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GAINS FROM TRADE IN NEW TRADE MODELS

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ABSTRACT

The pioneering work of Ricardo (1817) based on inter-industry comparative advantage provided the simplest setting to explain welfare gains from trade. However new trade theory focused on intra-industry trade in differentiated goods. The objective of this research paper is to survey recent body of theoretical work that aims to study trade gains in new trade models. Since there is vast amount of literature on international trade, for purposes of this literature survey, the focus will be on Ricardo, Armington and Melitz models. These models feature one factor of production, complete specialization, iceberg trade costs, a CES import demand system, and a gravity equation. Within these class of models, under either perfect competition (Ricardo and Armington) or monopolistic competition (Melitz), a recent paper by Arkolakis et al (2012) commonly referred to as ACRC, shows that new trade models yield the same gains as old trade models, the authors identify two important statistics in the measurement of trade gains (i) trade elasticity and (ii) share of spending on domestically produced goods. ACRC shows that so far there are no additional gains in new trade models as compared to the old trade models. However , ACRC has come under scrutiny and serious criticisms in recent international trade literature. Among contrasting thoughts, is that different models have different elasticities hence different gains, consequently ACRC framework may under estimate trade gains.

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1. INTRODUCTION

The pioneering work of Samuelson (1939) showed that there are gains from trade, consequently one of the most fundamental questions in economics is how best to measure these gains. The workhorse empirical tool to measure the welfare gains in international trade is the empirical gravity model of trade. There is a wide variety of theoretical models that provide the foundation for the gravity model and interpret the empirical patterns of bilateral trade. These theoretical models have many different motivations for trade, but recent work by Arkolakis, Costinot, and Rodriguez-Clare (2012) commoly denoted as ACRC, has shown that a broad class of quantitative trade models have equivalent implications for the welfare gains from trade which they derive via a single trade elasticity (taken to be 5 on average). The ACRC argue that new trade models yield the same welfare gains as in old trade models.

Under perfect competition, opening up to trade expands the production possibilities frontier and leads to pareto superior outcomes. Adam Smith (1776) explicated the causal role of international trade in determining the wealth of nations and Ricardo (1817) takes cross-country technology differences as the basis of trade and provided a detailed analysis of the principle of comparative advantage. Traditional models of trade, such as those based on Ricardo and Heckscher-Ohlin, focus on gains from specialization by comparative advantage. These gains are often referred to as the *static* gains from trade, in the sense that they are a one-off effect in improved efficiency.

Early attempts at understanding gains from trade focused on identifying aggregate relationships through cross-country econometric analysis. For example, Sachs and Warner (1995) argued that open economies tend to experience higher growth rates than closed economies. Harrison (1996) found a positive relationship between growth and a variety of trade openness measures.

More recent literature on gains from trade takes a different approach rather than broad-based measures of GDP and economic openness (focusing on firm and sector dynamics). On the theory side, the heterogeneous firms models of Melitz (2003) and Chaney (2008) provide a rigorous basis for the existence of a link between international trade and within-sector productivity gains: as less productive firms exit the market due to stronger competition from imports, resources shift to more productive firms which can then produce and sell more. The net result is an increase in average sectoral productivity.

1.1. Research Question

How large are the welfare gains from international trade and how has the development of new trade models changed our understanding of gains from trade?

To address this question, I will provide an overview of gains from trade in old trade models followed by an analysis of trade gains in new trade models.

This literature survey is arranged as follows; Section 2 discusses the gains from trade in old trade models, the discussion is limited to Ricardian and Heckscher Ohlin Models of trade. Section 3 provides an overview of gains in new trade models with particular reference to Krugman (1980) and Melitz (2003) trade models. Section 4 provides an analytical investigation of gains in 3 gravity models of trade to show that they are the same. In this section the general assumptions, macro-level restrictions are discussed. Moreover, this section entails a discussion of the impact of sectoral heterogeneity and different elasticities on trade gains. Section 5 is an exposition of emperics of trade gains. Finally, section 6 provides a conclusion which summarises key findings of this literature survey.

2. GAINS FROM TRADE IN OLD TRADE MODELS

Traditional international trade theory has concerned itself with these central questions: What determines the pattern of trade? What are the sources of gains from trade? The first set of questions leads to the notion that the pattern of trade is based on comparative advantage. The second set of questions is addressed by the result that there are always gains from trade, and both countries will gain from trade provided the relative price under free trade differs from both country's relative prices under autarky.

The gains and patterns of free trade in the old trade are based on comparative advantage :

- **The gains based on comparative advantage and specialization**

  Scarce resources are used in the production of the commodity for which countries have comparative advantage. Trade allows countries to specialize in the production of the goods for which they have a comparative advantage and import the goods that they produce relatively less efficient, i.e, goods for which they do not have comparative advantage. The exchange of these goods benefits both countries.

  When barriers to trade are eliminated, firms will face the demand of a larger market. Therefore, firms will be able to choose to produce at a more efficient level of production, and export commodities with which they have comparative advantage. To further explore the gains and patterns of trade in old trade models, this section will investigate specifically the Ricardian and Heckscher Ohlin(H-O) models of trade which are both based on the principle of comparative advantage. A full discussion of how comparative advantage arise in each model is provided in sections 2.1 and 2.2 for Ricardian model and H-O model respectively.

2.1. Technological Differences and Gains from trade

2.1.1. Ricardian Model

Ricardian trade theory takes cross-country technology differences as the basis of trade and it is often used to explore the principle of comparative advantage**.** Free trade leads each country to completely specialize in their comparative advantage good and leaves everybody better off. By definition, a country has a comparative advantage in the production of a commodity, if its relative productivity for the production of this commodity (relative to other commodities) is higher than for the other country.

The model assumes that there are two goods, two countries, home and foreign , one factor of production (labour) which is in fixed supply and immobile across countries, a Constant Returns to Scale(CRS) technology, homothetic Preferences: The form of the utility function does not depend on income. L_j units of labour produce one unit of a commodity $j \in \{C,T\}$ and labour is immobile across countries and mobile across sectors. As an example consider that home country (China) has comparative advantage over foreign country (Germany) in textile production(T) relative to cars (C) this implies that foreign country has comparative advantage over home country in cars relative to textiles: this is because the opportunity cost of producing a cars is lower in foreign than in home country.

If a country has comparative advantage in a commodity, that country has a lower opportunity cost of producing that commodity than the other country. The Ricardian model predicts that each country exports the good in which it has comparative advantage. In the example above, home country will export wine which is their comparative advantage good and foreign country will export cars. The knowledge of relative demand in the Ricardian model is instrumental in determining the exact volume of trade. Consider an example in the next page illustrating comparative advantage, trade gains and trade patterns in the Ricardian model.

- **Example and graphical illustration of the Ricardian discussion**

To illustrate the Ricardian result, consider table 1 of unit labour requirements for Germany and China.(these are hypothetical numbers for illustration)

Country	Textiles (T)	Cars (C)
Germany	4	2
China	2	4

Table 1: Unit labour requirements for Ricardian example

- 4 German workers needed to produce 1 unit of textile and 2 needed to produce a car. As a result, the opportunity cost of producing a car in Germany is the 0.5 of a textile that is forgone.
- 2 Chinese workers needed to produce one unit of textiles and 4 needed to produce a car. As a result , the opportunity cost of producing a car in China is the 2 textiles that are forgone.
- Since the opportunity cost of producing a car is lower in Germany than China, Germany has a comparative advantage in cars and China possesses a comparative advantage in textiles.

For argument sake let us rename Germany and China to be N(orth) and S(outh) respectively

- North (Germany) possess a comparative advantage in car production if and only if:

  $$\frac{a_C^N}{a_T^N} < \frac{a_C^S}{a_T^S}$$

  That is, $\frac{a_C^{Germany}}{a_T^{Germany}} = \frac{1}{2} < \frac{a_C^{China}}{a_T^{China}} = 2$

- The South will possess a comparative advantage in cars if and only if:

  $$\frac{a_C^N}{a_T^N} > \frac{a_C^S}{a_T^S}$$

- With only two goods, if a country possesses a comparative advantage in one good, the other country will possess the comparative advantage in the other good, therefore in the example, China has comparative advantage in Textiles.

- The North's Production Possibility Frontier (PPF) is as follows : $a_C^N Q_C^N + a_T^N Q_T^N \leq L^N$, where L^N is the amount of labour that the North possesses. A key insight is that in autarky, the PPF and the budget constraint will be the same line. In autarky, what you consume/purchase must be what you produce. With trade, you need not consume what you produce. Assuming full employment of all factors we get the expression: $Q_T^N = \frac{L^N}{a_T^N} - \frac{a_C^N}{a_T^N} Q_C^N$

- Since wages are considered to be the same in both sectors, i.e. $w = \frac{p_j}{a_j}$ for $j \in \{C,T\}$ we have the condition that: Autarky relative prices will be equal to the ratio of unit labour requirements in that country: $\frac{P_C}{P_T} = \frac{a_C}{a_T}$. Figure 1 below displays the PPF of North and the relative prices under autarky.

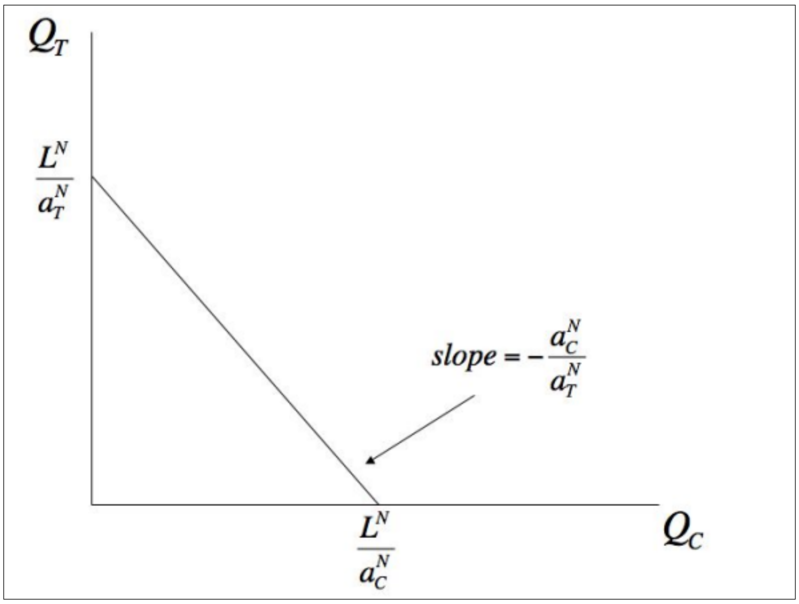


Figure 1: PPF of North and relative prices under autarky

Similarly following the same proceeding as above for the South, figure 2 displays the PPF and relative prices under autarky.

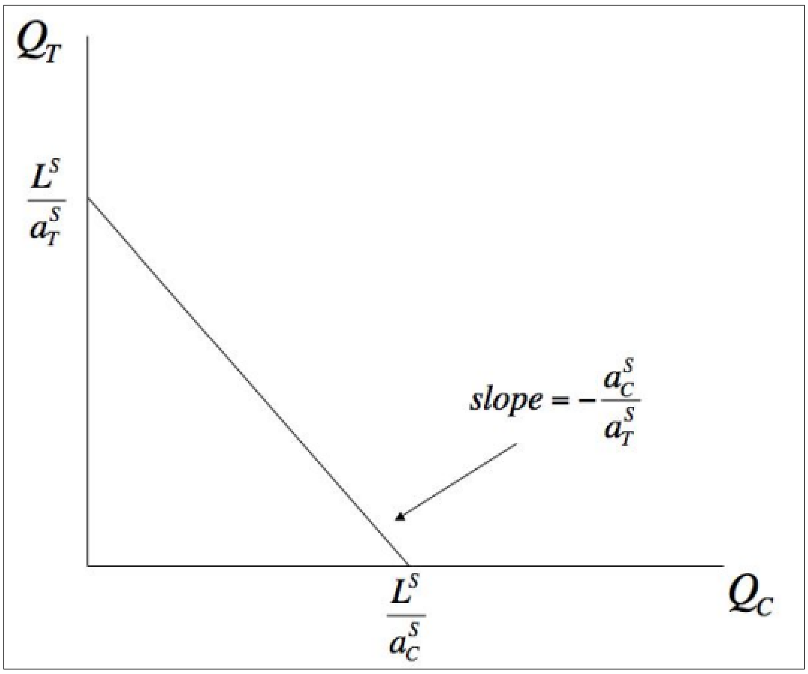


Figure 2: PPF of South and relative prices under autarky

- Now introducing trade, The PPF of both countries will look the same as before and will have a slopes of $-\frac{a_C^N}{a_T^N}$ and $-\frac{a_C^S}{a_T^S}$ for North and South respectively.

