Essays in International Economics

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to my parents, Leyla and Atilla ...

Abstract

This dissertation considers firms' optimal behavior while participating in international trade when firms are ex ante heterogeneous in terms of their productivity. The first chapter explains why a representative firm assumption cannot explain most of the observations we see in the data related to exporting firms and non-exporting firms. Moreover, this chapter explains the mechanism of why the theory needs a heterogeneous firm assumption to explain the observed facts.

The second chapter deals with the interaction between income differences across countries and international trade patterns. Income is not equally distributed among countries and this chapter analyzes the effect of this unequal distribution on bilateral trade patterns in an environment with heterogeneous firms. The second chapter develops a framework in which countries, depending on their income, potentially demand different sets of varieties as well as different quantities for a given variety using non-homothetic preferences which is in contrast to the standard framework with homothetic preferences. A quantitative comparison between the framework proposed in this chapter and a standard framework shows that they predict similar trade patterns even with different estimated inputs for the variable trade barriers, implying that when rich countries export, income differences with the trading partner in my framework play a similar role as additional trade barriers in the standard framework. Finally, this chapter analyzes the impact of high growth of poor countries. As poor countries grow, the trade barriers they face fall. As a consequence, the increase in the growth of world trade in the non-homothetic model will be higher than the predicted counterpart in the standard model.

The third chapter analyzes asymmetric information and impacts of this on the decisions of importers and exporters engaged in international trade. This chapter incorporates learning and reputation building into a simple stochastic dynamic model of trade and studies two bilateral trade flows influenced significantly by learning and reputation, namely United States imports of Japanese and French cars over the period

1961-2005. This chapter finds that since learning and reputation building require time, predicted short run trade patterns can be quite different than those predicted in the long run.

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Chapter 1

Representative versus Heterogeneous Firms

1.1 Introduction

Trade theories can be categorized into two main groups: Old (or conventional) theory and new theory. Old theories of international trade are based on the differences in opportunity costs of production. The two main old theories which are based on comparative advantage are: "Ricardian" and "Heckscher-Ohlin" theories. In a seminal contribution, Krugman (1980) introduced the "new" trade theory. New trade theory is based on imperfect competition, increasing returns to scale and consumers' love of variety. The main different implication of these "old" and "new" theories is if the trade is "inter-industry" or "intra-industry". Old theory implies that a country's exports and imports are in different industries. The latter one implies that a country exports and imports in the same industry. What we observe in the data is consistent with "intra-industry" meaning that there is a two-way trade within industry between countries. In contrast to the new theory, "old theory" cannot explain this observation. The most common example would be automobile industry implying two-way trade within industry between countries, such as Germany and the United States. In the 1980s since the aim was to explain large volumes of trade between countries with similar factor compositions and large volumes of intra-industry trade, differences in productivity or size were not considered to be important. As a result, the models assumed symmetry across firms within an industry in terms of available technology, which implied the symmetric optimal choices for firms.

However, a recent literature documented that most of firms do not export at all. Eaton, Kortum, and Kramarz (2004) report that in the mid 1980s only 17.4% of French firms in manufacturing industries exported. They also report that firms that are exporting only exported 21.6% of their output. Other papers that report these facts are: Clerides, Lach, and Tybout (1998) for Colombia, Mexico, and Morroco; Bernard and Jensen (1999) for the US; Aw, Chung, and Roberts (2000) for Tawian; Delgado, Farinas, and Ruano (2002) for Spain; and Baldwin and Gu (2003) for Canada. In response to the failure of new trade theory in terms of explaining that most firms do not export at all, Melitz (2003) and Bernard, Eaton, Jensen, and Kortum (2003) introduce firm heterogeneity in order explain this fact. Schmitt and Yu (2001) present a similar model where the heterogeneity comes from firms-specific fixed costs rather than marginal cost. Montagna (2001) also presents a Melitz-like model in terms of mechanism and results but does not have the Hopenhayn variety generation mechanism.

1.2 Representative versus Heterogeneous Firms

Within each industry, both old and new theory assumed a representative firm. The representative firm assumption is not perfectly realistic. Despite being an unrealistic assumption, the more crucial problem with this assumption in both theories, old and new, is that it cannot match some empirical facts which will be discussed later. Moreover, heterogeneous firm models introduce a channel where international trade allows improvements in aggregate productivity. Hence, heterogeneous firm models predict another channel for welfare gains from trade in contrast to old and new theory.

One of the main empirical challenges that both old and new theory cannot explain is that most of the firms within a country do not export. Bernard, Jensen, Redding, and Schott (2007) reports that only 4 percent of the operating 5.5 million firms engaged in exporting in the United States in 2000. They also report that only 18 percent of all U.S. manufacturing firms engaged in exporting according to data from 2002 U.S. Census of Manufacturers.

Another empirical challenge with old and new theories is to explain the different firm characteristics between exporters and non-exporters. Across a wide range of countries and industries, exporters are larger, more productive, more capital intensive and pay higher wages than non-exporting firms. These findings emerged beginning with Bernard and Jensen (1999). Among these characteristics, the two most important ones that are different between exporters and non-exporters are size (employment) and productivity (value-added per worker). Bernard, Jensen, Redding, and Schott (2007) reports that exporting firms have 119 percent more employment and 26 percent higher productivity (value-added per worker) by using the data from U.S. manufacturing exporters' "export premia" for 2002.

Hence, we see that there is a strong correlation between export status and firm characteristics (especially higher productivity). This correlation leads up to the question of causality. Recent literature examined this causality question. Most of the literature focuses on a firm's productivity trajectory over time relative to its export status decision. Most of these papers find that firms are relatively more productive prior to their entry into export markets. Clerides, Lach, and Tybout (1998) and Bernard and Jensen (1999) are the two early influential papers in this area.Clerides, Lach, and Tybout (1998) were one of the first to model the fixed exporting costs as a discrete choice framework. In their model, more productive firms with lower marginal costs earn higher gross profits from producing, but not all firms export. Only a subset of firms with sufficiently high profits to cover the fixed costs of entering export markets does so. Fixed cost of exporting and firm heterogeneity interact, and the most productive firms self-select into export markets.

However, these empirical patterns cannot be match by trade models based on representative firms. Due to the nature of the representative firm assumption, within a sector, international trade will affect all firms in similar ways. Clearly, with this assumption, all the firms' optimal decisions will be identical to each other. There are two classes of models in order to explain these empirical facts. The first one, developed by Bernard, Eaton, Jensen, and Kortum (2003), introduces stochastic firm productivity into the multi-country Ricardian model analyzed in Eaton and Kortum (2002). The second one, developed by Melitz (2003), introduces a firm heterogeneity into a Krugman (1980) model.

Bernard, Eaton, Jensen, and Kortum (2003) develop a model of firm heterogeneity based on the probabilistic model of comparative advantage of Eaton and Kortum

(2002). The main predictions of Bernard, Eaton, Jensen, and Kortum (2003) are the following: First, firms that are more efficient charge a higher markup. Second, only a subset of firms will export. Moreover, with the Frechet distribution assumption, the model implies that exporting firms in a given country are, on average, more productive than domestic firms. Third, exporters are, on average, bigger than non-exporters.

A second class of models initiated by Melitz (2003) introduces firm heterogeneity into a Krugman (1980) model of intra-industry trade. For the dynamic industry equilibrium part, it builds on Hopenhayn (1992). The two key assumptions of Melitz (2003) are the following. First, firms are ex-ante different in terms of their productivity and the productivity of each firm is randomly drawn from some distribution, prior to starting production. Second, a firm has to pay a fixed cost in order to export besides a variable cost (iceberg type). As a result of these assumptions, firms with more productivity earn larger profits. Due to the nature of fixed exporting cost, only a subset of firms (those that have sufficiently high productivity) can cover this fixed cost and export. This is can be called the "export productivity cut off." Other firms which do not have sufficiently high productivity cannot pay the fixed cost of exporting and, as a result, cannot export. The firms who can cover the fixed cost of exporting benefit from opening trade since there is an increased demand for their goods. However, other firms suffer from the additional competition from foreigners. As a consequence, when trade policy barriers fall or transportation costs decline, firms who have an ex ante productivity advantage survive and grow, while the firms who have lower productivity are more likely to fail. As a result, this reallocation of firms raises the aggregate productivity. Hence, trade liberalization leads to higher average productivity and a large turnover of firms. This channel of welfare gains from trade could not be addressed by both old and new trade theories. Trefler (2004) finds that both of these predictions are consistent with the impact of the Canada-US Free Trade Agreement on Canadian industries. Tybout and Westbrook (1995) also find market reallocations from low to high productivity plants in response to trade liberalization in Mexico. Bernard, Jensen, and Schott (2006) confirm the reallocations in favor of more productive exporting plants, and, hence, this implies an increase in average industry productivity. Tybout (2003) reports some cases where trade liberalization induces some reallocations between exporters and non-exporters competing in the same sector. Pavnick (2002) finds that most of the 25% productivity increase in export competing sectors in Chile between 1979 and 1986 is explained by reallocations between producers.

1.3 Extensions of Heterogeneous Firm Models

1.3.1 Different Views for Cost of Exporting

Roberts and Tybout (1997) use a structural model to estimate the size of sunk exporting costs for Colombian firms in three industries. They find that the sunk costs for small producers are between $412,000 and $430,000, and for large producers between $334,000 and $402,000. Earlier studies using sunk costs of exporting are Baldwin and Krugman (1989) and Dixit (1989).

In contrast to uniform fixed cost of exporting, Chaney (2008) introduces the assumption of a country specific fixed cost of entry. This framework has been shown by Eaton, Kortum, and Kramarz (2005) to account for the association between market size and firm entry along with features of firm level data for large exporters in each given destination. However, Arkolakis (2008) introduces a new formulation of market penetration costs and introduces it in Melitz (2003) in order to explain some observations which cannot be explained by the uniform fixed cost model. Arkolakis (2008) introduces marketing costs which are endogenous rather fixed in the sense that paying higher costs allows firms to reach an increasing number of consumers in a country. The small export volume of many firms has been especially puzzling to the uniform fixed cost model. However, Arkolakis (2008) shows that model with endogenous marketing costs quantitatively accounts for the small amounts exported by a large proportion of the French firms in each market, while it still predicts that most French firms do not export.

1.3.2 Combining Heterogenous Firm Models with Hecksher-Ohlin Theory

Bernard, Redding, and Schott (2007) have extended the Melitz (2003) model to accommodate variable factor proportions, producing a richer model of Helpman and Krugman (1985). Hence, Bernard, Redding, and Schott (2007) combine heterogeneous firms with assumptions of imperfect competition, scale economies, and Heckscher-Ohlin differences in factor endowments. The model generates predictions about the reallocation of resources across industries by firms. The main findings of this paper are as follows: Even trade raises average productivity in every country, importantly, within a country, trade raises average productivity proportionately more in the comparative advantaged industry, in other words, the sector that is relatively intensive in the input with which the country is relatively well-endowed. Factor composition generates the Heckscher-Ohlin type comparative advantage, and this also produces Ricardian comparative advantage. The two forms of comparative advantage are positively correlated. Moreover, trade increases the firm size, and relatively more so in sectors having comparative advantage.

1.3.3 Heterogenous Firms and FDI

Helpman, Melitz, and Yeaple (2004) have extended Melitz (2003) to handle foreign direct investment. In this extension, a firm in a home country has the option to build another production facility in another country. Alternatively, a firm can produce at home and then export. As long as the fixed cost of foreign direct investment is higher than the fixed cost of exporting, FDI raises firms' fixed costs but saves on variable unit costs by avoiding trade costs. Hence, most productive firms build a production facility in other country. Lower productivity firms serve the foreign market via exports, and still lower productivity firms only serve domestic markets. These findings are consistent with empirical evidence that multinational firms are more productive than exporters who are not multinationals, and exporters who are not multinationals are more productive than firms who serve only the domestic market. Helpman, Melitz, and Yeaple (2004) find that in 1996 US firms that engaged in FDI had a 15% labor productivity advantage over exporters who did not engage in FDI. Moreover, firms who did not engaged in FDI also had a 39% labor productivity advantage over firms who engaged in neither exporting nor FDI. Similar findings are reported by Head and Ries (2003) for evidence from Japan; Girma, Gorg, and Strobl (2004) for evidence from Ireland; and Girma, Kneller, and Pisu (2005) for evidence from the UK.

1.3.4 Heterogenous Firms and Financial Constraints

The Melitz (2003) model has been augmented with an additional dimension of firm heterogeneity that is exogenously given in addition to heterogeneity in productivity levels to analyze the decisions to enter export markets. Chaney (2005), for example, focuses on liquidity constrained exporting firms, assuming that firms inherit an exogenous amount of liquidity. Manova (2006) assumes that firms can only partially finance fixed cost of trade internally with this fraction differs exogenously across firms. Garcia-Vega and Guariglia (2007) analyze the effects of firms' exogenous income shocks on their probability of survival and their decisions to enter export markets. Goksel (2008a) develop a model with financing frictions in a model of international trade with firm heterogeneity and endogenous market access cost. This model gives opportunities to firms to reduce their market access cost endogenously in order to satisfy the financing constraints, allowing firms to enter the market with suboptimal levels. The model predicts that financing frictions not only determine a firm's export status but also its export volume. Goksel (2008a) also offers a potential explanation for the data observation that a large proportion of exporting firms export small amounts.

Suwantaradon (2008) studies the effects of financial market imperfections on a firm's operating and exporting decisions. Suwantaradon (2008) introduces financial frictions into a trade model with heterogeneous firms along the lines of Melitz (2003) in a dynamic setting. With the presence of financial constraints, even among a group of firms with the same productivity level, firms that are more financially constrained operate on a less efficient scale and, as a result, may no longer find operating and/or exporting profitable. Furthermore, financial frictions can have persistent effects on firms' dynamics. Productive firms with very low starting net worth will never accumulate enough to overcome credit constraints. Therefore, they will never start operating and never export even if they are very productive.

1.3.5 Heterogeneous Firms and Non-homothetic Preferences

The constant-elasticity demand function has been the workhorse of monopolistic competition studies in international trade. However, it has some undesirable features. The first undesirable result is that the CES demand function implies constant markups. Melitz and Ottaviano (2008) combine supply-side features from Melitz (2003) with demand side features from Ottaviano, Tabuchi, and Thisse (2008) to construct a model of international trade with variable markups in which market size affects average prices, price dispersion, and firm size. They reach the similar main conclusions with Melitz (2003) but with a different explanation. In Melitz and Ottaviano (2008), trade reduces markups as a result of the increase in competitive pressure from foreign exporters, and this raises the average productivity.

