Asia-7 are India and Asean, where traded volume and variety increase by 8.05%-41.23% and 6.64%-40.65%, respectively. The simulation results do not support the hypothesis that trade integration in Asia would yield particularly high welfare gains from variety in China. The impact of regional trade integration scenarios (CIFTA and ASEAN+3) is considerably smaller in Asia-7. Both under CIFTA and ASEAN+3, the aggregate trade and variety effects of trade integration for Asia-7 are moderate - up to 5% of their benchmark values. Generally, variable trade cost reduction has considerably larger impact on trade growth than fixed trade cost reduction, because the elasticity of variable trade costs is larger than the elasticity of fixed trade costs. Although, there is a sizeable variation between countries and trade integration scenarios, on average, trade growth due to reductions in variable trade costs is 4-5 times larger than due to fixed trade cost reduction.

Compared to previous literature, relying on trade models with representative firms, our model with heterogeneous firms predicts that the same trade barriers will have a larger impact on trade flows than in the model with representative firms (*Ballard* and *Cheong* 1997, *Roland-Holst et al* 2003, *Roland-Holst*, *Verbiest* and *Zhai* 2008). In addition to the adjustment of the intensive margin of trade described in existing models, there are important adjustments of the extensive margin. When trade barriers decrease, each firm exports more. In addition, new firms start exporting.

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