- The budget constraint will now be based on the equation $P_C Q_C + P_T Q_T \leq Y$ and will have the slope $-\frac{P_C}{P_T}$.

- Examining the case where $\frac{P_C}{P_T} > \frac{a_C^N}{a_T^N}$ for the North and the case where $\frac{P_C}{P_T} < \frac{a_C^S}{a_T^S}$ for the South, we get a representation of a consumption point in free trade which is above the initial point under autarky. Increased utility comes from increased consumption possibilities that allow consumers(workers) to attain a higher indifference curve. This is illustrated by figure 3 for the North and figure 4 for the South.

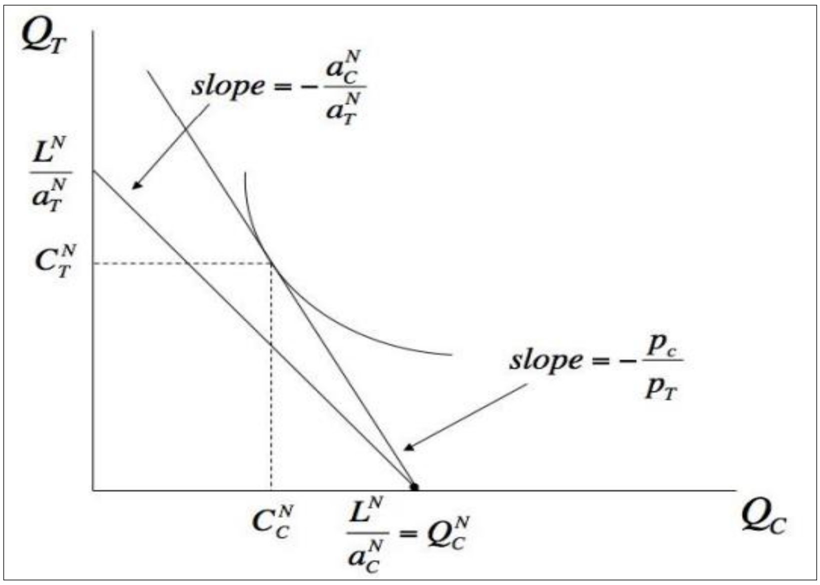


Figure 3: PPF and higher consumption points under free trade for the North

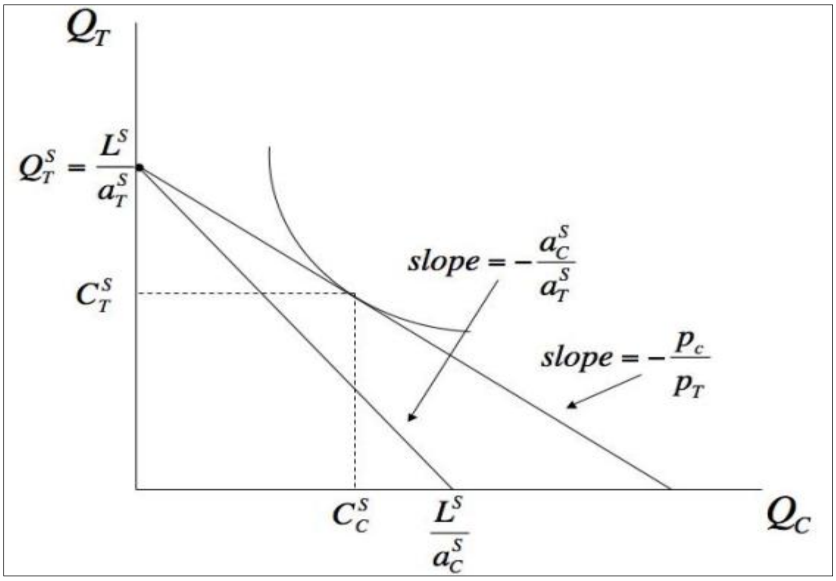


Figure 4: PPF and higher consumption points under free trade for the South

To conclude the Ricardian model, provided that free trade relative price differs from autarky relative price, a country gains from trade. In the Ricardian model, the condition for gains from trade is equivalent to saying a country gains whenever it becomes completely specialized in its comparative advantage good. All agents gain from trade in Ricardo. Thus, we would not be able to explain why some agents are against free trade, nor why there are barriers to trade. More over in the In Ricardo both countries gain from trade. Since there is only one factor of production (labour), it implies that if a country gains, then all individuals in that country also gain.

2.2. Relative Factor Endowments and Gains From Trade

2.2.1. Hecksher Ohlin Model

The Heckscher-Ohlin model is based on how differences in factor endowments between countries cause productive differences, leading to gains from trade. The model is built on assumptions of perfect competition , 2 countries, 2 sectors, 2 factors of production (e.g., capital and labour) perfectly mobile across sectors (but not across countries) and identical technologies across countries . The only difference between countries is their relative factor endowment, which allows them to use different combinations of those endowments, and achieve a higher efficiency in some sectors.

In the H-O model comparative advantage depends on countries' relative endowment of factors of production., *i.e.* a country which is relatively abundant in labour will have a comparative advantage in the production of relatively labour intensive goods. The nation which is relatively capital abundant will have a comparative advantage in the production of the relatively capital intensive goods. The implies that in the HO model, Countries tend to export goods whose production is intensive in factors with which they are abundantly endowed.

The theory of comparative advantage sheds more light on the trade gains in both the Ricardian and HO models, it states that, *when two countries specialize in producing the good in which they have a comparative advantage, both economies gain from trade, even if one country has an absolute advantage in both goods. In particular, each country will export the good for which they have a comparative advantage*.

Therefore, it can be concluded that in Ricardian model comparative advantage which is determined by differences in technologies and relative prices across countries underpins the gains from trade. However in the HOS differences in factor endowments across countries underpins trade gains. The Limitations of Ricardian model is that it is only able to explains inter-industry trade between countries with different endowments (North-South trade) - Does not explain intra-industry trade between countries with similar endowments (North-North trade) .

3. GAINS FROM TRADE IN NEW TRADE MODELS

The inability of old trade theories to explain trade between similar countries (intra-industry trade) prompted the beginning of new trade theories. Consequently, welfare gains in the new trade models has become a contentious issue of debate in economic cycles. Moreover the rising prominence of intra-industry trade and of heterogeneity in research agendas has transformed the way economists think of gains from trade.

The seminal contributions of Krugman (1979, 1980), Helpman (1981) and Lancaster (1980) made the first attempt to explain how economists try to quantify the gains from trade within a monopolistic competition setting. In such settings, there are three sources of gains from trade that are not present in traditional models:

(i) Love of variety gains associated with intra industry trade
(ii) Allocative efficiency gains: self-selection of firms with only the most efficient firms surviving after trade liberalization
(iii) Productive efficiency gains associated with trade-induced innovation.

3.1. Love of-variety gains associated with intra-industry trade

Within the monopolistic competition framework, consumers value additional varieties depending on the substitutability between varieties, captured by the elasticity of substitution. Consumer derive their gains from having access to new import varieties of differentiated products. Initial attempt to quantify the value of new varieties upon trade liberalization is done by Romer (1994). Those gains have recently been measured for the United States for the period 1972 to 2001 by Broda and Weinstein (2006), using the methods from Feenstra (1994).

Feenstra(1994) develops a methodology for measuring the impact of new varieties on an exact price index of a single imported good using only the data available in a typical trade database , the price index for imports that is corrected for new and disappearing varieties. New varieties lower the unit-costs depending on their substitutability with other varieties and their expenditure share. This allows Feenstra (1994) to quantify the upward bias in conventional import price indices that ignore changes in the set of imported varieties.

Broda and Weinstein (2006) asserted that Feenstra 's approach has two drawbacks that have prevented researchers from adopting it more widely. First, it cannot be used to assess the value of the introduction of completely new product categories. Second, Feenstra's methodology tends to generate a large number of elasticities that take on imaginary values, which are hard to interpret.

As a result Broda and Weinstein (2006) solve the problem encountered in the Feenstra (1994) approach by developing an aggregate import price index that allows for changes in varieties. Their result show that the impact of increased choice on the exact import price index is both statistically and economically significant. Between 1972 and 2001, if one adjusts for new varieties, import prices have been falling 1.2% points per year. The price decline is used to obtain an estimate of the gains from new imported varieties under the same structural assumptions as Krugman (1980). They show that the upward bias of the conventional import price index of 1.2% per year leads to a gain from imported variety of 2.6% of GDP over the whole period.

This result of Broda and Weinstein (2006) is the topic of a recent debate. Ardelean (2009) also argues that the standard Krugman (1980) model overstates the love of variety since it assumes that larger countries export more only at the extensive margin, while models in the vein of Armington (1969) assume that countries' exports grow only at the intensive margin. She develops a more general model that nests Krugman and Armington style models and concludes that the love of variety is 44% lower than in Krugman's CES model. These contributions imply that Broda and Weinstein (2006) may overestimate the gains from variety.

3.1.1. Krugman (1980)

As discussed above, Krugman (1980) offers an entirely new approach to international trade, and to the motives for international trade. He develops a very simple (simplistic) model of trade in differentiated good with increasing returns to scale. This model uses economies of scale, differentiated products and heterogeneous preferences to explain intra-industry trade.

The assumptions of the model are that; labour is the only factor of production, 1 product, 2 countries, identical technologies between countries, similar factor endowments, dixit stiglitz preferences, monopolistic competition with many firms, differentiated goods (number of firms equals the number of varieties), a large number of identical consumers-symmetric demand of all available varieties - love-for-variety (more varieties lead to greater utility), increasing returns to scale implies that countries specialize in producing a subset of goods

Unlike the Ricardian model, or the Heckscher-Ohlin model, even exactly identical countries would trade with one another, and would gain from trade. Opening up the economy to international trade yields a welfare gain deriving from variety.

3.2. Allocative Effeciency Gains

Allocative efficiency gains are associated with shifting labour and capital out of small, less productive firms into large, more-productive firms; The extension of the monopolistic competition model to allow for heterogeneous firms, due to Melitz (2003), leads to a second source of gains from the self-selection of more efficient firms into export markets.

This self-selection can still be interpreted as a gain from product variety, but now on the export side of the economy rather than for imports. Surprisingly, the consumer gains from new import varieties do not appear in this case, because they cancel out with disappearing domestic varieties. This finding as demonstrated in section 3, helps to explain the theoretical results of Arkolakis et al (2008), where the gains from trade depend on the import share but are otherwise independent of the elasticity of substitution in consumption.

3.2.1. The Melitz Model

The Melitz model incorporates firm productivity heterogeneity into the Krugman (1979) monopolistic competition framework. In each country, the industry is populated by a continuum of firms differentiated by the varieties they produce and their productivity.

Firms face uncertainties about their future productivity when making an irreversible costly investment decision to enter the domestic market. Following entry, firms produce with different productivity levels. In addition to the sunk entry costs, firms face fixed production costs, resulting in increasing returns to scale of production. The fixed production costs lead to the exit of inefficient firms whose productivities are lower than a threshold level, as they do not expect to earn positive profits in the future. Figure 5 depicts the productivity uncertainty and firms entry and exit.