The second undesirable feature is that the CES demand function is homothetic. This assumption requires all households to demand goods of all quality levels in the same proportion. However, a richer demand system would allow rich households to consume disproportionately more high quality goods than poor households. Melitz and Ottaviano (2008) assumes quasilinearity even though they use non-homothetic preferences. Hence, they eliminate all the income effects in order to focus on competition effects. Goksel (2008b) explores the predictions of the heterogenous firm model with non-homothetic preferences for bilateral trade. Goksel (2008b) takes account of income effects but not competition effects. Simonovska (2008) studies the positive relationship between prices of tradables and per capita income levels across countries using non-homothetic preferences. Fieler (2007a) also examines bilateral trade flows with non-homothetic preferences based on an Eaton-Kortum type model.

1.3.6 Technology Adoption and Industry Switching with Heterogeneous Firms

Bustos (2005) introduces a technology choice into a Melitz (2003) model to analyze the impact of trade liberalization on technology upgrading in Argentina. In this extension, a firm can choose to use an advanced technology or a traditional technology after learning its productivity. The fixed cost of advanced technology is higher, but its advantage is that it has lower variable costs. With suitable restrictions on the parameters, the most productive firms use the more advanced technology, and some low-productivity exporters use the traditional technology. Some intermediate firms (in terms of productivity level) which are using traditional technology upgrade their technology, which is consistent with the Argentina data.

Bernard, Redding, and Schott (2006) develops a model to explain an alternative form of exit to death, namely industry switching. In this model, product switching depends on the fixed costs associated with production of different products and heterogeneity in firm productivity. More productive firms endogenously choose to produce products with higher sunk costs. Firms alter their output mix towards industries in which they have a comparative advantage and, hence, avoid competition from countries in industries where they do not.

1.3.7 Labor Markets and Heterogeneous Firms

Felbermayr, Prat, and Schmerer (2007) introduces search unemployment a la Pissarides (2000) into Melitz (2003). They analyze the long-run equilibrium rate of unemployment under two different trade scenarios: a reduction of variable trade costs and the entry of new trading countries. They find that, in both scenarios, the long-run equilibrium rate of unemployment rate falls.

1.3.8 Growth of New Exporters and Heterogenous Firms

Ruhl and Willis (2008) quantitatively assess the slow growth of new exporters with models of heterogenous firms. First, they report that the standard heterogenous firm model cannot replicate the behavior of new exporters since exporters grow too large too quickly. They impose an ad hoc demand function that is increasing in the number of periods the plant has been an exporter. The goal is not to explain the slow growth of new exporters. However, such demand specification captures the other effects that might lead a new exporter to slowly increase its exports. As mentioned before, Arkolakis (2008) introduces marketing costs which are endogenous rather fixed in the sense that paying higher costs allows firms to reach an increasing number of consumers in a country which forces them to slowly build market share. Rauch and Watson (2003) and Ruhl and Willis (2008) have suggested learning from the demand side and supply side, respectively, as an explanation for the slow growth of new exporters.

1.4 Conclusion

This survey, first, discusses why we need new theory instead of old (or conventional theory) and then discusses why we need heterogeneous firm models. The goal of new theory was to explain large volumes of trade between countries with similar factor compositions and large volumes of intra-industry trade. However, in order to explain some empirical facts about firms, such as most of the firms within a country do not export, we do need more than representative firm models, namely heterogeneous firm models. Moreover, heterogeneous firms predict another channel for welfare gains from trade in contrast to old and new theory.

Second, this survey discusses the extensions of heterogenous firms related to different topics including endogenous market access cost, combining firm heterogeneity with Hecksher-Ohlin Theory, FDI, financial markets, non-homothetic preferences, industry switching, technology adaption, labor markets and slow growth of new exporters.

Chapter 2

Income, Trade Barriers, and International Trade

2.1 Introduction

Rich countries export more to other rich countries than they do to poor countries.[1] In 2006, 49 percent of total world exports were from rich countries to other rich countries. On the other hand, rich countries' total exports to poor countries were only 19 percent of total world exports. Given these observations, I ask and answer the following question: Do income differences with the trading partner act as trade barriers when rich countries are exporting? In other words, do income differences play a similar role as geographical distance or other trade barriers? This paper argues that

[1] I use the World Bank definition for high-income countries. I refer to a country as rich if per capita income of that country is greater than or equal to $11,456 and refer to it as poor otherwise. The data is from the IMF. There are 183 countries in the sample. 48 (135) of these countries are rich (poor) according to the definition I use.

income differences with the trading partner act as trade barriers when rich countries export.

I develop a multi-country general equilibrium model of trade with heterogenous firms, in terms of different efficiency levels. I use non-homothetic preferences, namely quadratic preferences, in contrast to the standard constant elasticity of substitution (C.E.S.) preferences often used in trade literature. Countries are assumed to have different human capital levels, which will generate differences in per capita income in equilibrium. Unlike the C.E.S. case, demand of a variety can drop to zero at a finite price depending on income levels of consumers. Countries, depending on their income, potentially demand different sets of varieties and different quantities of each variety. In equilibrium, rich countries have similar trade patterns among each other, and trade between rich countries is more intense. There are no assumed fixed production costs or bilateral fixed trade costs for countries. However, differences in income across countries endogenously generate bilateral trade patterns, since consumers may not demand some goods that they cannot afford. As Linder (1961) argues, the demand side is a key determinant of trade patterns.

In order to answer the main question of this paper, I compare my model with a benchmark model.[2] The benchmark model has homothetic preferences and bilateral fixed trade barriers for each pair of countries. However, bilateral fixed trade barriers for each pair of countries imply additional degrees of freedom for the benchmark model. In order to make the comparison between the two models, I make two assumptions: First, I assume that all fixed bilateral trade barriers are the same for each pair of countries. Second, I assume that importer per capita income is a function of

[2]The benchmark model, which is a version of Melitz (2003) and Chaney (2008), will be discussed in detail in section 2.7.2.

variable trade barriers.[3] In other words, variable trade barriers being a function of per capita income corresponds to the additional dimension of the benchmark model compared to my model.

Estimation results imply that rich countries, on average, face lower trade barriers compared with poor countries when exporting to a rich country. Moreover, estimation results show that poor countries, on average, face higher trade barriers compared with rich countries when exporting to a poor country. Both models predict the above relations between trade barriers and income differences. However, in order to match the observed bilateral trade patterns, rich countries should face lower trade barriers when exporting to other rich countries and should also face higher trade barriers when exporting to poor countries in the benchmark model. Recovered trade barriers from these estimation results imply that rich countries export more to other rich countries than they do to poor countries in the benchmark model. The reason for this is rich countries face less friction when exporting to other rich countries and face more friction when exporting to poor countries in the benchmark model due to different estimated inputs for the variable trade barriers. After recovering trade barriers and human capital levels in both models, I find that the two models generate similar trade patterns: Rich countries export more to other rich countries than they do to poor countries, as we observe in data. The two models, in terms of measurement errors, are very close to each other, which will be discussed in detail in section 4. The non-homothetic model, without the additional dimension–per capita income–in the

[3]In order to recover the variable trade barriers I assume a functional form for trade barriers following Eaton and Kortum (2002) and Waugh (2007). In addition to the assumed variables in my model (shared border, distance, exporter fixed effect), importer per capita income is also assumed to be a function of variable trade barriers in the benchmark model, which will be discussed in detail in section 2.3.3.

estimation, can get trade patterns that are similar to the benchmark model. This result leads me to conclude that when rich countries are exporting, income differences with the trading partner in the non-homothetic model endogenously play a similar role as the additional trade barriers in the benchmark model.

In my model, for a given variety, price elasticity of demand is affected by the maximum price level that a consumer can afford, which is influenced by income level. If the maximum price level that a consumer can afford goes up, then price elasticity of demand for that variety decreases. With standard C.E.S. utility, price elasticity of demand depends only on the elasticity of substitution parameter, which is constant. In my model, firms have the option to choose different prices for a given variety, hence markups, for different consumers. This mechanism introduces unit price variation across different import markets conditional on exporter and product category.

Recent empirical studies have documented unit price variation across importers conditional on exporter and variety–e.g., Fieler (2007b), Hummels and Skiba (2004). Hummels and Skiba (2004) report that unit price variation (free on board) is 0.64 conditional on exporter and product category.[4] Fieler (2007b) finds that unit prices systematically increase with importer per capita in 85 percent of commodity categories. All these findings imply "unit price variation" across different import markets conditional on exporter and variety. Standard models of international trade with C.E.S. preferences, both with competitive markets and monopolistically competitive markets, do not predict unit price variation. A familiar result from the trade literature implies that free on board (f.o.b.) prices are invariant to destination either due to competitive markets or constant markup over marginal cost in the case of

[4] Free on board prices exclude the insurance and transportation cost.

monopolistically competitive markets. I use the model to explore unit price variation across importing countries conditional on exporter and product category. The model predictions for unit price variation is in the range of $(0.14, 0.42)$, where the data observation reported by Hummels and Skiba (2004) is 0.64. Standard models predict no variation for unit prices across importers conditional on exporter and variety.

My model is related to Melitz (2003), Melitz and Ottaviano (2008), and Ottaviano, Tabuchi, and Thisse (2008) with crucial differences.[5] For the demand side, I use quadratic preferences that are similar to the ones used in Ottaviano, Tabuchi, and Thisse (2008) with two important differences.[6] First, since the objective of their paper is different than this paper, they allow an outside sector. The outside sector in their model totally eliminates the income effect. However, in this paper I analyze the effects of endogenous income differences across countries on bilateral trade patterns. Hence, I do not allow an outside sector, i.e. quasilinearity, in order to analyze income differences across countries. Second, since the focus of their paper is different, the preferences used in Ottaviano, Tabuchi, and Thisse (2008) have an additional term that captures the competition effect. Since this paper is mainly interested in income differences across countries, I set that parameter to be zero. In this sense, I use preferences that are similar to the ones used by Neary (2003). However, Neary (2003) analyzes oligopolistic competition instead of monopolistically competitive markets.

The supply side of the economy is similar to the one introduced by Melitz (2003) with one difference. In my model, non-homothetic preferences endogenously generate

[5]My model is also related to Chaney (2008), which is a version of Melitz (2003). Fieler (2007a) analyzes bilateral trade patterns with a Ricardian model of international trade with non-homothetic preferences. In Fieler (2007b), goods differ in two respects: the income elasticity of demand and the extent of heterogeneity in production technologies.

[6]Melitz and Ottaviano (2008) also uses the same preferences developed by Ottaviano, Tabuchi, and Thisse (2008). See Arkolakis (2008) for a further discussion.

zero demand for some varieties, even with a finite price, depending on income levels. Consumers cannot afford goods with prices above some certain level. Hence, if the price of a variety is higher than the maximum level that a consumer can afford, then demand goes to zero for that variety. Moreover, consumers with different income levels have different upper bounds for the maximum level that they can afford. As a consequence, I do not assume any fixed production costs or bilateral fixed trade barriers.

I quantify the model by choosing country-specific human capital levels and variable trade barriers. In order to estimate the variable trade barriers, I follow Eaton and Kortum (2002) and Waugh (2007). I estimate a structural relationship between observed bilateral trade shares and variable trade barriers representing a gravity equation that has been widely used in empirical trade literature. I assume a functional form for variable trade barriers in order to relate it to observable data. Furthermore, in order to recover the human capital levels, I use additional data: per capita income, population, and the estimation results. Calibration of the benchmark model is very similar to the calibration of my model, with one crucial difference. As discussed before, for the functional form of variable trade barriers, I also assume per capita income as an additional variable, which is assumed to capture the additional dimension for the benchmark model. In other words, in the benchmark model, per capita income is also a function of variable trade barriers in addition to the other variables.

The outline of the rest of the paper is follows: In section 2.2, I describe the model. Section 2.3 presents the quantification method. Section 2.4 discusses income differences and trade barriers. Section 2.5 discusses the unit price variation and variable markups. Section 2.6 analyzes the impact of high growth of poor countries.

Section 2.7 discusses a potential extension of the non-homothetic model. Section 2.8 concludes.

2.2 The Model

I assume that there exist $i, j = 1, 2, ..., N$ countries. i and j denote the source country and the destination country respectively.

2.2.1 Consumer

Country j has population of measure L_j. Within each country j, consumers are endowed with l_j units of human capital.[7] There is a continuum of differentiated products indexed by $z \in \Omega_j$, where Ω_j is the set of all potential products in country j. All consumers in all countries share the same utility:

$$\int_{z\in\Omega_j} c_j(z)dz - \frac{1}{2}\ \gamma \int_{z\in\Omega_j} (c_j(z))^2\, dz, \tag{2.2.1}$$

where γ is positive and $c_j(z)$ denotes the quantity consumed for good z in country j. Parameter γ indexes the degree of product differentiation between varieties. A larger γ implies that varieties are less substitutable with each other.[8] The consumer maximizes the utility function subject to the budget constraint

$$\int_{z\in\Omega_j} p_j(z)c_j(z)dz = w_j l_j, \tag{2.2.2}$$

[7]This can be interpreted as effective labor being different across countries.

[8]In the limit case, $\gamma = 0$, products are perfect substitutes since consumers only value the consumption level over all products.

where w_j is the wage in country j and $p_j(z)$ is the price of good z in country j.

The demand for each variety z in country j is

$$c_j(z) = \frac{1 - \lambda_j p_j(z)}{\gamma} \tag{2.2.3}$$

whenever $c_j(z) > 0$. λ_j is the Lagrangian multiplier of the budget constraint.[9] The non-negativity constraint for $c_j(z)$ implies that if the price of good z in country j is less than or equal to $\frac{1}{\lambda_j}$, then $c_j(z) > 0$. However, if $p_j(z) > \frac{1}{\lambda_j}$, then $c_j(z) = 0$. Hence, we can define,

$$p_j^{\max} := \frac{1}{\lambda_j}. \tag{2.2.4}$$

At $p_j^{\max}$, the demand of a variety is driven to zero, since $p_j^{\max}$ is the maximum level that a consumer can afford in country j. There is no demand for the goods that have higher prices than $p_j^{\max}$.[10] As the marginal utility of income, λ_j, decreases, the maximum price level that a consumer can pay in country j, $p_j^{\max}$, increases.

Market demand for variety z in country j is given by

$$c_j^m(z) = c_j(z) L_j \ \ \forall \ z \in \Omega_j^*, \tag{2.2.5}$$

where $c_j^m(z)$ denotes the market demand for variety z in country j, and Ω_j^* denotes the consumed subset of varieties, where $\Omega_j^* \in \Omega_j$.

Also note that for a given good z, price of elasticity of demand (p.e.d.) is given by $\varepsilon_z = [(\frac{p^{\max}}{p(z)} - 1)]^{-1}$, which depends on $p^{\max}$. As the maximum level a consumer can pay in country j increases, p.e.d. for good z decreases. In the case of C.E.S.