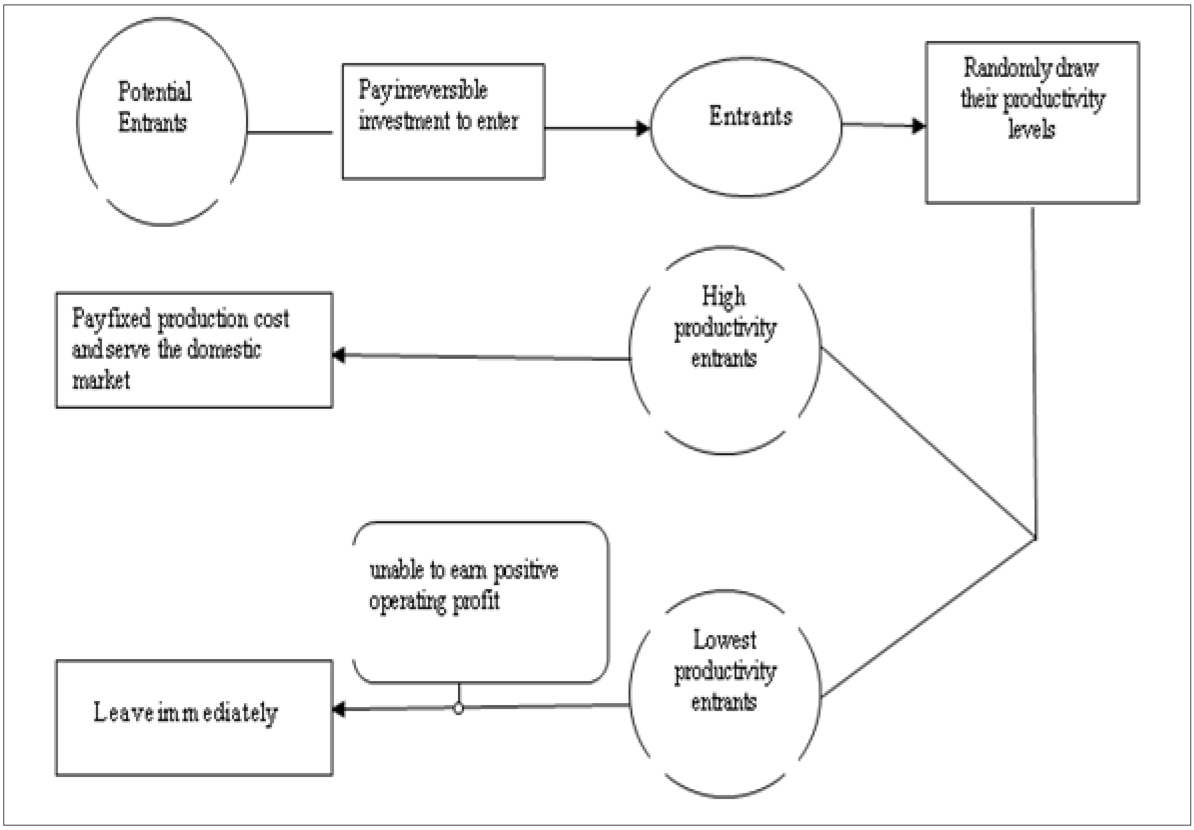


Figure 5: Productivity uncertainty and firms entry/exit

There are also fixed costs and variable costs associated with the exporting activities. The decision to export occurs after the firms observe their productivity. A firm enters export markets if the net profits generated from its exports in a given country are sufficient to cover the fixed exporting costs. The zero cutoff profit conditions in domestic and exporting markets define the productivity thresholds for firm's entry into the domestic and exports markets.

The combination of fixed export costs and variable export costs ensures that the exporting productivity threshold is higher than that for production for the domestic market, i.e., only a small fraction of firms with high productivity engage in exports markets. These exporting firms supply both the domestic and export markets. Figure 6 in the next page illustrates the productivity levels and probabilities of exporting, exiting and producing for local market

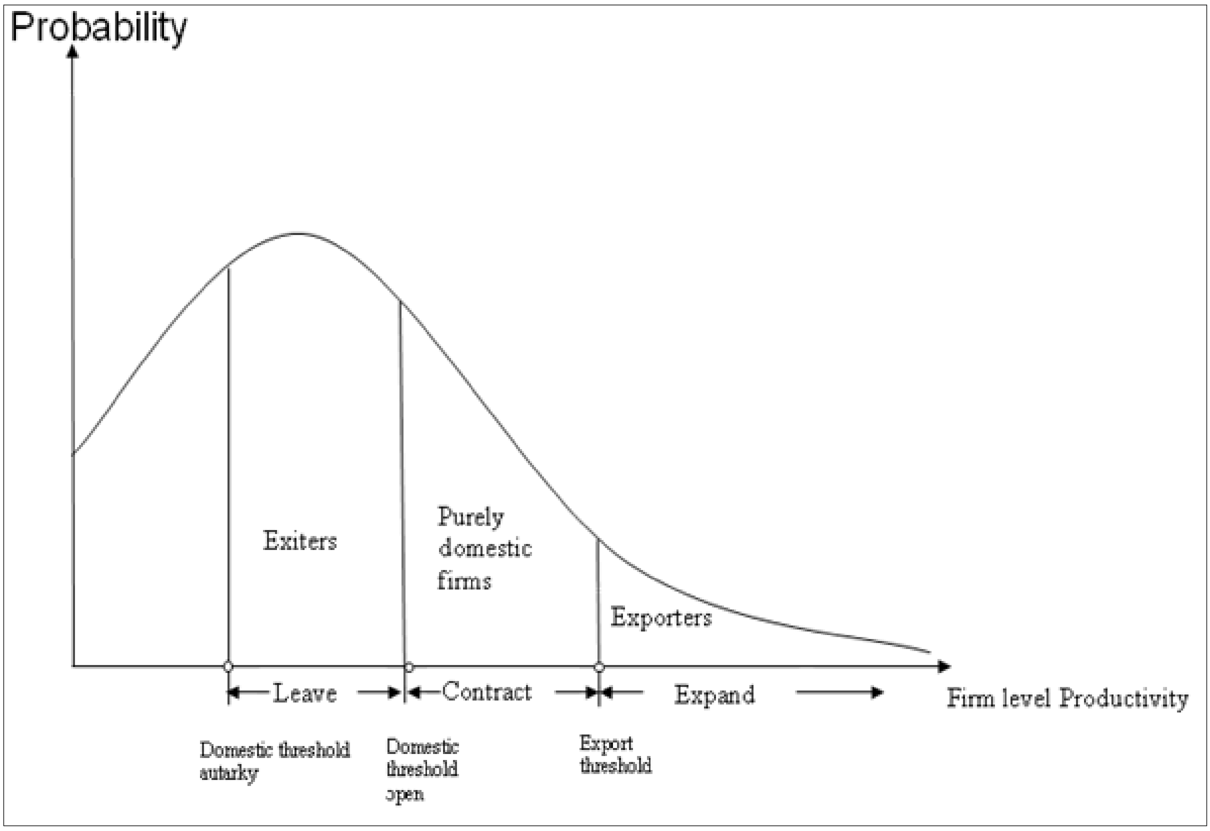


Figure 6: Productivity levels and probabilities of exporting,exiting and producing for local market.

What about trade gains in Melitz Models? Trade liberalization in the Melitz Model generates a trade gains. The magnitude of the gain is determined by the interactions between three factors:

- The decreased number of domestic firms supplying to domestic markets: This results in a negative variety effect for domestic consumers. But this effect is typically overpowered by the increased number of new foreign exporters, so that domestic consumers still enjoy greater product variety.

- The increased number of foreign exporters leads to increase variety of commodities to consumers hence resulting in welfare gains.

- The increased average productivity of domestic firms: In the event that a large number of domestic firms are replaced by foreign firms, and product variety has a negative impact on welfare, the positive contribution of aggregate productivity gain would more than offset the loss in variety. The net welfare gain from opening up to international trade is always positive.

3.3. Productive Efficiency Gains

Productive efficiency gains associated with trade-induced innovation ,this source of gains was stressed in Krugman (1979). The monopolistic competition model allows for gains from a reduction in firm markups due to import competition. In support of this view, Melitz and Ottaviano (2008) contend that , larger markets exhibit tougher competition resulting in lower average mark-ups and higher aggregate productivity.

Trade enhances the incentive to innovate through**:**

- **Competitive effect -** Through promoting and fostering innovation, trade has positive effects on economic growth. The incentive to innovate is determined by the difference between the profits that a firm would make if it innovates and the profits that it would make if another firm innovates. Trade increases competition between countries, therefore it increases the losses a firm would face, if it fails to innovate, while a competitive firms does it. This increases incentives to innovate

- **Scale effect** - By enlarging the size of the market, international trade increases the profits of a firm. The anticipated gains may thus increase the incentive to innovate and invest in research and development activities.

4. SAME TRADE GAINS: A REVIEW OF NEW AND OLD TRADE MODELS

International trade theory has emphasized the roles of imperfect competition and firm-level heterogeneity (Krugman, (1979 & 1980), Melitz (2003)). This research agenda has been successful in rationalizing important empirical facts such as intra-industry trade or within sector resource reallocation. However, new trade models have come under attack and scrutiny by Arkolakis, Costinot and Rodriguez-Clare (2012, henceforth ACR). These authors show that under two macro level restrictions;(i) a CES Import demand system; and (ii) gravity equation, models (Armington, Ricardo, and Melitz) deliver an identical expression for trade gains.

Gravity equation models are used to demonstrate the trade gains result. In this section I will provide a specific analysis of welfare gains in 3 gravity models of trade to show that gains are the same in both old and new trade models as argued by ACRC. Having carried out a theoretical discussion of trade gains under section 2 and 3, I proceed to carry out a mathematical analysis of these gains based on Ricardian, Armington and Melitz Models.

4.1. Three Gravity Models of Trade

Tinbergen (1962) and Linneman (1966) intoduced the gravity model which has been widely used for explaining international trade flows because they exhibit considerable empirical robustness and explanatory power for describing trade flows. Moreover, the gravity equation offers a common way to estimate the trade elasticity which facilitates welfare measurement. The three gravity equation models that will be considered in this section are (Armington, Eaton-Kortum, and Melitz) .

Based on ACRC, welfare gains are easy to quantify, using measures of λ and ε . (i) the share of expenditure on domestic goods, λ, which is equal to one minus the import penetration ratio; and (ii) an elasticity of imports with respect to variable trade costs, ε, which we refer to as the “trade elasticity.” . Thus, two parameters only, λ_{jj} and ε , summarize the welfare gains from trade in country j . The former because it reflects traded quantities in the current state of economy j, and the latter because it maps changes in quantities into changes in prices, which are what matter for welfare.

4.1.1. Assumptions of the models

The gravity models feature four primitive assumptions:

- **Dixit-Stiglitz preferences**;

$$P_i = \left(\int_{\omega \in \Omega} p_i(\omega)^{1-\sigma} d(\omega) \right)^{1/1-\sigma}$$

Where $p_i(\omega)$ is is the price of good in country i and $\sigma > 1$ is the elasticity of substitution between goods. We adopt the convention that $p_i(\omega) = +\infty$ if good ω is not available in country i.

- **Technology and Trade Costs**

Labour is the only factor of production and is supplied inelastically at quantity L_i and wages w_i. Output is linear in labour, and productivity may or may not differ across firms. Exporting from i to j involves iceberg trade costs τ_{ij}; where $\pi_{ii} = 1$. For every good $\omega \in \Omega$, there is a blueprint that can be acquired by one or many firms depending on the market structure . For any exporting country i and any importing country j, the blueprint associated with good ω contains a set of destination-specific techniques $t \in T_{ij}$ that can be used to produce the good in country i and sell it to country j. If a firm from country i uses techniques $t \equiv \{t_j\}$ to produce quantities $q \equiv \{q_j\}$ of good ω

The Cost function is given by :

$$C_i(w,q,t,\omega) = \sum_{j=1}^{n}\left[\underbrace{c_{ij}(w_i,t_j,\omega)}_{\substack{\text{Constant}\\\text{marginal}\\\text{cost}}}q_j + \underbrace{f_{ij}(w_i,w_j,t_j,\omega)}_{\substack{\text{Fixed}\\\text{Exporting}\\\text{Cost}}}\underbrace{\prod}_{\substack{\text{Indicator}\\\text{function}}}(q_j > 0)\right]$$

- **Structure of product markets**.

Two types of market structures are considered: perfect competition and monopolistic competition with either restricted or free entry. In both situations, firms maximise profits and take wages and aggregate variables as given. With monopolistic competition, firms have to pay to obtain blueprints for production. The allocation of these potentially heterogeneous blueprints across firms is random. Under perfect competition, firms have free access to all blueprints; there are no fixed exporting costs, $\phi_{ij}(\omega) = 0$ for all i, j, ω.

4.1.2. Macro Level Restrictions

In their analysis, ACRC impose three restrictions whose key role is to ensure that the framework described above gives rise to a gravity equation, i.e., a representation of bilateral trade flows where elasticities are constant. Restriction 1, requires a balance in trade; Restriction 2 , requires that aggregate gross profits are proportional to aggregate revenue, finally Restriction 3, puts a functional form on the gravity equation.

- **Restriction 1:** Balanced Trade

Let X_{ij} denote the value of country j's total imports from country i in domestic prices, the value of imports must be equal to the value of exports:

Then balanced trade requires that; $\sum_{i=1}^{n} X_{ij} = \sum_{i=1}^{n} X_{ji}$.

- **Restriction 2:** Aggregate profits are a constant share of aggregate revenues:

$\prod_j / R_j$, where $\prod_j$ is the aggregate profits of country j, gross of entry costs if there exists any. Profits $\prod_j$ must be a constant of the country j 's revenues R_j.

- **Restriction 3:** "The import demand system is CES."

Arkolakis et, al (2012) defines an import demand system as a mapping from (w, N, τ) into $X \equiv \{X_{ij}\}$, where $w \equiv \{w_i\}$ is the vector of wages; $N \equiv \{N_i\}$ is the vector of measures of goods that can be produced in each country. For simplicity, the import demand system can be thought of as a set of labour demand curves whose properties will be used to infer how changes in trade costs affect the relative demand for labour in different countries. Our third macro-level restriction imposes restrictions on the partial elasticities..

Each elasticity $\varepsilon_j^{ii'}$ captures the percentage change in the relative imports from country i in country j associated with a change in the variable trade costs between country i' and j holding wages and the measure of goods that can be produced in each country fixed.

According to Restriction 3, like in a simple Armington model, any given change in bilateral trade costs, τ_{ij}, must have a symmetric impact on relative demand, X_{ij} / X_{jj}, for all exporters $i \neq j$:

$$\varepsilon_j^{ii'} = \frac{\partial \ln(X_{ij} / X_{jj})}{\partial \ln \tau_{i'j}} = \begin{cases} \varepsilon < 0 & if \ i' = i \\ 0 & if \ i \neq i' \end{cases}$$

(Changes in relative demand are separable across exporters)

- **Defining Welfare Gains**

Armed with these tools, I proceed to illustrate how gravity models can be used to quantify the gains from international trade defined as the (absolute value of) the percentage change in real income that would be associated with moving one country from the current, observed trade equilibrium to a equilibrium with no trade, (an equilibrium with infinite iceberg trade costs)

$W_j \equiv Y_j / P_j$

Now that I have considered the assumptions, macro level restrictions and welfare measurement that applies to all the 3 gravity models, I proceed by examining providing a microscopic study of gains in each of the models respectively.

4.1.3. Armington Model and Trade Gains

The theoretical and empirical relationship between trade and welfare is studied in simplest model of international trade that yields a gravity equation: the Armington model. This model has played a central role in the gravity literature as outlined in Anderson (1979), and Anderson and Van Wincoop (2003).

The model features N countries populated by consumers with constant elasticity of substitution (CES) preferences and tradable goods that are differentiated by the country of origin. Perfect competition among producers and product differentiation by origin imply that each good is purchased in each destination at a price that equals the marginal cost of production and delivery of the good there.

- **Preferences**

On the demand side, there is a representative agent in each country maximizing the following Dixit-Stiglitz utility function:

$$U_j = \left[\sum_{i=1}^{n} q_{ij}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)} \tag{1}$$

where q_{ij} is the quantity of country j s good consumed by country i and $\sigma > 1$ is the elasticity of substitution between goods.

- **Price Index and Trade Costs**

International trade is subject to ice berg trade costs and wages. Such that $w_i > 0$ is the wage in country i and $\tau_{ij} \geq 1$ are the variable (iceberg) trade costs between country i and country j

The associated price index in country j is given by $P_j = \left[\sum_{i=1}^{n} (w_i \tau_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}$ (2)

- **Bilateral trade flows**

The value X_{ij} of country j's total imports from country i is equal to:

$$X_{ij} = \left(\frac{w_i \tau_{ij}}{P_j}\right)^{1-\sigma} Y_j \qquad (3)$$

Where $Y_j \equiv \sum_{i=1}^{n} X_{ij}$ is total expenditure in country and trade balance implies $Y_j = w_j L_j$

- **Trade elasticity**

$$\varepsilon \equiv -\frac{\partial \ln X_{ij} / X_{jj}}{\partial \ln \tau_{ij}} = \sigma - 1, \quad -\frac{\partial \ln X_{ij} / X_{jj}}{\partial \ln \tau_{i'j}} = 0 \qquad (4)$$

- **Welfare Impact of a foreign Shock**

Arkolakis et al, (2012) defines a foreign shock as "Changes in parameters affecting foreign endowments $L = \{L_i\}$ and entry costs $F = \{F_i\}$, variable trade costs $\tau = \{\tau_{ij}\}$ and fixed trade costs $\xi = \{\xi_{ij}\}$ that do not affect country j's endowment or its ability to serve its own market "$(L_j, F_j, \tau_{jj}, \xi_{jj})$"

What is the change in real income?: $W_j \equiv Y_j / P_j$ caused by such a shock? Answering this question will help to understand and derive the welfare gains in the in the gravity models under consideration. First consider a country j with the following implication for changes in trade balance:

$$d \ln Y_j = d \ln w_j \qquad (5)$$

Based on equations (3) and (4) changes in real income can be derived as:

$$d \ln W_j = -\sum_{i=1}^{n} \lambda_{ij} (d \ln w_i + d \ln \tau_{ij}) \qquad (6)$$

Where $\lambda_{ij} \equiv X_{ij} / Y_j$ is the share of country j's total expenditure that is devoted to goods from country i .

By equation (4), changes in relative imports are such that

$$d\ln\lambda_{ij} - d\ln\lambda_{jj} = (1-\sigma)(d\ln w_i + d\ln\tau_{ij}) \tag{7}$$

Now, combining equations (4) and (5), we obtain the welfare gains in Armington model:

$$d\ln W_j = \frac{\sum_{i=1}^{n}\lambda_{ij}(d\ln\lambda_{jj} - d\ln\lambda_{ij})}{1-\sigma} = \frac{d\ln\lambda_{jj}}{1-\sigma} \tag{8}$$

Integrating the previous expression between the initial equilibrium (before the shock) and the new equilibrium (after the shock), we finally get that the welfare impact of a foreign shock is $\hat{W}_j = \hat{\lambda}^{1/\varepsilon}$.

Gains from trade in Armington model
$GT_j \equiv 1-\hat{W}_j = 1-\lambda_{jj}^{1/\varepsilon}$ **,** such that $\varepsilon \equiv \sigma - 1$ is the trade elasticity,
$GT_j = 1-\lambda_{jj}^{1/\varepsilon}$

Table 2: Gains from trade in Armington model

To implement $GT_j = 1-\lambda_{jj}^{1/\varepsilon}$ we need to measure λ_{jj} and we need an estimate of ε. λ_{jj} is share of gross expenditure devoted to home purchases; The key parameter determining trade flows (equation (3)) is ε. To see the parameter's importance for trade flows, take logs of equation (3) yielding:

$$\ln X_{ij} = \varepsilon\ln w_i + \ln(Y_j P_j^{\varepsilon}) - \varepsilon\ln\tau_{ij} \tag{10}$$

As this expression makes clear, ε controls how a change in the bilateral trade costs, $\boldsymbol{\tau_{ij}}$, will change bilateral trade between two countries. This elasticity is important because if one wants to understand how a bilateral trade agreement will impact aggregate trade or to simply understand the magnitude of the trade friction between two countries, then a stand on this elasticity is necessary.

If we had data for τ_{ij} , then can run OLS regression of $\ln X_{ij}$ on $\ln\tau_{ij}$ with exporter and importer dummies to estimate ε A central estimate of ε is 5. To measure τ_{ij} *one would have* *to consider* tariffs and Price differences. Figure 7 below provides different estimates for trade elasticities:

	ε	$\hat{W}^A_{US}$	$\hat{W}^A_{open}$
EK, Method of moments	8.28	.991	.875
EK, 2Stages GLS+OLS	2.84	.975	.677
EK, 2Stages GLS+2SLS	3.60	.980	.735
EK, OLS Trade Eq.	2.44	.971	.635
EK, 2SLS Trade Eq.	12.86	.994	.917
SW, SMM	4.12	.983	.764
CDK, IV	6.53	.989	.844
CP, (mean)	8.22	.991	.874

EK=Eaton & Kortum (2002), CDK=Costinot et al (2011)
SW=Simonovska & Waugh (2011), CP=Caliendo & Parro (2011)
$\hat{W}^A_{US}$ uses $\lambda_{US,US} = .93$ from ACRC and $\hat{W}^A_{US} = \lambda_{US,US}^{-1/\varepsilon}$
$\hat{W}^A_{open}$ uses $\lambda_{open} = .33$, the value for Singapore.

Figure 7: Estimated trade elasticities and trade gains

4.1.4. Ricardian Model and Trade Gains

Considering the same assumptions and macro-level restrictions as above, I proceed to illustrate trade gains in Ricardian model. The welfare gains are exactly the same as the welfare gains in the Armington Model of Trade.

- **Perfect Competition**

Under perfect competition, the set of goods Ω_{ij} that country j buys from country i is given by $\Omega_{ij} = \{\omega \in \Omega \,|\, c_{ij}\alpha_{ij}(\omega) < c_{i'j}\alpha_{i'j}(\omega) \; for\ all\ i' \neq i$ such that $c_{ij} \equiv w_i \tau_{ij}$ (11)

- **Bilateral Trade Flows**

$$X_{ij} = \frac{\int_0^{+\infty} (c_{ij}\alpha_i)^{1-\sigma} g_i(\alpha_i, c_{1j}, ..., c_{nj}) d\alpha_i}{\sum_{i'=1}^{n} \int_0^{+\infty} (c_{i'j}\alpha_{i'})^{1-\sigma} g_{i'}(\alpha_{i'}, c_{1j}, ..., c_{nj}) d\alpha_{i'}} Y_j, \quad (12)$$

Where, where $g_i(\alpha_i, c_{1j}, ..., c_{nj})$ is the density of goods with unit labour requirements α_i in Ω_{ij}

.

- **Trade Elasticities**

Accordingly, for any importer j and any pair of exporters $i \neq j$ and $i' \neq j$, the import demand system of a Ricardian model satisfies:

$$\frac{\partial \ln(X_{ij} / X_{jj}}{\partial \ln \tau_{i'j}} \equiv \varepsilon_j^{ii'} = \begin{cases} 1-\sigma+\gamma_{ij}^i-\gamma_{jj}^i & \textit{for } i'=i \\ \gamma_{ij}^{i'}-\gamma_{jj}^{i'} & \textit{for } i' \neq i \end{cases} \tag{13}$$

Such that, $1-\sigma$ and $\gamma_{ij}^{i'} \equiv \partial \ln\left[\int_0^{+\infty} \alpha_i^{1-\sigma} g_i(\alpha_i, c_{1j}, ..., c_{nj}) d\alpha_i\right] / \partial \ln c_{i'j}$ are the intensive and extensive margin elasticities, respectively.

- **Welfare Impact of a Foreign Shock**

To understand the welfare gains, note that labour market clearing and the budget constraint of the representative agent imply that $d \ln Y_j = d \ln w_j = 0$.

Thus, just as in the Armington model, small changes in real income are given by

$$d \ln W_j = -g \ln P_j = -\sum_{i=1}^{n} \lambda_{ij} d \ln c_{ij} \text{ .} \tag{14}$$

Contrary to the Armington model, in the Ricardian model changes in trade flows now depend on changes in Ω_{ij} and hence, the extensive margin elasticities $\gamma_{ij}^{i'}$.