[9] $\lambda_j = \frac{1-\gamma \bar{c}_j}{\bar{p}_j}$. See in section 2.7.1 for details.

[10] Marginal utility is bounded for all goods with quadratic preferences, in contrast to the case of C.E.S.

preferences, p.e.d. is uniquely determined by the level of product differentiation γ.

2.2.2 Firm

Each good is produced by a single firm. In all countries, all the firms have the same technology, constant returns to scale production function at marginal cost a, where a is the unit labor requirement. Labor is the only factor used in production. Firms are ex-ante only different by their unit labor requirement, a. Firms have to pay a sunk entry cost, e, in order to draw a unit labor requirement realization. I assume that new entrants draw their unit labor requirements from a known distribution $G(a)$ with support on $(0, a_u]$. I also assume that the distribution $G(a)$ and the upper bound for this support, a_u, is the same for all firms and the same in all countries. Firms that can cover their marginal cost stay in the market and start to produce. Remaining firms exit immediately without operating. Surviving firms maximize their profits using the residual demand function. Firms take λ_j as given, which is a monopolistic competition outcome.

The variable trade cost is modeled in the standard "iceberg" formulation. If one unit of any differentiated good is shipped from country i to country j, only a fraction, $\frac{1}{\tau_{ij}}$, of the good arrives. $\tau_{ij} > 1$ for any $i \neq j$, and $\tau_{ii} = 1$.

The profit maximization problem of a firm with unit labor requirement a selling from country i to country j is given by

$$\pi_{ij}(a) = \max_{p_{ij}(a), c_{ij}(a)} p_{ij}(a)\ c_{ij}(a) L_j - \tau_{ij}\ w_i\ a\ c_{ij}(a) L_j \tag{2.2.6}$$

s.t.

$$c_{ij}(a) = \frac{1 - \lambda_j p_{ij}(a)}{\gamma}. \tag{2.2.7}$$

The F.O.C. of the firm problem implies that

$$c_{ij}^m(a) = \frac{L_j}{\gamma}\left(\lambda_j p_{ij}(a) - \lambda_j \tau_{ij} w_i a\right). \tag{2.2.8}$$

The profit maximizing price $p_{ij}(a)$ may be above the price bound $p_j^{\max}$, in which case the firm exits. Let the marginal firm (firm which earns zero profit) selling from country i to country j be a_{ij}^*.[11] The firm, a_{ij}^*, earns zero profit since marginal cost for this firm, $\tau_{ij} w_i a_{ij}^*$, is equal to its price, $p_{ij}(a_{ij}^*)$. The demand level, $c_{ij}(a_{ij}^*)$, is driven to zero for this marginal firm, a_{ij}^*. Setting $c_{ij}^m(a_{ij}^*) = 0$ in (2.2.8) we have

$$p_{ij}(a_{ij}^*) = \tau_{ij} w_i a_{ij}^*. \tag{2.2.9}$$

We also have that $p_{ij}(a_{ij}^*) = \tau_{ij} w_i a_{ij}^* = p_j^{\max}$, since the marginal firm sets the highest price. There is no demand for the goods which have higher prices than $p_j^{\max}$. Hence, all firms with a lower than or equal to a_{ij}^* (who are selling from country i to country j) remain in the industry, and other firms exit. Therefore, a_{ij}^* is a threshold level for a firm selling from country i to country j. We can express price and quantity in terms of the threshold, a_{ij}^*:

$$p_{ij}(a) = \frac{1}{2}\tau_{ij} w_i \left(a_{ij}^* + a\right), \tag{2.2.10}$$

[11] I assume parameters such that $a_u > a_{ij}^* \ \forall i, j$.

$$c_{ij}^{m}(a) = \frac{L_j}{2\gamma}\left(\lambda_j \tau_{ij} a_{ij}^{*} w_i - \lambda_j \tau_{ij} w_i a\right). \tag{2.2.11}$$

Moreover, since λ_j is defined as $\frac{1}{p_j^{\max}}$, we can write

$$\lambda_j = \frac{1}{\tau_{ij} w_i a_{ij}^{*}}. \tag{2.2.12}$$

In contrast to the standard C.E.S. case, f.o.b. prices for a firm selling from country i to j are destination specific. In the case of C.E.S., the f.o.b. price for a firm in country i that is selling to country j is determined by the marginal cost of that firm and constant markup. In contrast to the C.E.S. case, linear demand case gives variable markups. Firms with lower a have the advantage of both setting lower prices and setting higher markups relative to firms with higher costs. Let $m_{ij}(a)$ be markups for a firm with a selling from country i to j where markups are defined as $m_{ij}(a) = p_{ij}(a) - a$. Using equation (2.2.10), markups are given by

$$m_{ij}(a) = \frac{1}{2}\left(\tau_{ij} w_i a_{ij}^{*} - \tau_{ij} w_i a\right). \tag{2.2.13}$$

In this case, firms selling from country i have the option to set different prices, hence markups, for different destinations. Recall that, in contrast to the C.E.S. case, price elasticity of demand is not constant and varies with $p_j^{\max}$ for a given good.

Moreover, for a firm with given a, sales, $r_{ij}(a) = p_{ij}(a)c_{ij}(a)$, and profits, $\pi_{ij}(a) = r_{ij}(a) - c_{ij}(a)\tau_{ij} w_i a$ can be expressed in terms of thresholds:

$$r_{ij}(a) = \lambda_j \frac{L_j}{4\gamma}\left(\left(\tau_{ij} a_{ij}^{*} w_i\right)^2 - \left(\tau_{ij} a w_i\right)^2\right), \tag{2.2.14}$$

$$\pi_{ij}(a) = \lambda_j \frac{L_j}{4\gamma} (\tau_{ij})^2 \left((a^*_{ij} w_i) - (w_i a) \right)^2 . \qquad (2.2.15)$$

2.2.3 Market Clearing

The market clearing condition implies that total income of a country i is equal to the total spending of country i:

$$w_i l_i L_i = \sum_{j=1}^{N} T_{ji}. \qquad (2.2.16)$$

The left hand side (L.H.S.) denotes the total income of country i. L.H.S. can be decomposed in two parts, as $w_i l_i$ is the per capita income and L_i is the measure of population. T_{ji} denotes the country i's spending over the goods from country j. Summing over all countries, including domestic markets, the right hand side denotes the total spending for country i.

Total export sales from country i to country j, T_{ij}, can be expressed as the multiplication of average sales per firms and the measure of the firms selling from country i to country j. Let M_i^E be the number of entrants in country i.[12] However, not all entrants produce in country i. Only a fraction of entrants in country i produce in order to sell in country j. The measure of operating firms from country i to country j is given by $M_{ij} = M_i^E \left(\frac{a^*_{ij}}{a_u} \right)^{\varphi}$. Then, total sales from country i to j are given by

$$T_{ij} = M_i^E \frac{(a^*_{ij})^{\varphi}}{a_u} \frac{1}{(\varphi + 2)(2\gamma)} \frac{L_j}{\lambda_j}. \qquad (2.2.17)$$

[12] M_i^E can be determined by the free entry condition and labor market clearing condition which is going to be explained in section 2.2.5.

Equations (2.2.12), (2.2.16), and (2.2.17) imply the following market clearing condition:

$$w_i l_i L_i = \sum_{j=1}^{N} M_i^E \left(\frac{a_{ij}^*}{a_u}\right)^{\varphi} \frac{L_j}{2\gamma} w_i \tau_{ij} a_{ij}^* \left(\frac{1}{(\varphi+2)}\right). \tag{2.2.18}$$

2.2.4 Free Entry

Firms pay a sunk cost, e, in order to draw their unit labor requirement, a. After firms pay the sunk entry cost, I assume that they draw their unit labor requirement from a Pareto distribution with support on $(0, a_u]$ which is given by

$$G(a) = \left(\frac{a}{a_u}\right)^{\varphi}, \tag{2.2.19}$$

where $\varphi > 1$ is the shape parameter. Let $G^*(a)$ be the distribution of unit labor requirement conditional on entry. Then, the truncated unit labor requirement distribution will be given by $G^*(a) = \left(\frac{a}{a_{ij}^*}\right)^{\varphi}, a \in (0, a_{ij}^*]$.[13] Free entry implies that, in equilibrium, expected profits, conditional on entry, of a firm must be equal to entry costs, $w_i e$. If the expected profit is lower than the entry cost, then a firm chooses not to enter the industry. As a result, only firms that have higher expected profits (conditional on entry) than the entry cost enter the industry. After equating expected profits (conditional on entry) equal to entry cost,

$$\left(\frac{a_{ii}^*}{a_u}\right)^{\varphi} \sum_{j=1}^{N} \left(\frac{a_{ij}^*}{a_{ii}^*}\right)^{\varphi} \frac{L_j}{2\gamma} a_{ij}^* \tau_{ij} \left[\frac{1}{(\varphi+1)(\varphi+2)}\right] = e. \tag{2.2.20}$$

[13] The truncated distribution will also be Pareto with shape φ.

2.2.5 Number of Entrants

Using the market clearing and free entry condition, we can determine the number of entrants in country i, M_i^E. Replacing equation (2.2.20) inside the market clearing condition (2.2.18) yields the following:

$$M_i^E = \frac{l_i L_i}{(\varphi+1)e}. \tag{2.2.21}$$

Then, the number of operating firms selling from country i to j is

$$M_{ij} = \frac{l_i L_i}{(\varphi+1)e}\left(\frac{a_{ij}^*}{a_u}\right)^{\varphi}. \tag{2.2.22}$$

2.2.6 Market Shares

Let μ_{ij} be the market shares defined as the ratio of total export sales from country i to country j, T_{ij}, to the total spending of country j, $\sum_{v=1}^{N} T_{vj}$:

$$\mu_{ij} := \frac{T_{ij}}{\sum_{v=1}^{N} T_{vj}}. \tag{2.2.23}$$

Using the definition of μ_{ij} and equation (2.2.17) for total exports from country i to country j, we can express market shares as

$$\mu_{ij} = \frac{M_i^E \left(a_{ij}^*\right)^{\varphi}}{\sum_{v=1}^{N} M_i^E \left(a_{vj}^*\right)^{\varphi}}. \tag{2.2.24}$$

Since $\lambda_j = \frac{1}{a_{ij}^* w_i \tau_{ij}}$, we have

$$\mu_{ij} = \frac{M_i^E \left(w_i \tau_{ij}\right)^{-\varphi}}{\sum_{v=1}^{N} M_v^E \left(w_v \tau_{vj}\right)^{-\varphi}}. \tag{2.2.25}$$

Moreover, substituting equation (2.2.21) into equation (2.2.25) yields the following relation for market shares:

$$\mu_{ij} = \frac{L_i l_i \left(w_i \tau_{ij}\right)^{-\varphi}}{\sum_{v=1}^{N} L_v l_v \left(w_v \tau_{vj}\right)^{-\varphi}}. \tag{2.2.26}$$

2.2.7 Equilibrium

In order to characterize the equilibrium, I impose balanced trade. In other words, country j's total exports must be equal to country j's total imports. Moreover, including each country j's consumption of goods produced at home implies the following condition:

$$\sum_{j=1}^{N} T_{ij} = \sum_{j=1}^{N} T_{ji}. \tag{2.2.27}$$

Using the market clearing condition, free entry condition, and balanced trade equation, the equilibrium threshold for the firms in country i selling to country j is characterized by the following equation:

$$a_{ij}^{*} = \left(\frac{l_j w_j a_u^{\varphi} e(\varphi+1)(\varphi+2)2\gamma}{w_i^{(\varphi+1)} \tau_{ij}^{(\varphi+1)} \sum_{v=1}^{N} \left(L_v l_v w_v^{-\varphi} \tau_{vj}^{-\varphi} \right)} \right)^{\frac{1}{(\varphi+1)}}, \tag{2.2.28}$$

where balanced trade imposes restrictions on relative wages:

$$w_i l_i L_i = \sum_{j=1}^{N} \mu_{ij} w_j l_j L_j, \tag{2.2.29}$$

where μ_{ij} is the fraction of spending by country j on goods from country i. The equilibrium number of operating firms selling from country i to country j is given by

$M_{ij} = \frac{l_i L_i}{(\varphi+1)e}\left(\frac{a^*_{ij}}{a_u}\right)^{\varphi}$.

2.3 Quantification

In this section, I first describe the data. Then I explain the quantification methodology for the non-homothetic model and the benchmark model respectively.[14]

2.3.1 Data

I use a sample of 20 countries. I select countries according to the following criteria: I divide 183 countries into two groups, rich and poor, according to the World Bank definition for high-income countries. I refer to countries as rich if they are defined as high income countries according to the World Bank definition and refer them as poor otherwise. A country is a high-income country if per capita income is over $11,455. After dividing the countries into two groups according to their per capita income, I choose ten countries with the highest GDP in each group.[15] In my sample, the rich countries are Australia, Canada, France, Germany, Japan, Italy, Korea, Spain, United States, and United Kingdom. The poor countries in my sample are Brazil, China, India, Indonesia, Iran, Mexico, Poland, Russia, South Africa, and Turkey. These 20 countries represent approximately 81 percent of world GDP. The model year is 2006. Bilateral trade flow data is taken from the IMF-DOTS CD-ROM.[16]

The empirical counterparts for T_{ij}'s and T_{jj}'s are as follows: T_{ij} is the total export

[14]See in section 2.7.2 for a more precise description of the benchmark model and its associated gravity equation.
[15]I repeat all the calibration exercises with different sets of countries. Results do not qualitatively change.
[16]DOTS refers to the IMF's "Direction of Trade Statistics."

sales from country i to country j. T_{jj} represents the gross domestic production for country j minus exports of country j plus imports of country j. Trade shares are defined as the ratio of the T_{ij} to T_{jj}.[17] For my sample, I only have one pair of bilateral trade with zero trade out of 380 observations. I drop this observation and set a sufficiently high trade barrier when computing the bilateral trade patterns.

Per capita GDP data and population data are from the IMF. The distance measures and border data are from the Centre D'Etudes Prospectives Et D'Informations Internationales (http://www.cpeii.fr). Distance measures are in miles and calculated following the great circle formula.[18]

The parameter φ indexes the dispersion of unit labor requirements a and is treated as equal across countries, which is a standard approach in international trade. It is closely related to the parameter θ in Eaton and Kortum (2002). Eaton and Kortum (2002) find a range of $(3.60, 12.86)$ depending on their estimation method for parameter θ.[19] I selected a value of $\varphi = 6.67$, which lies in the middle of their different estimations.[20]

The parameter for the upper bound of the unit labor requirement, a_u, plays no quantitative role other than satisfying the necessary assumptions. For my model, I choose the demand parameter, γ, to be 5. For the benchmark model, I choose the constant elasticity of substitution, σ, to also be 5. Table 2.1 summarizes the selected parameters.