Therefore based on equation (12), we get

$$d \ln \lambda_{ij} = d \ln \lambda_{jj} = (1-\sigma+\gamma_{ij}^i-\gamma_{jj}^i) d \ln c_{ij} + \sum_{i' \neq i, j}^{n} (\gamma_{ij}^{i'}-\gamma_{jj}^{i'}) d \ln c_{i'j} \tag{15}$$

Moreover Based on Equation (14) and (15):

$$d \ln W_j = -\sum_{i=1}^{n} \lambda_{ij} \left[\frac{d \ln \lambda_{ij} - d \ln \lambda_{jj}}{1-\sigma+\gamma_{ij}^i-\gamma_{jj}^i} - \sum_{i' \neq i, j}^{n} \left(\frac{\gamma_{ij}^{i'}-\gamma_{jj}^{i'}}{1-\sigma+\gamma_{ij}^i-\gamma_{jj}^i}\right) d \ln c_{i'j}\right] \tag{16}$$

Equation (13) ans Restriction 3 Imply that $\gamma_{ij}^{i'} = \gamma_{jj}^{i'}$, $i' \neq i, j$ and $1-\sigma+\gamma_{ij}^i-\gamma_{jj}^i = \varepsilon$.

Furthermore, since $\sum_{i=1}^{n} \lambda_{ij} = 1$, we get the welfare gains in the ricardian model as:

$$d \ln W_j = \frac{d \ln \lambda_{jj}}{1-\sigma} = \frac{d \ln \lambda_{jj}}{\varepsilon} \qquad (17)$$

The trade gains in Ricardian model are therefore characterised by $\hat{W}_j = \hat{\lambda}^{1/\varepsilon}$ which for simplification I represent as $GT_j = 1 - \lambda_{jj}^{1/\varepsilon}$.

Gains from trade in Ricardian Model
$GT_j \equiv 1 - \hat{W}_j = 1 - \lambda_{jj}^{1/\varepsilon}$ **,** such that $\varepsilon \equiv \sigma - 1$ is the trade elasticity**,** $GT_j = 1 - \lambda_{jj}^{1/\varepsilon}$

Table 3: Gains from trade in Ricardian model

4.1.5. Trade Gains in the Melitz Model

The final trade gains analysis will be based on the Melitz model, which is the case of monopolistic competition with free entry and firm heterogeneity. As in the previous analysis, the objective is to specifically derive the gains and compare the result to the Armington and Ricardian models.

As a starting point, the Melitz assumes that specific unit labour requirements do not vary across destinations, that is; $\alpha_{ij}(\omega) \equiv \alpha_i(\omega)$ and it ignores heterogeneity in fixed costs, $\phi_{ij}(\omega) = 1$ for all i, j, ω. Moreover, in the derivations, consider $G(\alpha_1, ..., \alpha_n)$ to be the share of goods $\omega \in \Omega$ such that $\alpha_i(\omega) \leq \alpha_i$ for all i, and b $g(\alpha_1, ..., \alpha_n)$ to be the associated density function.

- **Monopolistic competition**

Consider a monopolistic competition setting in which firms charge a constant mark up $\sigma / (\sigma - 1)$. Let α_{ij}^* be the cutoff determining the entry of firms from country i in country j. This implies that the associated profits $\pi_{ij}(\omega) > 0$ if and only if $\alpha_i(\omega) < \alpha_{ij}^*$. Therefore, the set of goods Ω_{ij} that country j buys from country i can be written as:

$$\Omega_{ij} = \left\{ \omega \in \Omega \mid \alpha_i(\omega) < \alpha_{ij}^* \equiv \sigma^{\sigma/(1-\sigma)}(\sigma-1)\left(\frac{P_j}{c_{ij}}\right)\left(\frac{\xi w_i^{\mu} w_j^{1-\mu}}{Y_j}\right)^{1/(1-\sigma)} \right\} \tag{18}$$

- **Bilateral Trade**

$$X_{ij} = \frac{N_i \int_0^{\alpha_{ij}^*} [c_{ij}\alpha_i]^{1-\sigma} g_i(\alpha_i) d\alpha_i}{\sum_{i'=1}^{n} N_{i'} \int_0^{\alpha_{i'j}^*} [c_{i'j}\alpha_{i'}]^{1-\sigma} g_{i'}(\alpha_{i'}) d\alpha_{i'}} Y_j \tag{19}$$

- **Trade Elasticity**

The import demand system now satisfies the following expression for any importer j and any pair of exporters $i \neq j$ and $i' \neq j$:

$$\frac{\partial \ln(X_{ij} / X_{jj})}{\partial \ln \tau_{i'j}} = \varepsilon_j^{ii'} = \begin{cases} 1-\sigma-\gamma_{ij}+(\gamma_{ij}-\gamma_{jj})\left(\dfrac{\partial \ln \alpha_{jj}^*}{\partial \ln \tau_{ij}}\right) & \text{for } i' = i \\ (\gamma_{ij}-\gamma_{jj})\left(\dfrac{\partial \ln \alpha_{jj}^*}{\partial \ln \tau_{i'j}}\right) & \text{for } i' \neq i \end{cases} \tag{20}$$

Where $\gamma_{ij} \equiv d \ln \int_0^{\alpha_{ij}^*} \alpha^{1-\sigma} g_i(\alpha) d\alpha / d \ln \alpha_{ij}^*$ represents the counterpart of the extensive margin elasticities under perfect competition.

- **Welfare Impact of a foreign Shock**

Under free entry, labour market clearing and the representative agent's budget constraint still imply $d \ln Y_j = d \ln w_j = 0$. Formally, small changes in real income are now given by:

$$d \ln W_j = -d \ln P_j = -\sum_{i=1}^{n} \lambda_{ij} \left(d \ln c_{ij} + \frac{d \ln N_i + \gamma_{ij} d \ln \alpha_{ij}^*}{1-\sigma} \right) \tag{21}$$

Taking into account a cutoff α_{ij}^*, equation (21) becomes

$$d \ln W_j = -\sum_{i=1}^{n} \left(\frac{\lambda_{ij}}{1-\sigma-\gamma_j} \right) . \left[d \ln \lambda_{ij} - d \ln \lambda_{jj} - (\gamma_{ij} - \gamma_{jj}) d \ln \alpha_{jj}^* + d \ln N_j \right] \tag{22}$$

It can be inferred from Restriction 3 that, $\gamma_{ij} = \gamma_{jj}$ and that $1-\sigma-\gamma_j = \varepsilon$. Therefore from equation (22) we obtain the change in welfare as:

$$d \ln W_j = \frac{d \ln \lambda_{jj} - d \ln N_j}{\varepsilon} \quad (23)$$

Since there is free entry in the market this implies profits $\prod_j = N_j F_j$. Moreover , the macro level restriction 2 (aggregate profits ($\prod_j$) are constant share of revenues implies that $d \ln N_j = \ln Y_j = 0$.

In conclusion trade gains in Melitz model are:

$$d \ln W_j = \frac{d \ln \lambda_{jj}}{\varepsilon} \quad (24)$$

$\hat{W}_j = \hat{\lambda}^{1/\varepsilon}$ which for simplification I represent as $GT_j = 1 - \lambda_{jj}^{1/\varepsilon}$.

Consequently the welfare gains in Melitz model are the same as in Armington and Ricardian model. This confirms the studies done by Arkolakis el al (2008) and Arkolakis et al (2012) that the welfare gains in both the old and the new trade models are the same. The table below shows the summary of the welfare in the 3 gravity based models analysed above.

Gravity models of trade	Summary of trade gains
Armington **Ricardian**	$d \ln W_j = \frac{d \ln \lambda_{jj}}{\varepsilon}$
Melitz	Can be represented as $GT_j = 1 - \lambda_{jj}^{1/\varepsilon}$

Table 4: Summary of trade gains: Armington, Ricardo and Merlitz models

This result from ACRC has become under scrutiny and attack by recent empirical works. Ossa (2012) has shown that this result depends on using the average elasticity of imports, and that when using industry specific elasticities, the gains from trade are substantially larger. Moreover, Nigai (2013) contends that "Predictions under ARC are likely to overstate the gains from trade for the poor and understate them for the rich, He further asserts that, the assumption of a representative consumer, in an identical model setting, leads to large measurement errors in calculating welfare gains from trade. Nigai (2013) quantifies the measurement errors in the welfare gains from trade estimates caused by the assumption of a representative consumer in the ACRC paper and finds out that these errors are as large as 8.6 and -6.6 percentage points for the poorest and the richest consumer, respectively

4.2. Sectoral Heterogeneity and Trade Gains

Does the simple one sector formula derived by Arkolakis featuring the overall trade openness adequately capture this source of gains from trade? Arkolakis et al. (2012) show how under certain conditions, the formula can be extended to a setting with multiple sectors, but do not discuss how the gains from trade in a multi-sector formula differ er from the gains implied by the one-sector formula.

Levchenko and Zhang (2012) shows that by ignoring the sectoral heterogeneity in productivity and hence in trade volumes the one-sector formula systematically understates the gains from trade. Their main finding was that the simpler formulas that do not use information on sectoral trade.volumes understate the true gains from trade dramatically, often by more than two-thirds. Moreover, He concluded that, "*while no sufficient statistic formula reproduces the true gains from trade precisely, the formula that uses both sectoral trade data and information on input-output linkages within the tradeable sector performs far and away the best, understating the true gains by only 11% on average*".

In the proceeding analysis, I provide a summary of Levchenko and Zhang (2012) 's analysis that compares the gains from trade implied by two formulas: a one-sector formula in which the manufacturing sector is treated as one, and a multi-sector formula.

To obtain analytical results under endogenous factor price determination, he assumed (i) equal expenditure shares in the two sectors and (ii) a mirror image of productivities across sectors and countries: $T_1^a = T_2^b$ and $T_1^b = T_2^a$. Of course, relative productivities are not generically the same in the two countries, $T_1^a / T_1^b \neq T_2^a / T_2^b$ and thus the strength of comparative advantage can vary.

The mirror image assumption on sectoral productivity and symmetry in the utility function ensure that the wages are equal in the two countries, $w_1 = w_2$. Together with the normalization of labour endowments to 1 this implies that the total income/expenditure in each country is equal to 1, and trade flows expressed as shares of total expenditure also equal absolute trade flows.

Denote by π_{ni}^{j} the share of total expenditure in country n on goods coming from country i in sector j . The import shares in country 1 from country 2 are given by

$$\pi_{12}^{a} = \frac{T_2^a w_2^{-\theta}}{T_1^a w_1^{-\theta} + T_2^a w_2^{-\theta}} = \frac{T_2^a}{T_1^a + T_2^a} \tag{i}$$

$$\pi_{12}^{b} = \frac{T_2^b w_2^{-\theta}}{T_1^b w_1^{-\theta} + T_2^b w_2^{-\theta}} = \frac{T_2^b}{T_1^b + T_2^b} = \frac{T_1^a}{T_1^a + T_2^a} \tag{ii}$$

The last equality uses the mirror image assumption on the relative productivities $T_1^a = T_2^b$ and $T_1^b = T_2^a$. Furthermore, regardless of the sectoral import shares, the assumptions on preferences and technology imply that the overall imports (and thus domestically produced goods) as a share of total absorption is always one half: $\pi_{11} = \pi_{22} = \frac{1}{2}$

In the case where the economy is characterized by a one-sector EK model with labour as the only input in production, the (gross) gains from trade are:

$$\pi_{ii}^{-\frac{1}{\theta}} \tag{iii}$$

This implies that gains from trade computed using only aggregate trade volumes are always constant in this model. However, as comparative advantage and thus sectoral trade shares change, the true gains from trade will change as well. Welfare in country i is given by the indirect utility function, and corresponds to real income $\frac{w_i}{(p^a p^b)^{\frac{1}{2}}}$ where p^j is the price of sector $j = a, b$.

.