[17] Note that market shares are defined as $\mu_{ij} := \frac{T_{ij}}{\sum_{v=1}^{N} T_{vj}}$. However, I define trade shares as $\frac{T_{ij}}{T_{jj}}$.

[18] The great circle formula uses latitudes and longitudes of the capital cities of different countries.

[19] Another related work Gatto, Mion, and Ottaviano (2006) find that average φ estimated to be close to 2 by using 11 EU countries and 18 manufacturing sectors.

[20] I also repeat the exercises for different values of φ in order to show the robustness of my results.

Table 2.1: Parameter Values

	My model	Benchmark
parameter		
γ	5	-
a_u	2	2
f	-	1
σ	-	5
φ	6.67	6.67

2.3.2 Quantification of the Non-homothetic Model

I calibrate the human capital parameters and trade barriers using bilateral trade, per capita income, and population data. First, I estimate the trade barriers by using the bilateral trade data. Second, I calibrate the human capital parameters by using the estimation results, per capita income, and population data. I follow the methodology used in Eaton and Kortum (2002) and Waugh (2007) in order to estimate the trade barriers. The model yields a gravity equation for aggregate bilateral trade flows. In order to derive the gravity equation, I use the equation for T_{ij}, total export sales from country i to j. Then, dividing both sides by country j's spending on home country goods, T_{jj},

$$\frac{T_{ij}}{T_{jj}} = \frac{L_i l_i w_i^{-\varphi} \tau_{ij}^{-\varphi}}{L_j l_j w_j^{-\varphi}}. \tag{2.3.1}$$

Similar to Eaton and Kortum (2002) and Waugh (2007), taking logs implies the following log-linear relationship:

$$\log\left(\frac{T_{ij}}{T_{jj}}\right) = V_i - V_j - \varphi \log \tau_{ij}, \tag{2.3.2}$$

where $V_j = \log(L_j) + \log(l_j) - \varphi \log(w_j)$. Following Waugh (2007), I assume the following functional form for variable trade barriers in order to relate them with the observable data:[21]

$$\log(\tau_{ij}) = b_{ij} + d_k + x_i + \delta_{ij}. \tag{2.3.3}$$

Here, b_{ij} is the border effect and equals 1 if country i and j share a border and 0 otherwise. $d_k (k = 1, ..., 6)$ is the effect of distance between country i and j lying in the kth intervals. The six distance intervals are in miles: $[0, 375]$; $[375, 750]$; $[750, 1500]$; $[1500, 3000]$; $[3000, 6000]$; $[6000, \text{maximum}]$. Following Waugh (2007) I use exporter fixed effects, x_i $(j = 1, ..., 20)$. x_i captures the additional cost country i faces to export a good to country j. I also assume that the error term δ_{ij} is orthogonal to the other regressors. Equations (2.3.2) and (2.3.3) provide the basis for the estimation of τ_{ij}'s and V_j's. I use ordinary least squares method for the estimation. Table 2.4 shows the estimation results. Finally, I use the estimation results in order to recover the trade barriers.[22]

2.3.3 Quantification of the Benchmark Model

The benchmark model has homothetic preferences. On the other hand, in the benchmark model, countries face bilateral fixed trade barriers for each pair of countries in addition to variable trade barriers. Note that with non-homothetic preferences, there are no fixed production cost or bilateral fixed trade barriers. Since there is always positive demand for all produced goods in the benchmark model, bilateral fixed

[21] Eaton and Kortum (2002) uses importer fixed effect instead of exporter fixed effect. See Waugh (2007) for a detailed discussion.

[22] in section 2.7.3 for the calibration of human capital levels. The third column in table (2.6) presents the calibrated human capital levels.

trade barriers are necessary for the existence of some firms not exporting from country i to country j. As discussed earlier, bilateral fixed trade barriers give additional degrees of freedom to the benchmark model. In order to answer the main question of this paper, I make a comparison between the two models. To do so, I make two assumptions for the benchmark model: First, I assume that bilateral fixed trade barriers are the same for each pair of countries. Second, I assume that variable trade barriers are a function of per capita income. The second assumption captures the additional country specific characteristic for the trade barriers in the benchmark model.

Quantification of the benchmark is similar to the quantification of the non-homothetic model with one crucial difference: For the functional form of variable trade barriers, I assume importer per capita income, y_j, as an additional variable. Hence, y_j corresponds to the additional dimension for the benchmark model. For the benchmark model, the assumed functional form for the trade barriers takes the following form:

$$\log(\tau_{ij}) = b_{ij} + d_k + x_i + y_j + \delta_{ij}. \tag{2.3.4}$$

y_j captures the effect of importer's per capita income on trade barriers while country i exports to country j. Table 2.5 presents the estimation results for the benchmark case. Using these estimation results, I recover the trade barriers for the benchmark model.[23]

Estimation results of these two models imply that in the benchmark model, countries systematically face lower trade barriers when exporting to rich countries com-

[23]See in section 2.7.4 for the calibration of human capital levels for the benchmark model. The second column in table 2.6 presents the calibrated human capital levels for the benchmark model.

pared to the estimation results of my model. Moreover, countries systematically face relatively higher trade barriers when exporting to poor countries compared to the estimation results of my model. For example, exporter i faces lower trade barriers when exporting to the United States (relatively rich country in the sample) with the recovered trade barriers calculated from (2.3.4) compared to those which are calculated from (2.3.3). Moreover, exporter i faces higher trade barriers when exporting to Poland (relatively poor country in the sample) with the recovered trade barriers calculated from (2.3.4) compared to those which are calculated from (2.3.3). Since the above findings are robust across countries in my sample, these results imply lower trade barriers when exporting to rich countries with the recovered trade barriers from the benchmark model compared to my model. Moreover, these results imply higher trade barriers when exporting to poor countries with the recovered trade barriers from the benchmark compared to my model.

2.4 Do Income Differences Act as Trade Barriers?

This section first presents the relation between income differences and trade barriers. Second, I compare the estimated trade barriers for the two models. Finally, I compare the two models in terms of bilateral trade patterns in order to answer the following question: Do income differences with the trading partner act as trade barriers when rich countries export?

Figure 2.1 depicts the estimated trade barriers the United States faces when exporting to other countries (in my sample) in the benchmark model. The x-axis shows the income differences between the United States and the trading partner,

$y_{US} - y_{tradingpartner}$. Figure 2.1 implies that the United States, on average, faces lower trade barriers when exporting to other rich countries and faces, on average, higher trade barriers when exporting to poor countries. In other words, when the income difference between the United States and the trading partner goes up, the trade barriers which the United States faces go up. In order to match the observed bilateral trade pattern, trade barriers should be given as in figure 2.1–large differences between the trade barriers the United States faces when exporting to rich and poor. However, this paper claims that income differences can be some portion of this large difference between the trade barriers the United States faces when exporting to rich and poor.

Figure 2.2 depicts the relation between income differences with the trading partner and the estimated trade barriers when exporting to a rich country, the United States, in the benchmark model. In figure 2.2, the x-axis shows the per capita income difference between the United States and the exporting country i, $y_{\text{US}} - y_i$. Figure 2.2 implies that rich countries, on average, face lower trade barriers than what poor countries face when exporting to United States. This result is robust for all rich countries in the sample.

Figure 2.3 shows the relation between income differences and the estimated trade barriers when exporting to a poor country, India, in the benchmark model. In figure 2.3, the x-axis shows the per capita income difference between the exporting country i and India, $y_i - y_{India}$. Figure 2.3 implies that poor countries, on average, face higher trade barriers than what rich countries face when exporting to India. This result is robust for all poor countries in the sample.

Now, I compare the estimated trade barriers of the two models. In the benchmark model, rich countries face lower trade barriers when exporting to other rich countries compared to my model. Moreover, in the benchmark model, rich countries face higher trade barriers when exporting to poor countries compared to my model. As a consequence, recovered trade barriers from the estimation results imply that rich countries export more to other rich countries than they do to poor countries in the benchmark model. These results are the impact of the additional dimension of the benchmark model–per capita income–which is assumed to be a function of variable trade barriers. Table 2.2 shows the percentage difference between the estimated trade barriers in my model and the estimated trade barriers in the benchmark model when rich countries are exporting to other rich countries. For example, the first row shows that rich countries, on average, face 7 percent lower estimated trade barriers in the benchmark model when exporting to a rich country, Australia, compared to my model. Table 2.2 also shows that rich countries systematically face lower trade barriers in the benchmark model when exporting to other rich countries. In the benchmark model, rich countries, on average, face 7 percent lower estimated trade barriers when exporting to other rich countries.

Table 2.3 shows the percentage difference between estimated trade barriers from the two models when rich countries export to poor countries. For example, the first row shows that rich countries, on average, face 5 percent higher estimated trade barriers in the benchmark model when exporting to a poor country, Brazil, compared to my model. Table 2.3 also implies that rich countries systematically face higher trade barriers when exporting to poor countries in the benchmark model. In the benchmark model, rich countries, on average, face 6 percent higher estimated trade barriers when exporting to poor countries compared to the estimated trade barriers of my model.

Table 2.2: Differences in Trade Barriers: Rich Countries Exporting to Rich Countries

Destination	Difference (in percentage)
Australia	-7
Canada	-9
France	-8
Germany	-8
Italy	-6
Japan	-6
Korea	-1
Spain	-4
United Kingdom	-9
United States	-10
Average	-7

Figure 2.4 depicts an example for the findings in Table 2.2 and Table 2.3 for the case of United States exports. Note that the y-axis shows the ad valorem trade barriers that the United States faces when exporting to country j and the x-axis shows country j's per capita income. On average, in order to match the observed bilateral trade patterns, relatively high trade barriers should be imposed in the benchmark model compared to the non-homothetic model when the United States exports to poor countries. However, on average, in order to match the observed data, relatively low trade barriers should be imposed in the benchmark model compared to the non-homothetic model when the United States exports to the rich countries. Hence, the slope of the trend for the non-homothetic model is smaller than the slope of the trend for the homothetic model. This paper claims that the difference in the slopes of these two trends can be endogenously explained by income differences across countries, which will be discussed later. Moreover, if I use a lower threshold when dividing countries into two groups according to their per capita income, the difference in the

Table 2.3: Differences in Trade Barriers: Rich Countries Exporting to Poor Countries

Destination	Difference (in percentage)
Brazil	5
China	7
India	11
Indonesia	7
Iran	8
Mexico	5
Poland	5
Russia	6
South Africa	5
Turkey	5
Average	6

slopes of the two trends is even higher.

After recovering the trade barriers, I calibrate human capital levels for both models separately. With the recovered trade barriers and human capitals, I compare the results of the two models in terms of bilateral trade patterns. Figure 2.5 depicts the data and results of the two models. Both models generate similar bilateral trade patterns in terms of matching data. In figure 5 the distance between the points and the 45 degree line shows the measurement errors for both models.

In order to compare the two models in terms of matching trade shares, $\frac{T_{ij}}{T_{jj}}$, I calculate the measurement errors. First, I calculate the errors for each observation, s, in both models and then take the absolute values of these errors. e_s^{mymodel} and $e_s^{\text{benchmark}}$ denote the errors (after taking absolute values) for each observation, s, respectively for my model and the benchmark model, where $e_s^{\text{mymodel}}=|\text{data}_s - \text{prediction}_s|$ in my model and $e_s^{\text{benchmark}}=|\text{data}_s - \text{prediction}_s|$ in the benchmark model. Then, I calculate the difference between these two values, $e_s^{\text{mymodel}} - e_s^{\text{benchmark}}$, and divide this value by the corresponding data, data_s. I repeat this for every observation, s, and take the average. Hence, the measurement errors between two models can be calculated as follows:

$$\frac{\sum_{s=1}^{S}\left(\frac{e_s^{\text{mymodel}} - e_s^{\text{benchmark}}}{\text{data}_s}\right)}{S} = 0.012, \qquad (2.4.1)$$

where S is the total number of observations. A value of 0.012 implies that, on average, the difference between the measurement errors of these two models is 1.2%. Hence, I conclude that non-homothetic preference generate similar trade patterns as the benchmark model: Rich countries export more to other rich countries then they do to poor countries. Due to the low income levels of poor countries, rich countries cannot export to poor consumers as much as they do to rich countries. In other words, poor countries' imports are restricted by their low income.

In order to answer the main question of the paper, I pursue the following steps: First, I show that in the benchmark model, rich countries face lower trade barriers when exporting to other rich countries and also face higher trade barriers when exporting to poor countries compared to my model. Second, I compare two models in terms of bilateral trade patterns. Even with the different inputs for variable trade barriers, the two model generate similar bilateral trade patterns as we observe in data: Rich countries export more to other rich countries than they do to poor countries. These arguments lead me to conclude that when rich countries export, income differences between the trading partner in the non-homothetic model endogenously play a similar role as additional trade barriers in the benchmark model.

2.5 Unit Price Variation

Recent empirical studies have documented unit price variation across importers conditional on an exporter and a variety–e.g., Fieler (2007b), Hummels and Skiba (2004). For example, Hummels and Skiba (2004) look at all the export partner countries for six importers. They report that unit price variation (f.o.b.) is 0.64 conditional on an exporter and a category. Fieler (2007b) analyzes years from 1984 through 2000 for approximately 150 countries and finds that unit prices systematically increase with importer per capita income in 85 percent of commodity categories. These findings imply unit price variation across different importers given the same exporter and same variety.

In a standard trade model with monopolistically competitive markets, the pricing rule is equal to marginal cost over constant markup. With standard C.E.S. preferences markups do not depend on cost or demand levels. Hence, conditional on exporter and variety, f.o.b prices are invariant to destination. In other words, for a given variety, an exporter charges the same price to all consumers in all countries. Due to the nature of competitive markets, f.o.b. prices are invariant to destination, similar to monopolistically competitive markets.

In the case of C.E.S., price elasticity of demand, ε, is uniquely determined by the level of product differentiation, which is constant. However, in my model, price elasticity of demand for a given good depends on the maximum level that a consumer can afford, which varies across countries. If the maximum price level that a consumer can afford goes up, then the price elasticity of demand for a given good decreases, as seen in the following equation: $\varepsilon_z = [(\frac{p_{\max}}{p(z)} - 1)]^{-1}$. Given this fact, a firm can set different prices, hence markups, for consumers in different countries.

I use the model to analyze unit price variation across different importers conditional on same exporter and same variety. I follow a similar method with Hummels and Skiba (2004). I define $p_{\bar{i}j}(\bar{a})$ as the mean of the prices which exporter $\bar{i}$ charges for a variety $\bar{a}$ across different importers, where $\bar{i}$ denotes the fixed exporter and $\bar{a}$ denotes the fixed variety. I also define $s_{\bar{i}j}(\bar{a})$ as the standard deviation for the different prices charged across different import markets by a fixed exporter $\bar{i}$ and for a fixed variety $\bar{a}$. For example, for a given exporter, $\bar{i}$ =United States, and for a fixed variety, $\bar{a} = 0.2$, my model predicts that $\frac{s_{\bar{i}j}(\bar{a})}{p_{\bar{i}j}(\bar{a})} = 0.24$. For different exporters and varieties I get similar results which are in the range of $(0.14, 0.42)$. The data observation reported by Hummels and Skiba (2004) is 0.64.[24] The main quantitative models predict zero for this statistic due to either competitive markets or constant markup–in the case of monopolistically competitive markets–whereas my model generates variable markups.

2.6 Analyzing the Impact of High Growth of Poor Countries

In this section, I use the model to analyze the impact of high growth in poor countries. In this experiment, I take two points of time, T1 and T2, and compare them to analyze the growth in trade. At time T2, the increase in human capital levels in rich countries, on average, is higher than the increase in human capitals in poor countries. However, in this experiment at time T2, the increase in human capital levels in some poor countries are higher than the corresponding increase in

[24] This is the reported value for all exporters. See Hummels and Skiba (2004) for details.

rich countries. In the model, the high growth in some poor countries implies that the trade barriers they face fall. This reduction in trade barriers will increase the growth of world trade higher than the predicted counterpart in the standard model. Standard models are not successful in terms of matching the growth of trade to GDP ratio. Hence, the impact of high growth in poor countries is a possible explanation of the growth to trade to GDP ratio.

2.7 Discussion

One of the possible future extensions includes introducing fixed bilateral trade barriers into the framework with non-homothetic preferences. The extended model can potentially generate "zeros" in the bilateral trade matrix. Zeros in the bilateral trade matrix imply no trade between two countries. We observe many "zeros" in the bilateral trade matrix that are not easy to generate with standard models without additional assumptions.[25] However, since the marginal utilities are bounded for all varieties in my model, introducing bilateral fixed trade barriers into my framework can potentially generate no trade between some pairs of countries depending on the calibration of the bilateral fixed trade barriers. Hence, the non-homothetic model can do a better job in terms of matching bilateral trade patterns, including the zeros in the bilateral trade matrix.

[25] See Heplman, Melitz, and Rubenstein (2007) for a further discussion.

2.7.1 Deriving the Marginal Utility of Income

In order to derive the marginal utility of income, λ_j, first let Ω_j be the set of all potential goods in country j and Ω_j^* be the set of consumed varieties in country j, where $\Omega_j^* \in \Omega_j$. Let M_j be the measure of this subset Ω_j^*. Also define average prices as:

$$\bar{p}_j := \left(\frac{1}{M_j}\right) \int_{z \in \Omega_j^*} p_j(z) dz, \tag{2.7.1}$$

and average consumption as:

$$\bar{c}_j := \left(\frac{1}{M_j}\right) \int_{z \in \Omega_j^*} c_j(z) dz. \tag{2.7.2}$$

Then, integrating equation (2.2.3), $c_j(z) = \frac{1-\lambda_j p_j(z)}{\gamma}$ over all $z \in \Omega_j^*$ and simple algebra yields:

$$\lambda_j = \frac{1 - \gamma \bar{c}_j}{\bar{p}_j}. \tag{2.7.3}$$

2.7.2 Benchmark Model

The benchmark model is a version of Melitz (2003) and Chaney (2008). For the demand side, the difference is that the benchmark model has homothetic (Constant Elasticity of Substitution) preferences. With C.E.S. preferences, consumers have positive demand for all varieties produced in the economy. For the supply side, firms in country i have to pay bilateral fixed trade barriers f_{ij}'s in order to enter the market in country j in addition to variable trade barriers τ_{ij}. Hence, some firms from country i that cannot cover the fixed bilateral trade barriers cannot enter the market j. In contrast, with the non-homothetic preferences, demand for a good can go to zero at a finite price, so there is no need to assume bilateral fixed trade barriers. The demand side endogenously determines the firms that are entering from market i to market j. Preferences in homothetic model are given by:

$$\int_{z\in\Omega_j} \left(c_j(z)^{\frac{(\sigma-1)}{\sigma}} dz\right)^{\frac{\sigma}{(\sigma-1)}}, \tag{2.7.4}$$

where the $\sigma > 1$ is the constant elasticity of substitution parameter.

For the supply side, the maximization problem for a firm selling from country i to country j with unit labor requirement a is given by (note that firms take demand, $c_{ij}(a)$, as given):

$$\pi_{ij}(a) = \max_{p_{ij}(a)} p_{ij}(a)\ c_{ij}(a)L_j - \tau_{ij}\ w_i\ a\ c_{ij}(a)L_j - w_i f_{ij}, \tag{2.7.5}$$

where the last term shows the cost of fixed bilateral trade barriers for a firm selling from country i to country j.

2.7.3 Recovering the Human Capital Levels for the Non-homothetic Model

In order to calibrate the human capital levels for my model, I pursue the following steps. Total income for country j is given by $Y_j = w_j l_j L_j$. First, taking logs implies the following:

$$\log(Y_j) = \log(w_j) + \log(l_j) + \log(L_j). \tag{2.7.6}$$

Then, substituting (2.7.6) into following equation:

$$V_j = \log(L_j) + \log(l_j) - \varphi \log(w_j), \tag{2.7.7}$$

and solving for l_j yields,

$$\log(l_j) = \frac{V_j + \varphi \log(Y_j)}{(1+\varphi)} - \log(L_j). \tag{2.7.8}$$

Since V_j's are known from the estimation and Y_j's and L_j's are observable, we can recover human capital levels l_j's. In table 2.6, the third column presents the calibrated human capital levels.

2.7.4 Recovering the Human Capital Levels for the Benchmark Model

Trade shares, $\frac{T_{ij}}{T_{jj}}$, for the benchmark model can be expressed as:

$$\frac{T_{ij}}{T_{jj}} = \frac{L_i l_i w_i^{-\varphi} \tau_{ij}^{-\varphi} f_{ij}^{\frac{\sigma-1-\varphi}{\sigma-1}}}{L_j l_j w_j^{-\varphi} f_{jj}^{\frac{\sigma-1-\varphi}{\sigma-1}}}, \tag{2.7.9}$$

where $\varphi > \sigma - 1$. In order to compare the model, I assume $f_{ij}{=}f \;\forall\; i,j$. However, the additional dimension of the benchmark model is captured by variable trade barriers, τ_{ij}. Importer per capita income y_j is assumed to be an additional variable in the functional form for variable trade barriers besides shared border, distance, and fixed exporter effect:

$$\log(\tau_{ij}) = b_{ij} + d_k + x_i + y_j + \delta_{ij}. \tag{2.7.10}$$

In order to recover human capital parameters, $\hat{l}_j$, in the benchmark model, I pursue the similar steps given for my model. The only difference shows up for $\hat{V}_j$, since the estimation results differ. Hence, we can calculate $\hat{l}_j$ using the following equation:

$$\log(\hat{l}_j) = \frac{\hat{V}_j + \varphi \log(Y_j)}{(1+\varphi)} - \log(L_j). \tag{2.7.11}$$

Since we know $\hat{V}_j$'s from the estimation results and Y_j's and L_j's are observable, we can recover $\hat{l}_j$s. In table 2.6, the second column presents the calibrated human capital levels for the benchmark model.

2.8 Conclusion

In this paper, I develop a multi-country general equilibrium model of trade with monopolistically competitive markets. First, I argued that the demand side, per capita income, is a key determinant of bilateral trade patterns. Similar income levels of rich countries imply similar demand patterns among rich countries, and this makes trade more intense among them. Second, I argued that when rich countries are exporting income differences with the trading partner act as trade barriers. When the income differences between the rich exporter and the trading partner go up, then this will act as even higher trade barriers, which cause even lower exports to poor countries. Third, the model with non-homothetic preferences and variable markups yields unit price variation (f.o.b.) across different import markets conditional on same exporter and same variety. Finally, this paper proposes a possible explanation for the growth of trade to GDP ratio.

The model presented in this paper is highly tractable, relatively simple in terms of taking the model to the data, and shows the importance of per capita income and trade barriers to understanding the bilateral trade patterns. Furthermore, understanding the role of income differences as trade barriers is also important to understanding the direction of trade.

Figure 2.1: Trade Barriers Imposed on U.S. Exports

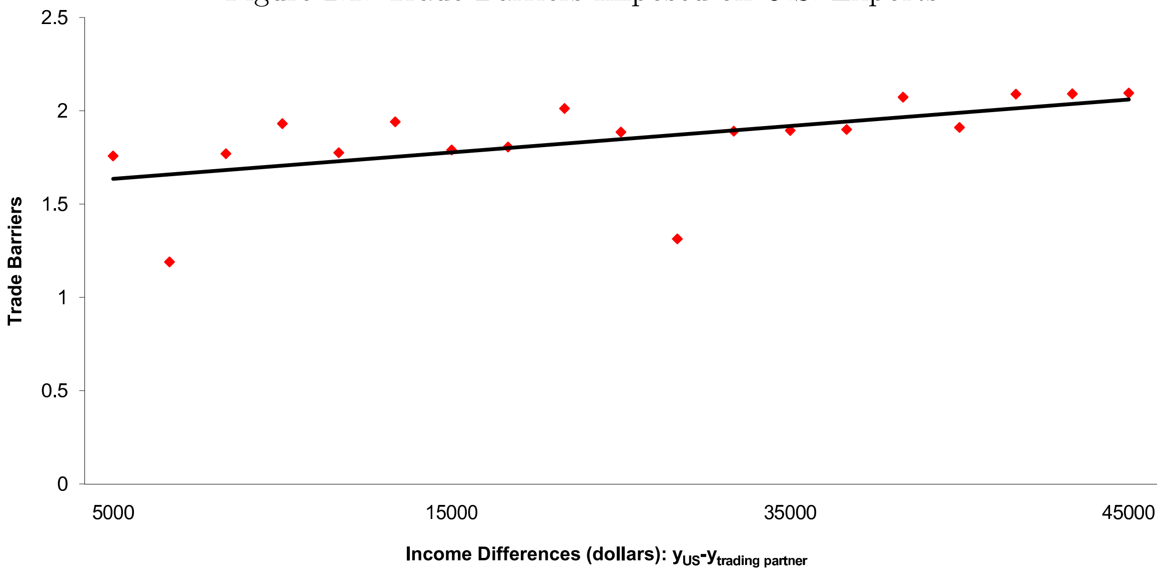


Figure 2.2: Trade Barriers: Exporting to U.S.

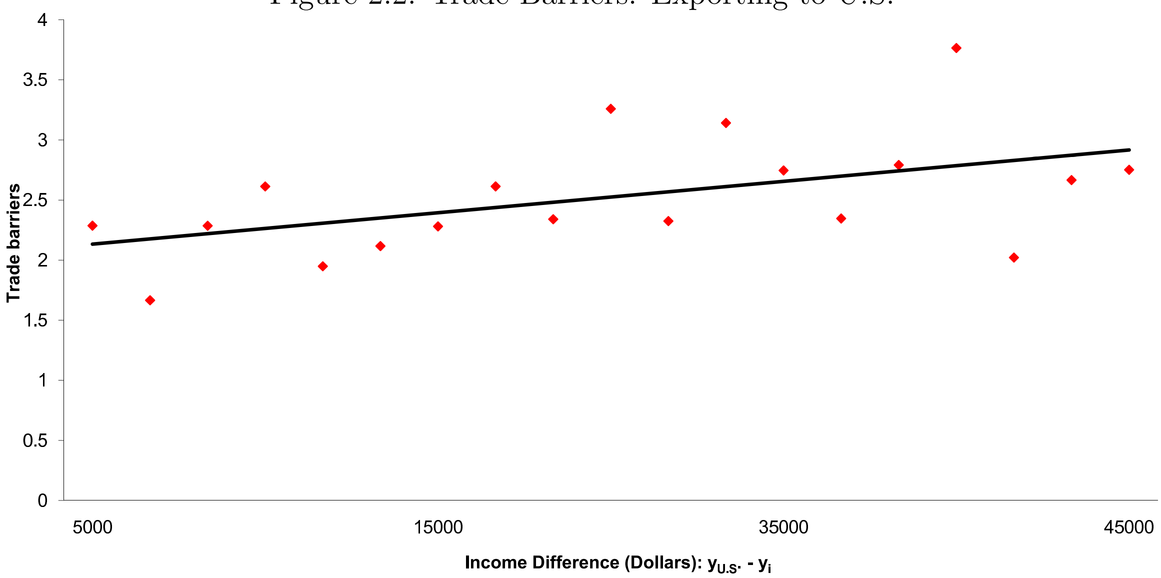


Figure 2.3: Trade Barriers: Exporting to India

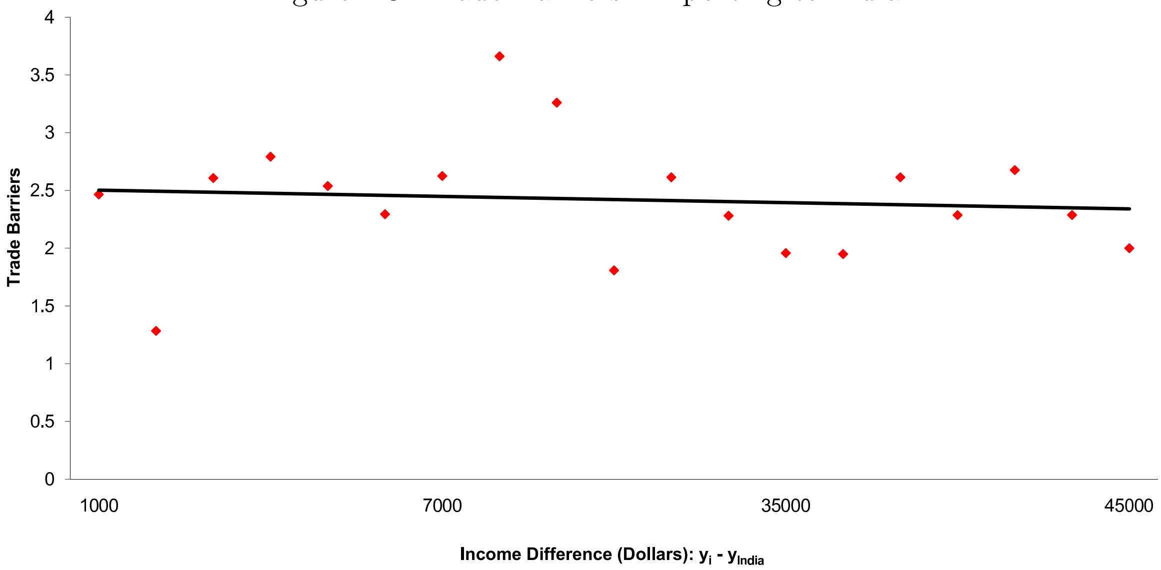


Figure 2.4: Different Trade Barriers Should Imposed in Two Models (When U.S. Exports)