Thus, the true gains from trade in this model are expressed as:

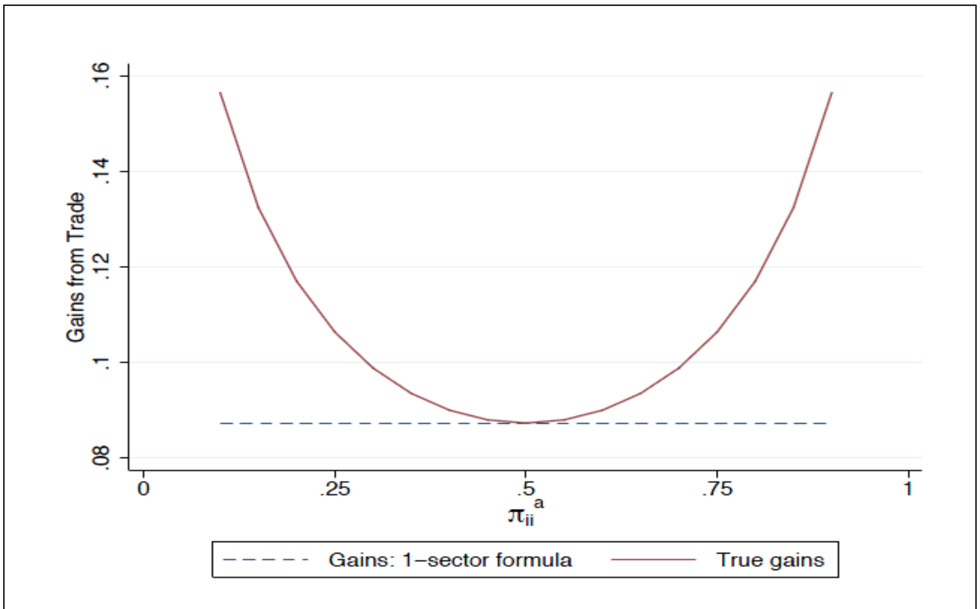
$$(\pi_{ii}^{a} \pi_{ii}^{b})^{\frac{1}{2\theta}} = (\pi_{ii}^{a}(1 - \pi_{ii}^{a}))^{-\frac{1}{2\theta}} \tag{iv}$$

Where the second equality is due to the fact that $\pi_{11}^{b} = \pi_{22}^{a} = 1 - \pi_{21}^{a} = 1 - \pi_{12}^{a}$.

The following result is immediate, coming from differentiating (iv) with respect to π_{ii}^{a}:

Lemma 1. *"When the share of absorption spent on domestically produced goods is the same across sectors, $\pi_{ii}^{a} = \pi_{ii}^{b}$ (i) the true gains from trade attain their minimum, and (ii) the gains from trade implied by the one-sector formula (3) and computed based on aggregate imports and absorption coincide with the true gains from trade. Therefore, the one-sector formula understates the true gains from trade as long as $\pi_{ii}^{a} \neq \pi_{ii}^{b}$."*Levchenko and Zhang (2012).

The result stated in the Lemma is illustrated in Figure 8 which plots the true gains from trade and the gains from trade implied by the one-sector formula against the share of spending on domestic goods in sector a, π_{ii}^{a}. The symmetry assumptions implies that, the total trade volume as a share of absorption is fixed throughout, and so the gains implied by the one sector model are constant as π_{ii}^{a} varies.



(a) Sectoral Trade Shares and the Gains from Trade

Figure 8: Trade gains using one sector formula and true gains

Comparing the gains from trade implied by two formulas: a one-sector formula in which the manufacturing sector is treated as one, and a multi-sector formula..

The one-sector formula is: $\pi_{ii}^{-\frac{\xi}{\theta}} - 1$ (v)

The multi-sector formula is: $\prod_{j=1}^{J} \left(\pi_{ii}^{j}\right)^{-\frac{\xi \omega j}{\theta}} - 1$ (vi)

where j indexes sectors. In these formulas, the absorption shares in manufacturing, both in aggregate (π_{ii}) and at the sector level (π_{ii}^{j}) come directly from the data on production and trade. Table 5 presents the summary statistics for the gains from trade implied by the one-sector formula (v) and the multi-sector formula (vi), Cobb-Douglas shares of sectors in consumption ω_j.The two parameters (θ *and* ξ) do not matter for the qualitative conclusions about the direction of the effect, since they both exponentiate the whole formula.

	Mean	Std. Dev.	Min	Max
$\pi_{ii}^{-\frac{\xi}{\theta}} - 1$	0.022	0.010	0.005	0.051
$\prod_{j=1}^{J} \left(\pi_{ii}^{j}\right)^{-\frac{\xi \omega_j}{\theta}} - 1$, Equal-weighted	0.035	0.017	0.006	0.067
$\prod_{j=1}^{J} \left(\pi_{ii}^{j}\right)^{-\frac{\xi \omega_j}{\theta}} - 1$, Expenditure-weighted	0.030	0.016	0.005	0.080
Pct difference, equal-weighted to one-sector	0.567	0.421	-0.069	1.706
Pct difference, exp.-weighted to one-sector	0.321	0.222	0.032	0.990

Notes: This table presents the summary statistics for the gains from trade implied by the one-sector formula, the equal-weighted multi-sector formula, and the expenditure-weighted multi-sector formula in the sample of 79 countries. The bottom two rows present the summary statistics for the proportional deviations of the multi-sector formulas relative to the one-sector one.

Table 5: Trade gains implied by one and multisector formulas

In table 5 above, the bottom two rows report the summary statistics for the proportional difference between each multi-sector gains from trade and the one-sector gains from trade. The clear result is that the one sector formula systematically understates the gains from trade relative to the multi-sector formula.

4.3. Different Trade Elasticities different Gains

Siminovska and Waugh (2012) argue that different models imply different trade elasticities and, hence, different gains from trade. Their study was motivated by the Arkolakis (2011) result that new trade models have the same welfare gains as old trade models based on a similar trade elasticity.

A key highlight in their study is that the different margins of adjustment in new trade models, e.g., variable markups in Bernard, Eaton, Jensen, and Kortum (2003), or the extensive margin in Melitz (2003), affect the mapping from the data to the estimate of the trade elasticity. Therefore, Siminovska and Waugh (2012) provide a sharp contrast to Arkolakis (2011) that different models will have different trade elasticities(see table 6 below) and, hence, different welfare gains from trade. In the Arkolakis paper the trade elasticity was estimated to be about 5.

Models	**Estimation of Trade Elasticity** θ
BEJK (Bernard, Eaton, Jensen, and Kortum)	2.81
EK (Eaton and Kortum)	4.21
Melitz	3.41
Armington/Kartoum	5.21

Table 6: Estimation of different trade elasticities for different models

The exercise conducted by Siminovska and Waugh (2012) resulted in different elasticity estimates across the three models. In particular, the Bernard, Eaton, Jensen, and Kortum (2003) model yields the lowest estimate of 2.81, while the Armington and Krugman (1980) models generate the highest estimate of 5.21. Since, welfare is inversely related to θ, the results imply that the Bernard, Eaton, Jensen, and Kortum (2003) model generates the highest, while the Armington and Krugman (1980) models yield the lowest gains from trade.
Figure 9 in the next page provides a graphical representation of the different levels of trade elasticities.

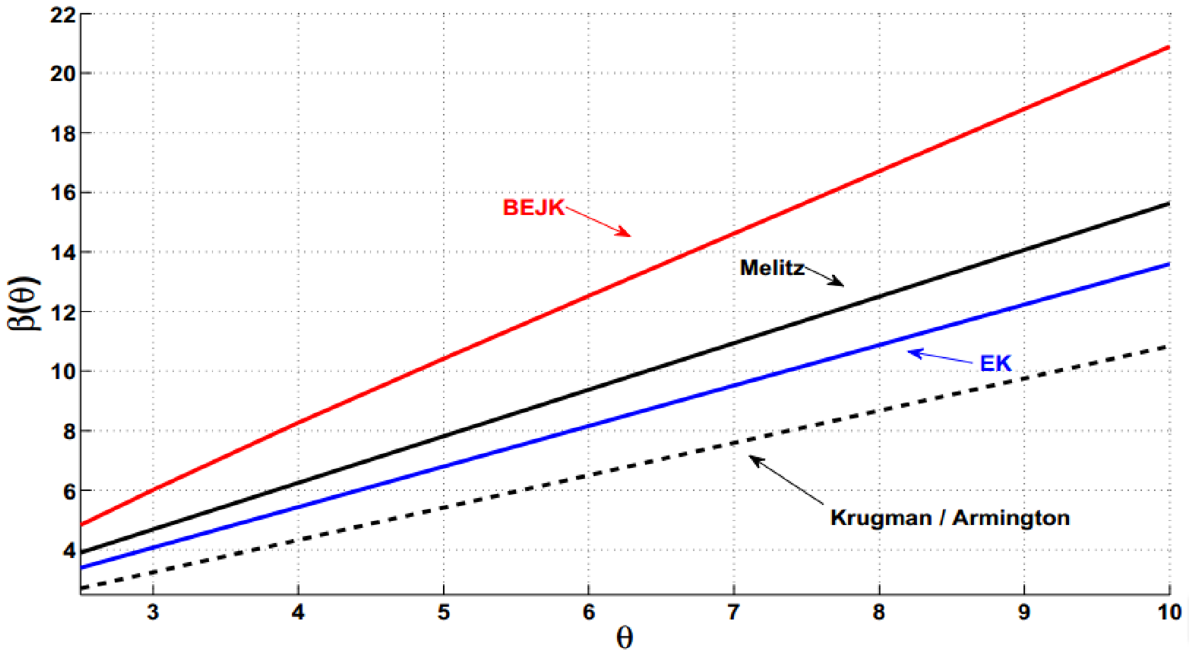


Figure 9: Representation of different levels of elasticities for different models

5. EMPIRICS

5.1. Empirics from : Costinot and Rodriguez-Clare (2013), "Trade Theory with Numbers: Quantifying the consequences of Globalisation."

In this chapter, I proceed to show empirical results from studies that were conducted to measure trade gains for different countries. The first set of empirics are based on the paper entitled, "Trade Theory with Numbers: Quantifying the consequences of Globalisation," by Costinot and Rodriguez-Clare (2013).

They explore quantitatively how various economic considerations; market structure, firm-level heterogeneity, multiple sectors, intermediate goods, affect the magnitude of the gains from. They use data from the World Input-Output Database (WIOD) in 2008. The database covers 27 EU countries and 13 other major countries.

- **The Case of One Sector Formula**

Gains from international trade G_j in country j, are defined as the absolute value of the percentage change in real income that would be associated with moving to autarky in country. The expression for these gains is given by :

$$G_j = 1 - \lambda_{jj}^{1/\varepsilon} \qquad \text{(i)}$$

In order to compute G_j we need measures of the trade elasticity, ε , and the share of expenditure on domestic goods, λ_{jj}. The trade elasticity is set to be five (ε = 5),which is a typical value used in the literature; see e.g. Anderson and Van Wincoop (2004) and Head and Mayer (2013).

To measure λ_{jj} in the data consider that

$$\lambda_{jj} = X_{jj} / E_j = 1 - \sum_{i \neq j} X_{ij} / \sum_{i=1}^{n} X_{ij} \qquad \text{(ii)}$$

Where $\sum_{i \neq j} X_{ij}$ measures the total imports by country j and $\sum_{i} X_{ij}$ is the total expenditure by country j.

The results are shown in table 7. In the column labelled 1 the gains from trade calculated using equation (i) for a single sector,. Costinot and Rodriguez-Clare (2013), assert that according to the simple armington model, gains from trade are below 2% for three countries: Brazil (1.5%), Japan (1.7%), and the United States (1.8%). It is evident that the gains from trade tend to be larger for smaller countries. The largest predicted gains are for Ireland (8.0%) and Hungary (8.1%)

- **The Case of Multiple Sectors**

Taking into account that gravity models can be extednded to multiple sectors, as in the frameworks of Levchenko and Zhang (2011), Hsieh and Ossa (2011) and Ossa(2012), the expression for trade gains in a multiple sector frame work is expressed as :

$$G_j = 1 - \prod_{s=1}^{S} \left(\lambda_{jj,s} \left(\frac{e_{j,s}}{r_{j,s}} \right)^{\delta_s} \right)^{\beta_{j,s}/\varepsilon_s} \qquad \text{(iii)}$$

$e_{j,s}$ denotes the share of total expenditure in country j allocated to sector s and $r_{j,s}$ denotes the share of total revenues in country i generated from sector s . $\beta_{j,s} \geq 0$ are exogenous preference parameters satisfying $\sum_{s=1}^{S} \beta_{j,s}$

The parameter δ characterizes the market structure: under monopolistic competition with free entry it is equal to one and under perfect or Bertrand competition zero . , gains from trade predicted by multi-sector gravity models with monopolistic competition differ from those predicted by models with perfect competition because of scale effects, as discussed in Arkolakis, Costinot, and Rodríguez-Clare (2012).