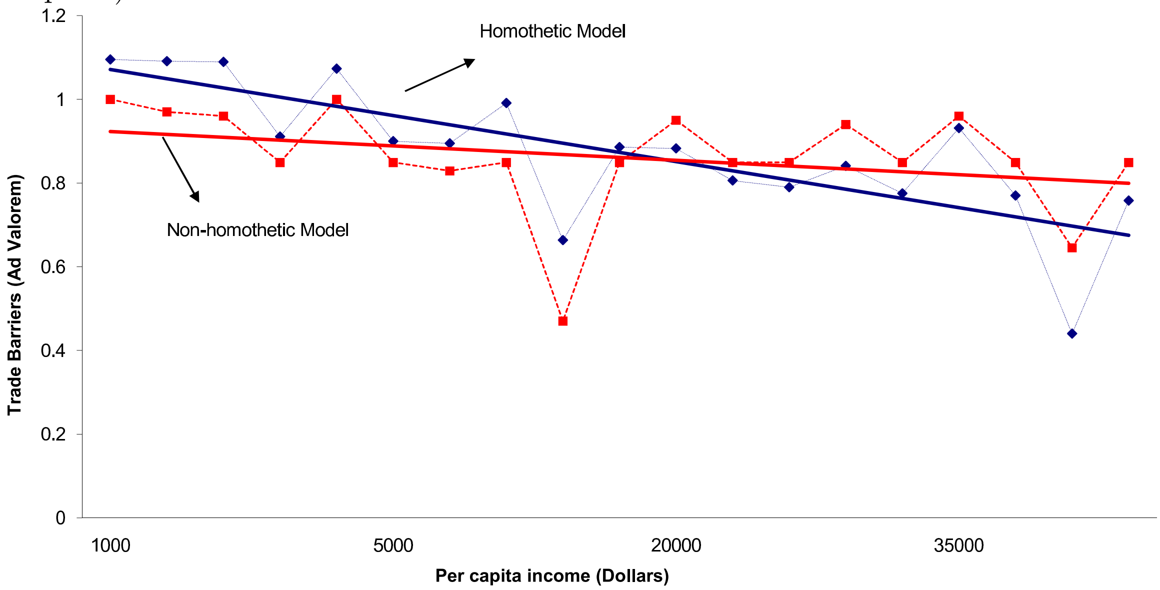


Figure 2.5: Trade Shares

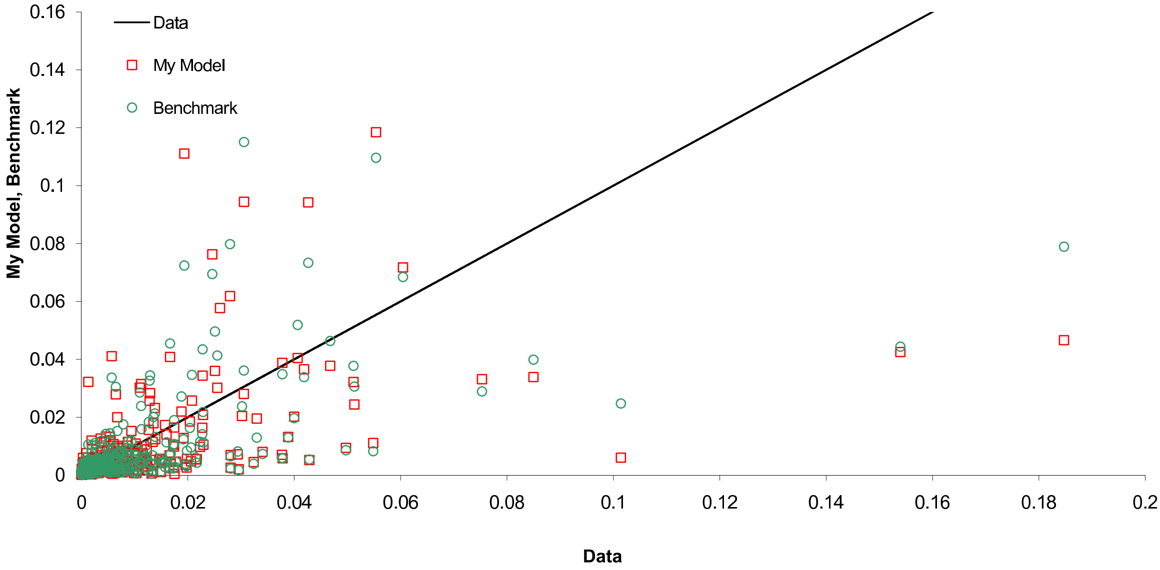


Table 2.4: Recovering Trade Barriers

Variable		est.	s.e.
Distance [0,375)	$-\varphi\ d_1$	-4.01	(0.28)
Distance [375,750)	$-\varphi\ d_2$	-4.13	(0.29)
Distance [750,1500)	$-\varphi\ d_3$	-4.69	(0.20)
Distance [1500,3000)	$-\varphi\ d_4$	-4.87	(0.21)
Distance [3000,6000)	$-\varphi\ d_5$	-6.01	(0.08)
Distance [6000,maximum]	$-\varphi\ d_6$	-6.60	(0.12)
Shared Border	$-\varphi\ b$	1.30	(0.34)
Australia	$-\varphi\ x_1$	0.15	(0.26)
Brazil	$-\varphi\ x_2$	0.34	(0.18)
Canada	$-\varphi\ x_3$	-0.01	(0.12)
China	$-\varphi\ x_4$	1.86	(0.18)
France	$-\varphi\ x_5$	0.52	(0.13)
Germany	$-\varphi\ x_6$	1.58	(0.17)
India	$-\varphi\ x_7$	-0.19	(0.18)
Indonesia	$-\varphi\ x_8$	0.02	(0.13)
Iran	$-\varphi\ x_9$	-2.28	(0.50)
Italy	$-\varphi\ x_{10}$	0.53	(0.14)
Japan	$-\varphi\ x_{11}$	1.55	(0.18)
Korea	$-\varphi\ x_{12}$	0.88	(0.18)
Mexico	$-\varphi\ x_{13}$	-2.09	(0.94)
Poland	$-\varphi\ x_{14}$	-1.84	(0.20)
Russia	$-\varphi\ x_{15}$	-0.70	(0.18)
South Africa	$-\varphi\ x_{16}$	-0.81	(0.16)
Spain	$-\varphi\ x_{17}$	-0.37	(0.15)
Turkey	$-\varphi\ x_{18}$	-1.59	(0.24)
United Kingdom	$-\varphi\ x_{19}$	0.52	(0.17)
United States	$-\varphi\ x_{20}$	1.93	(0.22)

Table 2.5: Recovering Trade Barriers (Benchmark Model)

Variable		est.	s.e.
Distance [0,375)	$-\varphi\ d_1$	-4.31	(0.33)
Distance [375,750)	$-\varphi\ d_2$	-4.41	(0.34)
Distance [750,1500)	$-\varphi\ d_3$	-5.02	(0.26)
Distance [1500,3000)	$-\varphi\ d_4$	-5.19	(0.27)
Distance [3000,6000)	$-\varphi\ d_5$	-6.33	(0.22)
Distance [6000,maximum]	$-\varphi\ d_6$	-6.90	(0.19)
Shared Border	$-\varphi\ b$	1.30	(0.34)
Importer per capita income	$-\varphi\ y$	0.02	(0.01)
Australia	$-\varphi\ x_1$	0.15	(0.26)
Brazil	$-\varphi\ x_2$	0.34	(0.18)
Canada	$-\varphi\ x_3$	-0.01	(0.12)
China	$-\varphi\ x_4$	1.86	(0.18)
France	$-\varphi\ x_5$	0.52	(0.13)
Germany	$-\varphi\ x_6$	1.58	(0.17)
India	$-\varphi\ x_7$	-0.19	(0.18)
Indonesia	$-\varphi\ x_8$	0.02	(0.13)
Iran	$-\varphi\ x_9$	-2.28	(0.50)
Italy	$-\varphi\ x_{10}$	0.53	(0.14)
Japan	$-\varphi\ x_{11}$	1.55	(0.18)
Korea	$-\varphi\ x_{12}$	0.88	(0.18)
Mexico	$-\varphi\ x_{13}$	-2.09	(0.94)
Poland	$-\varphi\ x_{14}$	-1.84	(0.20)
Russia	$-\varphi\ x_{15}$	-0.70	(0.18)
South Africa	$-\varphi\ x_{16}$	-0.81	(0.16)
Spain	$-\varphi\ x_{17}$	-0.37	(0.15)
Turkey	$-\varphi\ x_{18}$	-1.59	(0.24)
United Kingdom	$-\varphi\ x_{19}$	0.52	(0.17)
United States	$-\varphi\ x_{20}$	1.93	(0.22)

Table 2.6: Calibrated Human Capital Levels

	Benchmark	My model
Countries	$\log(l_j)$	$\log(l_j)$
Australia	8.78	8.74
Brazil	6.80	6.82
Canada	8.75	8.71
China	5.76	5.79
France	8.56	8.52
Germany	8.57	8.53
India	4.87	4.91
Indonesia	5.77	5.81
Iran	6.45	6.48
Italy	8.47	8.45
Japan	8.42	8.39
Korea	8.14	8.14
Mexico	7.23	7.25
Poland	7.42	7.38
Russia	6.96	7.05
South Africa	6.98	7.01
Spain	8.41	8.40
Turkey	7.22	7.24
United Kingdom	8.67	8.63
United States	8.52	8.47

Chapter 3

Reputation, Learning, and International Trade

3.1 Introduction

This paper studies how asymmetric information affects international trade patterns and how learning and building up a reputation may be crucial in reducing information problems in international trade. Asymmetric information exists regarding producers' (exporters') characteristics.[1] Consumers (importers) cannot completely observe the characteristics of exporters and have imperfect information about them, whereas exporters fully know their own characteristics.[2]

Since the publication of Akerlof (1970), it has been well understood how asymmet-

[1]In general, the characteristics we discuss here can be thought of as affecting the consumers' beliefs, such as producers' productivity, quality, honesty, etc. For simplicity, we later narrow our concept of characteristics to be just productivity in our model.

[2]Henceforth, we refer to consumers as importers and producers as exporters.

ric information can cause adverse selection in markets. We argue that asymmetric information problems are also crucial in international markets, even more so than closed economies, since information regarding foreign exporters is potentially less available and more difficult to access. For instance, inspection of foreign exporters may be difficult and costly to undertake. As a result, asymmetric information problems about a foreign exporter's productivity or the quality of a foreign exporter's good can be more severe in international markets. Additional factors, such as culture, language, or religion, have further effects on international markets with informational asymmetries. These factors can either exacerbate the problem by building prejudices between groups who differ in these respects or alleviate it by networking geographically dispersed groups together who are similar in these respects.[3]

In environments with informational asymmetries, Spence (1973) demonstrates how signaling can improve the market outcome, and Shapiro (1983) shows how building up a reputation can be important as well. Similarly, in international markets, exporters can use signals to build their reputations and alleviate problems caused by asymmetric information. Falvey (1989) extends the framework used in Shapiro (1983) to study the effects of commercial trade policies, such as origin labelling requirements, in a world in which reputation matters.

In parallel to the above findings, we argue that all these concepts—asymmetric information, learning, signaling, and reputation building—are important in international trade and should be incorporated into models in the international trade litera-

[3]See, for example, Guiso, Sapienza, and Zingales (2005) for a study involving a set of European Union countries on how culture effects trust between citizens of different countries and how these bilateral trust relations affect international trade, portfolio investment, and foreign direct investment. See Gould (1994), Greif (1989), and Rauch and Trindade (2002) for examples of ethnic-based networks as means to alleviate asymmetric information problems and facilitate international trade.

ture. The international trade literature usually implicitly assumes perfect information among agents, and, hence, asymmetric information plays no role.[4]

This paper presents a mechanism based on a simple stochastic dynamic model of international trade with asymmetric information through which the relation between information and international trade can be better understood. Our model is not based on traditional trade theory models and excludes some features of standard models. In particular, we take trade incentives as given and then narrow our attention to how asymmetric information, reputation, and learning affect international trade.

The mechanism we propose works as follows: There are two types of agents, exporters and importers. Exporters have private information about their characteristics. Importers only have beliefs about these characteristics. Importers wish to exchange their endowments for the output produced by exporters. The importers make offers to exporters in exchange for shipments of exporters' goods. These offers are based on beliefs importers hold about exporters' characteristics. Importers' beliefs, in turn, depend on the export history of an exporter, that is, an exporter's reputation. Exporters choose to accept or reject the offer depending on its profitability and how acceptance may affect the exporters' reputations. Hence, exporters potentially have the chance to send signals to affect the beliefs of importers through their acceptance of an offer and their output performance. An exporter can either build up a good or bad history or reputation through their output performance. Importers learn about the characteristics of exporters after receiving and consuming the shipment of goods and update their beliefs accordingly. All importers share common information. Updated beliefs affect future decisions, because importers change their offers according

[4]See, however, Nieuwerburgh and Veldkamp (2007) for a recent treatment of asymmetric information and learning in the international finance literature.

to their updated beliefs. After learning about the exporters, if an importer undervalued (overvalued) their characteristics and shipments of goods previously, then the importer can raise (lower) the offers.

We use our model to study the contrasting experiences of United States car imports from Japan and France over the years 1961-2005. The evolution of these two trading experiences depends in part on asymmetric information, learning, and reputation. Very few Japanese and French cars were exported to the United States before the 1970's. At the time, big American cars ruled the road. American consumers showed little interest in the lightweight compact cars slowly trickling into the American market from Asia and Europe. The oil crises of the 1970's changed all that, though, as Americans began to show an interest in the fuel efficient Japanese and French cars.

As American consumers learned more about the new Japanese cars, they discovered that not only were the Asian imports fuel efficient, but they were well-built and more reliable vis-*à*-vis their American rivals. Japanese cars established a good reputation, as evidenced by such publications as *Consumer Reports*. Japanese car imports to the United States increased dramatically thereafter, as seen in figure 3.1. In addition, Wojcik (2001) documents total sales of Japanese cars in the United States as increasing by 427% over the years 1971-1990, while total new car sales increased by only 9%. Total sales numbers for Japanese cars from 1971 to 1990 are primarily being driven by imports, since Japanese manufactures did not begin setting up factories in the United States until the mid-1980's.

The experience of French cars differed greatly from the Japanese. Figure 3.2 shows the pattern of United States imports of French cars over the years 1961-2005. Imports of the diesel-powered French cars initially increased sharply around the second oil crisis in 1979. However, as American consumers learned more about the new French cars, they discovered frequent mechanical failures and the need for constant repairs. French cars were unreliable and gained a bad reputation, which, again, can be seen in publications such as *Consumer Reports*. Despite the initial attraction for being diesel-powered, United States imports of French cars eventually almost stopped. To this day, French cars are not exported to the United States at any sizeable level.

In order to apply our model to the experiences of United States imports of Japanese and French cars, we simulate our model numerically to generate sample model time series data. We then compare this model data with the actual time series data and find that the model does a good job of matching the actual data. We show the reliability of these results with a test of robustness. After showing the capability of our model in capturing the Japanese and French car experiences, we discuss further results from our model which highlight the effects of asymmetric information, learning, and reputation in international trade.

Even though the structure of our model differs from Melitz (2003), it predicts similar results, namely that firms engaged in exporting are relatively more productive. However, this is a long run result, which corresponds to the case when asymmetric information problems have been reduced. In our model, the reduction of asymmetric information problems occurs when importers' beliefs are similar to the actual characteristics of the firms. In this case, our model makes the same predictions as Melitz (2003). In the short run, however, when asymmetric information still exists between importers and exporters, the results of our model are different. A firm's ability to export depends not only on its characteristics but also on what importers believe about those characteristics. Hence, an important implication of models with asymmetric information is that short run trade patterns can be quite different from those seen in the long run. Consequently, this can affect things like government policies as well.

One could argue that the learning and reputation building process generating the transition from the short (high informational asymmetries) to long run (low informational asymmetries) trade patterns occurs quite quickly. This might be true for some sectors, such as foods and beverages, in which it is easier to obtain information and update beliefs. For other sectors, however, the speed of the learning and reputation building process is much slower. Shapiro (1983) cites the automobile industry as such a sector. Information regarding a particular car or car manufacture is revealed slowly over the course of the entire life of that car. Characteristics such as reliability can only be observed after long periods of time. Our model captures this sectorial difference in the speed of learning and reputation building with a parameter. We then show how our model's predicted trade patterns change with changes in this parameter.

We measure the extent of asymmetric information existing between importers and exporters in our model by identifying the relation between importers' beliefs and exporters' true characteristics. Tracking this relation over time allows us to show how the informational environment in which importers and exporters interact changes. The relation between importers' beliefs and exporters' true characteristics can be thought of as a policy variable, which can be affected through different channels. We show that the incorporation of trade barriers or export subsidies in our model effects this relation, alongside the effects on trade patterns. In the case of trade barriers, exporters find it more difficult to export, which draws out the learning and reputation building process. As a result, the length of time required to reduce asymmetric information increases compared to the free trade case with no export subsidy policy. Export subsides produce the opposite result. The learning and reputation process shortens, as exporters now find it easier to export with the aid of subsidies. It then follows that asymmetric information between importers and exporters decreases faster than the free trade case with no export subsidy policy.

The remainder of the paper is organized as follows: Section 3.2 describes the model in detail. In section 3.3, we use our model to evaluate the experience of United States car imports from Japan and France. In section 3.4, we discuss additional model results. Section 3.5 concludes.

3.2 Model

In this section, we develop a stochastic dynamic model of international trade with asymmetric information. This model is not built upon a standard international trade model and excludes some features of these models, as mentioned in the introduction. Instead, our model focuses exclusively on how asymmetric information, reputation, and learning can be crucial in the international trade literature.

As discussed in the introduction, exporters build their reputations based on characteristics observed by importers. For example, we could model reputation based on expected quality or, as we prefer to do here, expected productivity. In the case of expected quality, we could fix the output produced by each exporter i, normalizing it to 1 for simplicity, and allow for different quality levels. Given the representative importer enjoys consuming different levels of quality simultaneously, importers make offers to each exporter i according to their expectations for quality conditional on their information set. In this case, exporters choose the quality level to export in order to affect the importers' beliefs.

What we do in this model is an isomorphic version of the above. Instead of fixing the output level, we focus on a homogeneous good, normalizing the price to 1. We then allow different levels of output for each exporter i. The importers' offers are determined by expected quantity. Exporters now choose their output level to affect the importers' beliefs instead of quality. Hence, our model captures the idea of reputation as being the ability to produce more of the same good per period. We do this for simplicity. In general, our idea of reputation captures not only productivity, but also characteristics like quality, honesty, etc.

3.2.1 Environment

Consider an economy with two countries, home and foreign.[5] The home country contains a continuum of identical risk-neutral importers, and the foreign country contains a finite number of risk-neutral exporters which operate independently of one another. We are mainly interested in studying imports to the home country, which is why we divide our economy's agents into home country importers and foreign country exporters.

Foreign country exporters produce and potentially export a homogeneous good, y, to the home country. In contrast, importers do not possess the technology to produce y. In each period, importers are endowed with ω. Importers want to exchange their endowment, ω, for good y. Since we are focusing on studying imports to the home

[5]This two country model can easily be extended to the multi-country case.

country, domestic production is not modeled.[6] In the case of the home country, this can be interpreted as there also being domestic production for goods similar to y, but not exactly the good y. Due to taste for variety, the home country also wants to consume good y. In the case of the foreign country, this can be interpreted as all the exporters producing for their domestic market with some getting the chance to export and some not. Lastly, the economy exists for an infinite number of discrete time periods indexed by $t = 0, 1, ...$

3.2.2 Information Structure and Uncertainty

The key feature of this model is asymmetric information between importers and exporters. Exporters, indexed by $i = 1, 2, ..., I$, have potentially different actual productivity levels, η_i. Productivity levels are assumed to be fixed over time, that is, at the beginning of time $t = 0$, each exporter is assigned a productivity level, which they keep forever. These actual productivity levels are exporters' private information and are incompletely known by importers. Rather, importers hold prior beliefs, $\hat{\eta}_{i0}$, about each exporter's actual productivity level, η_i. Importers' prior beliefs, $\hat{\eta}_{i0}$, are assumed to be normally distributed with mean $\mu_{\hat{\eta}_{i0}}$ and variance $\sigma^2_{\hat{\eta}_{i0}}$. As time passes, learning about η_i will occur through the observation of exporter i's output. This gives rise to endogenously determined posterior beliefs, which will affect the status of the exporters.

Importers cannot directly observe the productivity level of individual exporters due to idiosyncratic productivity shocks, ϵ_{it}. We assume that ϵ_{it} is normally distributed with mean zero and variance σ^2_ϵ. We also assume productivity shocks are

[6] Adding domestic production to our model will not change any results.

i.i.d. across exporters and time. These productivity shocks, ϵ_{it}, along with an exporter's productivity level, η_i, determine exporter i's output, y_{it}, at time t, which is given by the technology

$$y_{it} = \max\{\eta_i + \epsilon_{it}, 0\}, \tag{3.2.1}$$

where each exporter i knows the actual realization of ϵ_{it} at the beginning of each period t, but importers only know the distribution of ϵ_{it}. The exporters' production technology is assumed to be publicly known. Under the above specification of the productivity shocks' distribution, we refer to $\epsilon_{it} < 0$ as "bad" shocks and $\epsilon_{it} > 0$ as "good" shocks, since they decrease or increase an exporter's output respectively.

Recall that η_i is fixed over time for each exporter and is private information from time $t = 0$ onwards. In contrast to exporters, importers cannot observe η_i and ϵ_{it} separately but can only observe the total output, y_{it}, if the exporter ships goods to the home country. Importers update their beliefs according to the total output they observe being shipped by each exporter. Information about each exporter perfectly spreads among the importers. In the event that an exporter chooses not to ship any amount of the good, y_{it}, in a given period, then importers do not change their beliefs about this exporter.

Exporters also experience idiosyncratic cost shocks, u_{it}. We assume that u_{it} is normally distributed with mean zero and variance σ_u^2. The cost shocks are i.i.d. across exporters and time. Both exporters and importers know the distribution of u_{it}, but only exporters observe the actual realization of u_{it}. The exporters' cost function is assumed to be publicly known:

$$c_{it} = \max\{f - u_{it}, 0\}, \tag{3.2.2}$$

where f is a fixed cost of exporting.

3.2.3 Timing

Figure 3.3 summarizes the timing within a period in the model. At time $t = 0$, exporters know their η_i's, which are fixed over time. In addition to this information, at the beginning of each period, exporters see their productivity shocks, ϵ_{it}, and cost shocks, u_{it}. Recall that importers cannot observe the ϵ_{it}'s directly. After the realization of the productivity and cost shocks to each exporter, importers make offers, ϕ_{it}, to each exporter i at time t according to their beliefs in that period.[7] The importers' offers, ϕ_{it}, are made from their total endowment, ω_t. Given the offer and the realization of the productivity and cost shocks, an exporter decides either to accept or reject the offer. If an exporter chooses to accept the offer, then importers pay their offer, ϕ_{it}, to the exporter, and the exporter pays the cost of producing and exporting, c_{it}, and ships the output, y_{it}, to the home country. If an exporter chooses to reject the offer, then the exporter receives zero payment, and no cost is paid. Once the shipments of output arrive in the home country, importers update their beliefs based on the output received. Importers update their beliefs about those exporters who actually shipped goods and keep the same beliefs for those who did not ship goods.

[7] There is no renegotiation between importers and exporters in a given period. An interpretation of this assumption is that negotiation between firms engaged in international trade is costly and time consuming. Thus, renegotiation within a given period is prohibited.

3.2.4 Importers

There is a continuum of risk-neutral importers of measure M in the home country with importers indexed by m. Importers are endowed with ω_t in each period and wish to exchange their endowment for the homogeneous good, y. In each period, representative importer m makes a list of offers with one offer for each exporter. The representative importer m chooses how much to offer each exporter according to the beliefs at that period, $\hat{\eta}_{it}$. The expected utility of importer m at time t for dealing with a particular exporter i is given by

$$U_{it}^{m} = E_t[y_{it}] - \phi_{it}, \tag{3.2.3}$$

where $E_t[\cdot]$ denotes the expectations with respect to the importer's available information at the beginning of time t and ϕ is the offer paid to the exporter.[8]

Under risk neutrality, the competitive market equilibrium implies the market offer for each exporter i will be

$$\phi_{it}\left(\Omega_{it}\right) = E[y_{it}|\Omega_{it}] = \mu_{\hat{\eta}_{it}} \quad \forall\ i, t > 0, \tag{3.2.4}$$

where $\Omega_{it} = \{y_i^{t-1}, \cdot\}$ and $y_i^{t-1} = \{y_{i0}, ..., y_{it-1}\}\ \ \forall\ i, t > 0$.[9]

Ω_{it} denotes the information set available to importers about exporter i at time t. The information set consists of the history of exporter i's output up to time t, y_i^{t-1}. Since importers update their beliefs according to exporter i's output each period,

[8] An importer's total utility is given by $\sum_{i=1}^{I} U_{it}^{m}$. We also assume $\sum_{i}^{I} \phi_{it} = \omega_t\ \ \forall\ t$, which implies importers have an exactly sufficient amount of endowment in each period.

[9] At $t = 0$, $\phi_{i0} = \mu_{\hat{\eta}_{i0}}$. Note that, because $E[\epsilon_{it}] = 0$, the productivity shocks, ϵ_{it}, do not influence the optimal offers made by importers. From now on, we simply denote the importer's information set about exporter i as the history of output, y_i^{t-1}.

their information sets are also updated. Importers only update their information set for an exporter if that exporter decides to accept the offer and ship an amount of goods to the home country. If an exporter decides not to accept the offer and not ship any goods, then importers do not update their information set for that particular exporter. Ω_{it} is always the same for all importers, as additional information received by representative importer m in each period perfectly spreads among importers.

If an exporter accepts the offer and sends an amount of the good, y_{it}, then learning on the part of the importers results in normally distributed posterior beliefs, $\hat{\eta}_{it+1}$. The mean, $\mu_{\hat{\eta}_{it+1}}$, and precision, $h_{\hat{\eta}_{it+1}}$, of $\hat{\eta}_{it+1}$ are given by[10]

$$\mu_{\hat{\eta}_{it+1}} = \frac{\mu_{\hat{\eta}_{it}} h_{\hat{\eta}_{it}} + y_{it} h_{\epsilon}}{h_{\hat{\eta}_{it}} + h_{\epsilon}} \text{ and } h_{\hat{\eta}_{it+1}} = h_{\hat{\eta}_{it}} + h_{\epsilon}, \tag{3.2.5}$$

where h's denote precisions of the respective variables. If an exporter rejects the offer and does not send any goods, than importers will have the same beliefs next period:

$$\mu_{\hat{\eta}_{it+1}} = \mu_{\hat{\eta}_{it}} \text{ and } h_{\hat{\eta}_{it+1}} = h_{\hat{\eta}_{it}}. \tag{3.2.6}$$

We choose to use precisions in equations (3.2.5) and (3.2.6) to simplify the discussion of results in section 4.

3.2.5 Exporters

There are a finite number of risk-neutral exporters operating independently of one another in the foreign country indexed by $i = 1, ..., I$. Each exporter potentially has

[10] This is a well-known learning formula resulting from the normality and independence assumptions.

a different productivity level, η_i, which is assigned to them at time $t = 0$ and remains fixed over time. Each exporter earns profits by selling the homogeneous good, y, in exchange for the importers' endowment, ω.

We formulate the exporter's problem recursively for expositional simplicity.[11] At the beginning of a period, let $v(\mu, h, \epsilon, u)$ be the optimal value of the problem for an exporter with (μ, h, ϵ, u).[12] μ refers to the mean of the importers' beliefs. By equation (4), it is clear that $\phi = \mu$. We could either use ϕ or μ as a state variable. h refers to the precision of the importers' beliefs. ϵ and u are the realized productivity and cost shocks at a given period. The set (μ, h, ϵ, u) summarizes the state variables for an exporter. Then, an exporter chooses whether to accept or reject the offer made by importers. The Bellman equation is given by

$$v(\mu, h, \epsilon, u) = \max\{\pi + \int\int \beta v(\mu', h', \epsilon', u')dF(u')dG(\epsilon'), \int\int \beta v(\mu, h, \epsilon', u')dF(u')dG(\epsilon')\}, \tag{3.2.7}$$

subject to the constraints

$$\pi \geq 0, \tag{3.2.8}$$

$$\mu' = \frac{h\mu + h_\epsilon(\eta + \epsilon)}{h + h_\epsilon}, \tag{3.2.9}$$

$$h' = h + h_\epsilon, \tag{3.2.10}$$

where $\pi = \mu - f + u$. The fixed cost, f; actual productivity, η; and precision of the

[11] We also formulate the problem sequentially in section 3.5.1.