To compute the gains from trade using Equation (iii), we need measures of $e_{j,s}$ $r_{i,s}$ $\beta_{j,s}$ $r_{j,s}$

and sector-level trade elasticities ε_s for s = 1, ...,S. The data was from 35 sectors from the WIOD in 2008.17 Sector-level trade elasticities are from Caliendo and Parro (2010).

Columns 2 and 3 of table 7 report gains from trade using the multiple sector equation (iii). In Column 2, all sectors are assumed to be perfectly competitive, while in column 3, all sectors are assumed to be monopolistically competitive. The results we observe from the two columns are two fold:

- Costinot and Rodriguez (2013) claim that there are no systematic differences between the gains from trade predicted by multi-sector models with perfect competition

(Column 2) and those predicted by models with monopolistic competition (Column 3). Therefore as evident from the table, for some countries the gains under monopolistic competition are larger than under perfect competition. For example gains in Germany increase from 12.7% to 17.6%), while for other countries the opposite holds, take for example gains for Greece decrease from 16.3% to 4.7%

- The gains from trade predicted by multi-sector models under both market structures, Columns 2 and 3, are significantly larger than those predicted by one-sector models, Column 1. The average among all the countries in table 4 more than triples, increasing from 4.4% (Column 1) to 15.3% (Column 2), a point also emphasized in Ossa (2012).

Trade gains (G_j) Expressed in percentages computed using:							
One Sector (i)		**Multiple Sectors, No Intermediates (iii)**		**Multiple Sectors with Intermediates**			
		Perfect Comp.	Monopolistic Competition	Perfect Competition (data Alpha)	Perfect Comp.	Monopoly Comp. (Krugman)	Monopoly Comp. (Melitz)
Country	1	2	3	4	5	6	7
AUS	2.3	8.6	3.7	15.8	15.7	6.9	6.8
AUT	5.7	30.3	30.5	49.5	49.0	57.6	64.3
BEL	7.5	32.7	32.4	54.6	54.2	63.0	70.9
BRA	1.5	3.7	4.3	6.3	6.4	9.7	12.7
CAN	3.8	17.4	15.3	30.2	29.5	33.0	39.8
CHN	2.6	4.0	4.0	11.5	11.2	28.0	77.9
CZE	6.0	16.8	21.2	34.0	37.2	65.1	86.7
DEU	4.5	12.7	17.6	21.3	22.5	41.4	52.9
DNK	5.8	30.2	24.8	41.4	45.0	42.0	44.8
ESP	3.1	9.0	9.5	18.3	17.5	24.4	30.5
FIN	4.4	11.1	10.5	20.2	20.3	24.2	28.0
FRA	3.0	9.4	11.1	17.2	16.8	25.8	32.1
GBR	3.2	12.9	11.7	21.6	22.4	22.2	23.5
GRC	4.2	16.3	4.7	23.7	24.7	6.8	6.1
HUN	8.1	29.8	31.3	53.5	55.3	75.7	91.0
IDN	2.9	5.5	4.0	13.1	11.6	11.2	14.6
IND	2.4	4.6	4.3	9.2	8.6	9.5	11.7
IRL	8.0	23.5	14.2	37.1	38.9	28.1	29.1
ITA	2.9	8.7	9.2	16.4	16.2	21.7	26.5
JPN	1.7	1.4	3.7	4.6	3.5	20.7	32.7
KOR	4.3	3.9	8.6	12.5	11.4	44.1	70.2
MEX	3.3	11.1	12.1	18.4	18.6	24.3	28.4
NLD	6.2	24.3	23.1	40.1	39.8	43.4	47.6
POL	4.4	18.4	19.7	33.8	34.5	46.9	57.0
PRT	4.4	23.8	20.6	35.9	37.4	36.7	40.3
ROM	4.5	17.7	12.7	26.4	29.2	20.8	20.7

RUS	2.4	18.0	0.9	35.9	30.7	-2.1	-7.1
SVK	7.6	22.2	23.6	48.3	50.5	78.6	96.4
SVN	6.8	39.6	39.3	57.8	61.6	71.3	79.7
SWE	5.1	12.5	14.5	24.4	23.6	36.6	45.8
TUR	2.9	11.9	13.3	20.0	20.9	26.4	29.5
TWN	6.1	9.6	9.9	19.9	19.4	28.6	37.8
USA	1.8	4.4	3.8	8.3	8.0	8.6	10.3
RoW	5.2	15.2	7.3	33.3	28.4	18.1	21.8
Average	4.4	15.3	14.0	26.9	27.1	32.3	40.0

Table 7: Trade gains expressed as percentages under different market structures, single and multiple sectors with or without intermediates

(The numbers in parenthesis indicate the equation used for the computation. All data is from WIOD and trade elasticities are from Caliendo and Parro (2010). Under perfect competition $\delta_s = 0$ for all s and under monopolistic competition $\delta_s = 1$ for all s.)

Turning our attention to the different market structures with intermediates (column 4-7), we find that predicted gains from trade are much higher than those predicted by the same models without intermediate goods. For instance the gains from trade for the Sweden and United Kingdom in Column 4 are twice as high as those in Column 2.

The interpretation of the results is two fold:

- Trade in intermediates is associated with a decrease in the price of domestic goods, which implies additional welfare gains. In the case where domestic goods are used as inputs in domestic production, this triggers additional rounds of productivity gains, leading to even larger gains. (Costinot and Rodriguez, 2013)
- For given data on the share of expenditure on domestic goods, $\lambda_{jj,s}$, models featuring intermediate goods necessarily predicts more trade relative to total income. So, perhaps, it should not be too surprising that the same models predict that real income increases by more because of trade. (Column 2). (Costinot and Rodriguez, 2013)

These results prompt the question: ***Why do multi-sector gravity models predict much larger gains than their one-sector counterparts?***

Costinot and Rodriguez (2013) argue that , *"part of the art of the answer is: Cobb-Douglas preferences. This assumption implies that if the price of a single good gets arbitrarily large as a country moves to autarky—because it cannot produce that good—then gains from trade are infinite. According to Equation (iii), this will happen either if the share of expenditure on domestic goods,* $\lambda_{jj,s}$*, is close to zero—which implies arbitrarily large costs of production for* *that good at home—or if the trade elasticity, ε_s, is close to zero—which implies that foreign varieties are essential."*

5.2. Empirics from: Ossa (2012), "Why Trade Matters After All."

Ossa (2012) explores quantitatively how, firm-level heterogeneity, , intermediate goods, and affect the magnitude of the gains from.

The data used on international trade flows is from the UN-Comtrade database which covers most countries in the world. In particular, the focus is on the world's 49 largest economies and a residual Rest of the World in the year 2005. The elasticities are taken from Broda and Weinstein (2006). Table 8 summarizes the changes in real income resulting from a move from autarky to year 2005 levels of trade.

The results under "True gain" are computed using the industry-level formula

$$\frac{\hat{w}_j}{p_j} = (\lambda_j)^{-\frac{\beta_j}{\gamma_j}\sum_{s=1}^{S}\alpha_{js}\frac{\log\lambda_{js}}{\log\lambda_j}\frac{1}{\sigma_s - 1}} \qquad \text{(iv)}$$

In equilibrium, a share β_i is the share of workers is working in the traded goods sector earning a share γ_i

The results under "Naive gains" are computed using the aggregate formula

$$\frac{\hat{w}_j}{p_j} = (\lambda_j)^{-\frac{\beta_j}{\gamma_j}\frac{1}{\sigma - 1}} \qquad \text{(v)}$$

The results under "Ratio" are simply the ratio of the (iv) and (v). Columns 1-3 do not adjust for nontraded goods or intermediate goods (i.e. set $\beta_j = 1$ and $\gamma_j = 1$) while columns 4-6 do (i.e. set $\beta_j = 0.188$ and $\gamma_j = 0.312$).

It is evident from the results in table 5 that allowing for cross-industry heterogeneity in the trade elasticities increases the estimated gains from trade for all countries in the sample. For example, the estimated gains from trade of the US increase from 6.4 percent to 42.0 percent if I do not adjust for nontraded goods and intermediate goods and from 3.8 percent to 23.5 percent if I do. Similarly, the gains from trade of the UK increase from 10.8 percent to 79.2

percent if I do not adjust for nontraded goods and intermediate goods and from 6.4 percent to 42.1 percent if I do. On average, the "true" gains from trade exceed the "naive" gains from trade by a factor of 8.5 if I do not adjust for nontraded goods and intermediate goods and by a factor of 7.5 percent if I do.

Gains from Trade

	Unadjusted $\beta = 0$ and $\gamma = 0$			**Adjusted $\beta = 0.188$ and $\gamma = 0.312$**		
	True Gain (%)	Naive Gain (%)	Ratio	True Gain (%)	Naive Gain (%)	Ratio
Argentina	39.7	4.8	8.2	22.3	2.9	7.8
Australia	73.1	9.1	8.0	39.2	5.4	7.2
Austria	145.7	16.2	9.0	71.9	9.5	7.6
Belgium	158.2	22.3	7.1	77.1	12.9	6.0
Brazil	21.7	3.2	6.7	12.6	1.9	6.5
Canada	96.3	12.9	7.5	50.2	7.6	6.6
Switzerland	135.1	14.3	9.4	67.4	8.4	8.0
Chile	49.8	7.6	6.6	27.6	4.5	6.1
China	152.6	8.6	17.8	74.8	5.1	14.7
Columbia	52.1	6.3	8.3	28.8	3.7	7.7
Czech Republic	193.4	18.1	10.7	91.3	10.5	8.7
Germany	86.9	10.0	8.7	45.8	5.9	7.7
Denmark	139.0	15.5	9.0	69.0	9.0	7.6
Spain	73.1	10.0	7.3	39.2	5.	6.6
Finland	99.6	10.0	9.9	51.7	5.9	8.7
France	104.6	12.9	8.1	54.0	7.6	7.1
UnitedKingdom	79.2	10.8	7.3	42.1	6.4	6.6
Greece	76.9	10.4	7.4	41	6.1	6.7
Crotia	98.9	13.1	7.5	51.3	7.7	6.6
Hungary	263.4	18.1	14.6	117.6	10.5	11.2
Indonesia	25.5	3.6	7.1	14.7	2.2	6.8
India	42.4	5.0	8.5	23.7	3.0	8.0
Ireland	133.5	14.0	9.5	99.7	3.0	8.1
Iran	54.3	8.3	6.6	29.9	8.2	6.1
Italy	60.1	7.9	7.6	32.8	4.9	7.0
Japan	13.4	2.3	5.8	7.9	4.7	5.7
Kazakhstan	71.7	11.3	6.4	3.5	1.4	5.8
Korea	70.7	7.1	9.9	38.0	6.6	9.0
Morocco	95.4	9.6	10.0	49.7	4.2	8.8
Mexico	117.2	10.1	11.6	59.6	5.7	10.0
Netherlands	188.9	19.8	9.5	89.5	6.0	7.8
Norway	78.5	11.3	6.9	41.8	11.5	6.3
New Zealand	55.9	8.5	6.6	30.7	6.7	6.7
Pakistan	57.6	6.1	9.4	31.5	5.0	8.7
Peru	41.1	5.2	7.8	23.1	3.6	7.4
Poland	123.0	13.3	9.2	62.1	3.1	7.9
Portugal	89.0	11.9	7.5	46.7	7.8	6.7
Rest of World	68.1	11.4	6.0	36.8	7.0	5.5
Russia	39.8	5.4	7.3	22.3	6.7	6.9
Saudi Arabia	75.4	9.8	7.7	40.3	3.2	7.0
Sin/Mal/Phi	144.8	13.6	10.6	71.5	5.8	8.9

Slovokia	129.5	15.7	8.2	65.0	8.0	7.1
Slovenia	149.9	17.5	8.6	73.6	9.2	7.2
Sweden	110.8	12.4	9.0	56.7	10.2	7.8
Thailand	115.8	10.5	11.0	58.9	7.3	9.5
Turkey	47.4	7.6	6.3	26.3	6.2	5.9
Ukraine	104.6	12.8	8.2	53.9	4.5	7.2
United States	42.0	6.4	6.6	23.5	7.5	6.2
Venezuela	54.4	6.3	8.6	29.9	3.8	8.0
South Africa	63.9	8.3	7.7	34.7	4.9	7.0
AVERAGE	92.1	10.5	8.5	47.1	6.2	7.5

Table 8: Summary of changes in real income resulting from a move from autarky to year 2005 levels of trade.

"True gain" are computed using the industry-level formula and "Naïve gain" are computed using the aggregate formula.

The key result obtained from this empirical study is that accounting for cross-industry variation in trade elasticities greatly magnifies the estimated gains from trade. He supports this result by arguing that , *"While imports in the average industry do not matter too much, imports in some industries are critical to the functioning of the economy*." To illustrate this argument consider figure 10 in Appendix A which shows that a large share of the adjusted "true" gains from trade can be attributed to a small share of critical industries. As can be seen, the 10 percent most important industries account for more than 80 percent of the log gains from trade on average. To provide an overview of the critical industries, table 9 in Appendix B, lists the 10 percent of critical industries in the sample with the lowest elasticities of substitution.

6. CONCLUSION

To conclude, I will revisit the research question of this literature survey, how large are the welfare gains from international trade and how has the development of new trade models changed our understanding of the welfare gains from trade?

In new trade theory (Krugman, Merlitz, Krugmann Helpmann) welfare gains from intra-industry trade have focused on three sources of gains: 1) gains from increased variety and economies of scale, 2) productivity gains at the industry level from shifting resources away from low productivity firms and towards high-productivity firms, and 3) productivity gains at the firm level from innovating for a larger market.

Krugman(1980) stressed that through the expansion of available product variety to consumers trade liberalization should yield larger welfare gains than when these mechanisms are not present (as in the perfect competition Armington trade model as used, e.g., by Anderson and van Wincoop, (2003). In a similar vein, Melitz (2003) is of the view that international trade under the new trade regime should yield larger gains through the weeding out of inefficient firms.

On the contrary, a recent paper by Arkolakis et al, (2012) has forcefully challenged the views of new trade theory above. The paper concludes that so far there has no been significant gains. Arkolakis derives a formula that relates welfare gains to the change in observed openness and to the elasticity of trade flows with respect to iceberg trade costs. In the analysis of this literature survey, exactly the same formula holds in the Melitz (2003), Krugman (1980) and Armington models, the gravity based models stressed that there are no additional welfare gains in new trade models as compared to old trade theory.

Arkolakis, Costinot, and Rodriguez-Clare (2011) show that within the gravity models of trade, there exist two sufficient statistics for welfare analysis: (i) the share of expenditure on domestic goods; and (ii) the trade elasticity.In response to the research question above, they show that the trade elasticity is one of only two statistics needed to measure the welfare cost of autarky in a large and important class of trade models. However , Waugh and Simonovska (2012) criticised Arkolakis et al (2011) by arguing that that different models different trade elasticities and,hence, different welfare gains from trade. Levchenko and Zhang, (2012) also pointed out that, one of the demerits of the Arkolakis result is that “when there are multiple sectors, a one-sector formula that only incorporates information on the total trade volume relative to absorption systematically understates the true gains from trade.”

Why are the estimated gains considerably large? The empirical studies conducted by Ossa (2012) and Costinot and Rodriguez (2013 both showed that allowing for sectoral heterogenity leads to large trade gains than was initially estimated by Arkolakis (2011). While it is true that Arkolakis et al (2012) discuss a multi-industry formula in an extension , the authors did not contrast it to their aggregate formula or use it to actually calculate the gains from trade. Costinot and Rodriguez (2013) argues that, *“part of the art of the answer is: Cobb-Douglas preferences. This assumption implies that if the price of a single good gets arbitrarily large as a country moves to autarky—because it cannot produce that good—then gains from trade are infinite.”* Ossa (2013) offers another insight by stating that *“While imports in the average industry do not matter too much, imports in some industries are critical to the functioning of the economy*.”

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APPENDIX A: Industry contributions to gains from trade

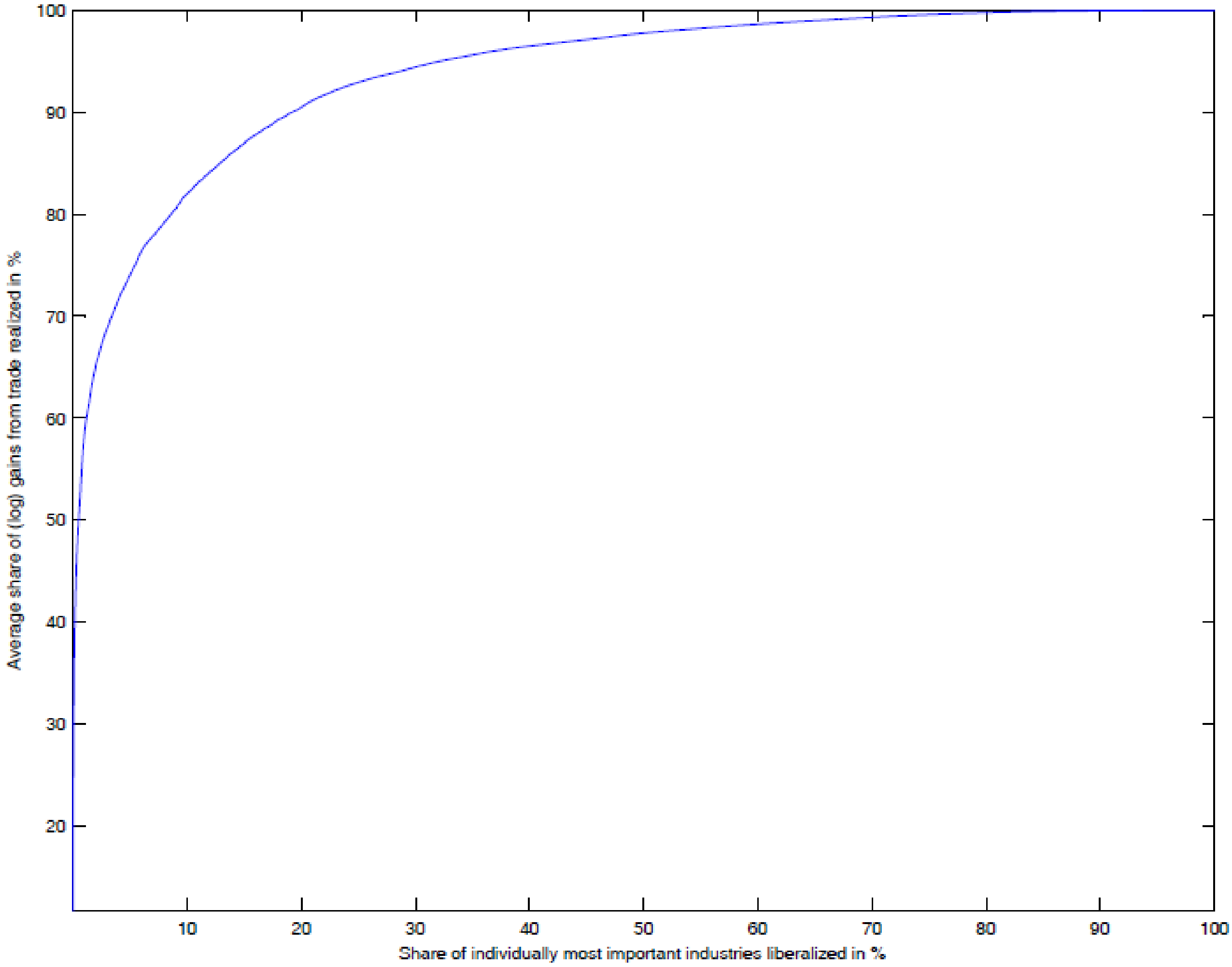

Figure 10: Industry contributions to gains from trade

APPENDIX B: List of critical industries with lowest elasticity of substitutions

Sitic Code	PRODUCT DESCRIPTION
6648	GLASS MIRRORS(INCL.REAR-VIEW MIR.),UNFRAMED.FRAMED
6747	TINNED SHEETS AND PLATES,OF STEEL
7763	DIODES,TRANSISTORS AND SIM.SEMI-CONDUCTOR DEVICES
7782	ELECT.FILAMENT LAMPS AND DISCHARGE LAMPS
8993	CANDLES,MATCHES,PYROPHORIC ALLOYS ETC.
5122	CYCLIC.ALCOHOLS & THEIR HALOGENATED DERIVATIVES
5163	INORGANIC ESTERS,THEIR SALTS,& THEIR DERIVATIVES
5311	SYNTHETIC ORGANIC DYESTUFFS
6597	PLAITS AND SIMILAR PRODUCTS OF PLAITING MATERIALS
6951	HAND TOOLS OF A KIND USED IN AGRICULTURE ETC
6954	INTERCHANGEABLE TOOLS FOR HAND & MACHINE TOOLS
7169	PARTS OF ROTATING ELECTRIC PLANT
7263	MACH.,APPAR.,ACCESS.FOR TYPE FOUNDING OR SETTING
7451	TOOLS FOR WORKING IN THE HAND,PNEUMATIC,PARTS
7643	RADIOTELEGRAPHIC & RADIOTELEPHONIC TRANSMITTERS
7723	RESISTORS,FIXED OR VARIABLE AND PARTS
8482	ART.OF APPAREL & CLOTHING ACCESSORIES,OF PLASTIC
8952	PENS,PENCILS AND FOUNTAIN PENS
8982	OTHER MUSICAL INSTRUMENTS OF 898.1-
8997	BASKETWORK,WICKERWORK ETC. OF PLAITING MATERIALS
8998	SMALL-WARES AND TOILET ART.,FEATHER DUSTERS ETC.
5335	COLOUR.PREPTNS OF A KIND USED IN CERAMIC,ENAMELLI
5983	ORGANIC CHEMICAL PRODUCTS,N.E.S
6549	FABRICS,WOVEN,N.E.S.
6624	NON-REFRACT.CERAMIC BRICKS,TILES,PIPES & SIM.PROD.
6637	REFRACTORY GOODS(EG.,RETORTS,CRUJCIBLES ETC) N.E.S
6924	CASKS,DRUMS,BOXES OF IRON/STEEL FOR PACKING GOODS
6978	HOUSEHOLD APPUANCES,DECORATIVE ART.,MIRRORS ETC.
7246	AUXIL.MACHINERY FOR HEADINGS 724.51/52/53
7268	BOOKBINDING MACHINERY AND PARTS
7272	OTHER FOOD PROCESSING MACHINERY AND PARTS
7422	CENTRIFUGAL PUMPS,OTHER THAN 742.81
7423	ROTARY PUMPS,OTHER THAN 742.81
7712	OTHER ELECTRIC POWER MACHINERY,PARTS OF 771-
8742	DRAWING,MARKING-OUT,DISC CALCULATORS AND THE LIKE
8842	SPECTACLES AND SPECTACLE FRAMES
8935	ART.OF ELECTRIC LIGHTING OF MATERIALS OF DIV.58
8981	PIANOS AND OTHER STRING MUSICAL INSTUMENTS
8989	PARTS OF AND ACCESSORIES FOR MUSICAL INSTRUMENTS
8124	LIGHTING FIXTURES AND FITTINGS AND PARTS
5123	PHENOLS & PHEN.-ALCO.& THEIR HALOGENAT.DERIVATIVES
5222	INORGANIC ACIDS AND OXYGEN COMPOUNDS OF NON-METAL
5223	HALOGEN AND SULPHUR COMPOUNDS OF NON-METALS
5322	TANNING EXTRACTS OF VEGET.ORIGIN;TAN.& DERIVATIVES
6665	TABLEWARE & OTHER ARTICLES OF OTH.KINDS OF POTTERY
8745	MEASURING,CONTROLLING & SCIENTIFIC INSTRUMENTS
8748	ELECTRICAL MEASURING,CHECKING,ANALYSING INSTRUM

Table 9: List of critical industries with low elasticity of substitution, adopted from Ossa (2012)