[12] Note that WLOG we drop the i's.

distribution of productivity shocks, h_ϵ, are constant over time.

The maximization is over the two actions: (1) accept the offer or (2) reject the offer. The first term on the R.H.S. of equation (3.2.7) refers to the case of accepting. An exporter earns current profit, π, and begins the next period facing importers with updated beliefs, μ' and h'. The second term on the R.H.S. of equation (3.2.7) refers to the case of rejecting. An exporter earns zero profit today and faces importers with the same beliefs, μ and h, during the next period. Successive draws of ϵ and u are independent. $F(u)$, the c.d.f. of u, and $G(\epsilon)$, the c.d.f. of ϵ, are independent of each other. There is no returning to earlier options. Equation (3.2.8) shows the nonnegativity condition for π. Equations (3.2.9) and (3.2.10) show how μ and h evolve over time.

Lemma 1 If an exporter chooses to accept, then $y = \eta + \epsilon$.

Proposition 1: Given Lemma 1 and (μ, h, ϵ, u), an exporter chooses

$$\begin{cases} \text{Accept,} & \text{if } \pi \geq 0 \text{ and } \epsilon \geq \underline{\epsilon}(\mu, \cdot) \\ \text{Reject,} & \text{otherwise} \end{cases} . \tag{3.2.11}$$

Proposition 2: $\underline{\epsilon}(\mu, \cdot)$ is decreasing in μ.

Proofs: See section 3.5.1.

Lemma 1 clearly shows that if an exporter satisfies the conditions for accepting, then in order to build a good reputation in the shortest amount of time or to hide its bad productivity as long as possible, an exporter ships all the goods produced in a given period of time.

Proposition 1 is one of the main results of this paper. It captures the strategic choices made by exporters concerned with how current decisions affect their reputations and, thus, future profits. Consider the case when exporters make positive profits at a given time. Exporters still have to decide whether to enter the market or not, because they not only care about their current profits but their reputations, which affect future profits. For instance, if the current realization of the productivity shock is sufficiently low such that accepting and shipping the goods, y, would affect the importers' beliefs in a negative way, then an exporter i may not choose to send the good, despite earning current positive profits. An exporter must weigh the current profit gain versus the discounted expected loss from future profits resulting from a negative reputation. Clearly, if the latter is greater, then an exporter chooses to reject even in the case of positive profits. Hence, $\underline{\epsilon}$ is the productivity threshold level which equates the value of the discounted expected lifetime profit streams in the cases of accepting and rejecting.

Proposition 2 shows that an increase in the mean of the beliefs, μ, in a given period of time decreases the threshold productivity. By equation (3.2.4), an increase in μ increases the offer importers make to an exporter. This result is crucial for the decision of an exporter deciding whether to accept or reject. Intuitively, if an exporter has a better reputation, then it can withstand worse shocks. In other words, an exporter who already established a good a name in the market can choose to accept and send the goods even with a lower productivity shock.

3.3 The Case of U.S. Car Imports from Japan and France

In the above analysis, we introduced a mechanism stressing the importance of asymmetric information, learning, and reputation in international trade. We now use our model to study two contrasting bilateral trade flows, namely United States imports of Japanese and French passenger cars over the period 1961-2005. We choose to study these particular trade flows for two reasons. First, the automobile sector is a large and important sector in international trade. Second, asymmetric information, reputation, and learning occupy a leading role in explaining the evolution of these trade flows, especially in answering why Japanese and French cars had such different experiences in the United States market.[13]

3.3.1 Japan

Figure 3.1 shows United States passenger car imports from Japan over the period 1961-2005 from the OECD's International Trade by Commodity Database. Very few Japanese cars were exported to the United States before the 1970's. At the time, American consumers showed little interest in the lightweight compact cars coming from Japan, preferring instead the larger models produced by GM, Ford, and Chrysler,

[13]In the case of Japan, see Mannering and Winston (1991), Train and Winston (2006), Wojcik (2001), and, for recent treatments in the popular press, Crandall and Winston (2005) and Gertner (2007). For France, see Archawski and Wolek (1995).

the so-called Big Three of automobile production. During the oil crises of 1973 and 1979, though, American consumers began to show an interest in the fuel efficient Japanese cars. As consumers learned more about the new Japanese cars, they discovered not only were the cars fuel efficient, but they were also well-built and more reliable vis-à-vis their American rivals. Wojcik (2001) studies American consumer learning about a particular model, manufacturer, or Japanese cars in general during the 1970's, the period of the oil crises, and the 1980's. Wojcik (2001) uses a data set in which approximately 9% of households buy new cars each year. The share of new cars accounted for by Japanese imports increases from 5.7% in 1971 to 26.1% in 1990, averaging 15.4% over the entire period. Wojcik (2001) finds all three sources of learning impacted the demand for individual Japanese cars in the American market and were significant factors in the increase in overall Japanese market share.

The oil crises of the 1970's gave the Japanese exporters the opportunity to signal to American consumers about their cars and begin the process of building a reputation. In the years since the oil crises, the reputation of Japanese cars consistently ranked among the highest in the automobile industry, as publications like *Consumer Reports* clearly attest. Mannering and Winston (1991) documents that consumer brand loyalty, one potential measure of reputation, towards Japanese produced cars relative to American produced cars grew during the years after the oil crises. Mannering and Winston (1991) shows this brand loyalty explains a significant fraction of the increase in Japanese market share in the 1980's American automobile market. Through this signaling and learning process, United States car imports from Japan increased dramatically after 1975, as shown in figure 3.1. In addition, Wojcik (2001) documents total sales of Japanese cars in the United States as increasing by 427%

over the years 1971-1990, while total new car sales increased by only 9%. Total sales numbers for Japanese cars from 1971 to 1990 are primarily being driven by imports, since Japanese manufactures did not begin setting up factories in the United States until the mid-1980's.

In the language of our model, Japanese exporter i's actual productivity level, η_i, is high. However, Japanese exporters face American importers with such low prior beliefs, $\hat{\eta}_{i0}$, in the years before the oil crises that Japanese exporters choose not to export. Eventually, the Japanese exporters in the model face cost shocks good enough such that they are able to export. We interpret the good cost shocks as the oil crises and a means by which Japanese exporters are able to signal to American importers about themselves, despite initially being faced with unfavorable beliefs on the part of American importers. Once American importers receive and consume a shipment of exporter i's goods, they update their beliefs, which affects future decisions made by the Japanese exporters. In this way, Japanese exporters eventually enter the American market and continue to export thereafter.

Figure 3.4 compares a sample trade flow simulation of our model,

$$\sum_{i=1}^{I} y_{it} \ \forall \ t, \tag{3.3.1}$$

with the actual trade flow data on United States imports of Japanese cars over the years 1961-2005. The model replicates both the period of low imports before the 1970's oil crises and, once the oil crises occur, the subsequent years of increasing imports. All in all, figure 3.4 shows our model is capable of matching the data well. However, figure 3.4 presents one sample trade flow simulation of our model. In order to test the reliability of this result, we construct a test of robustness. Figures 3.5

and 3.6 report our robustness results. The construction of figures 3.4, 3.5, and 3.6 is outlined in section 3.5.2.

3.3.2 France

Figure 3.2 shows United States passenger car imports from France over the period 1961-2005 from the OECD's International Trade by Commodity Database. Very few French cars were exported to the United States prior to the 1970's. As in the case with Japan, the oil crises of the 1970's gave French exporters the chance to enter the American market. Once given the chance to enter the American market, French exporters had the opportunity to signal to American consumers about their cars and begin the process of building a reputation. The French cars established a reputation thereafter. Unlike the Japanese, however, French cars became known not for their reliability but for their chronic need to be taken to the repair shop. The impact of learning and reputation on imports of French cars to the United States was exactly the opposite as that in the Japanese case. Instead of imports of French cars continuing to increase after the effects of the oil crises subsided, imports decreased as sharply as they had increased, as can be seen in figure 3.2. Imports of French cars actually decreased to a level lower than the one prior to the oil crises. Indeed, figure 3.2 shows imports of French cars virtually stopped after 1990.

In the context of our model, the French case is similar to the Japanese. French exporters face American importers with such low prior beliefs, $\hat{\eta}_{i0}$, that French exporters choose not to export. Eventually, however, French exporters face cost and productivity shocks good enough such that they are able to export. Again, we interpret the good cost and productivity shocks as the oil crises. The good shocks serve as a way for French exporters to signal to American importers, despite the fact that American importers initially have unfavorable beliefs about the French exporters. American importers update their beliefs about French exporter i after seeing the exporter's goods. Unlike the Japanese exporters, though, French exporter i's actual productivity level, η_i, is low. As a result, once the effects of the good cost and productivity shocks are eliminated, American importers learn about the low productivity, which affects future decisions made by the French exporters. French exporters again face American importers with such unfavorable beliefs that they choose not to export. In this manner, American importers import French cars during the oil crises but then decrease their imports after learning about the French cars.

Figure 3.7 compares the actual data of United States imports of French cars over the years 1961-2005 with equation (3.3.1), a sample trade flow simulation from the model. The model is capable of capturing both the increased imports during the period affected by the oil crises and the years of low imports before and after the oil crises. Again, we report our measure of robustness in figures 3.8 and 3.9. The construction of figures 3.7, 3.8, and 3.9 is discussed in section 3.5.2.

3.4 Additional Model Results

In order to analyze the impact of asymmetric information, learning, and reputation on international trade patterns, we show the importance of differentiating between the short run and long run. This differentiation is crucial in terms of understanding trade patterns seen in the data and the implications of trade policies, such as import tariffs and export subsidies, in a world characterized by asymmetric information. We organize all the results in this section around numerical simulations of the model, the details of which are described in in section 3.5.3.

3.4.1 Short Run versus Long Run

As in closed economies, asymmetric information can cause adverse selection problems in international markets in the short run. As time passes, a "reduced information problem" can be a solution to adverse selection. In the context of our model, any additional information achieved by the signals from exporters will aid importers in their learning process and help importers to update their information sets.

In the long run, importers' beliefs converge to the actual values of each exporter's productivity, η_i. This implies η_i will be fully known in the limit. As a result, in the long run, relatively more productive exporters end up with larger amounts of exports. Relatively less productive exporters will still export but in relatively smaller amounts. A subset of these relatively less productive exporters will end up not exporting at all. These long run results are not different from existing trade literature and match those of Melitz (2003). However, in the short run these trade patterns can be potentially different.

In order to better understand this result, consider an example in which there are two types of exporters: exporters of type η^H have high productivity, and those of type η^L have low productivity. There are potentially many exporters of each type. The exporters' productivity levels are incompletely known by importers. Exporter η^H is relatively more productive than exporter η^L, but this may not be true in terms of beliefs. Suppose at time $t = 0$ the imperfect information is such that importers believe exporters of type η^L are relatively more productive than η^H.

Given these conditions, the model predicts the trade flows depicted in figure 3.10. Exporters of type η^L start with exporting a relatively higher amount due to the importers' beliefs, which result in higher offers. But, as time passes, the amount of type η^L's exports decreases. This occurs through importers learning about the actual productivity of exporters of type η^L, which in turn decreases the offers for these exporters. At the same time that the exports by type η^L are decreasing, the exports by type η^H are increasing due to a similar learning and reputation building mechanism. Once importers are able to learn about exporters of type η^H, the offers made to these exporters increase. As a result of these two effects, the trade patterns switch over time. Figure 3.10 shows the exporters of both types converging to a long run pattern, but the transition to these long run patterns, that is, the short run trade patterns, can be dramatically different due to asymmetric information, leading to an adverse selection problem. In the short run, importers are largely importing from exporters of type η^L, instead of η^H. Over time, though, this adverse selection problem is solved. Signals by η^H exporters reveal more and more information, and type η^H exporters build a stronger reputation. Eventually, goods from exporters of type η^H dominate the trade flows.

We can use this result to further our discussion of United States imports of Japanese Cars. Since this paper develops a model of international trade, it is natural to study a significant bilateral trade relationship. The other side of the story about United States imports of Japanese cars is, of course, the oft-lamented decline in the competitiveness of the American automobile industry. The same *Consumer Reports* documenting the positive reputation of most Japanese cars documents the negative reputation of many American cars. The gap between American consumers' beliefs about Japanese and American cars is not improving. Indeed, Crandall and Winston (2005) compares annual issues of *Consumer Reports* in 1985 and 2005 suggesting this fact. In 1985, American consumers who purchased American cars were six times more likely to need "worse than average" or "much worse than average" car repairs than those consumers owning Japanese cars. American cars were still five times more likely than Japanese cars to need major repairs in 2005.

Reputation and consumer beliefs have their consequences. Figure 3.11 presents data taken from Train and Winston (2006) on American and Japanese market share of car sales in the United States.[14] In the context of the model, if we consider American and Japanese manufactures as exporters trying to sell to importers, or American consumers, then the above result helps to understand figure 3.11. Notice the relation between figures 3.10 and 3.11. Recall figure 3.10 shows total exports of low and high productivity exporters. Importers' beliefs are such that low productivity firms dominate the market initially and only later do high productivity firms enter the market and eventually dominate. With American manufactures being the low productivity firms and Japanese manufactures being the high productivity firms, figure 3.10 provides a possible explanation for figure 3.11. Although figure 3.11 shows Japanese market share in 2005 as still being 2% lower than American, it seems almost certain that the "switching" in relative positions seen in figure 3.10 will occur, especially in light of such news as Toyota overtaking General Motors as the largest car manufacturer for the first time in 2007.[15] Whatever the future holds for American car manufacturers, our model suggests influencing consumers' beliefs by rebuilding a

[14] We only include American and Japanese manufacturers. As a result, the shares do not sum to 100.

[15] See Bradsher (2007) for reporting on this event.

good reputation will be necessary if the trends seen in figure 3.11 are to be reversed.

3.4.2 Speed of Learning and Reputation Building

The learning and reputation process in our model depends on how the importers' beliefs evolve over time. As a result, the manner in which the beliefs change will influence the trade patterns predicted by the model. How the importers' beliefs evolve depends on the nature of the good being exported. Different sectors are associated with different learning and reputation processes. For example, Shapiro (1983) points out that beliefs about cars change only slowly. Consumers do not completely change their beliefs about a car manufacture after one period. The consumers partially adjust their beliefs, giving weight not only to what they see as their new car but also to their previously held beliefs. This occurs because certain attributes of a car, like its durability, are difficult, if not impossible, to immediately detect. Over time, these beliefs change as the car is used. An example of a sector associated with rapid learning and reputation processes is the agricultural goods sector. Consumers can easily inspect and discern the nature of the good by tasting the food or beverage, updating their beliefs immediately.

In our model, we capture the learning and reputation process associated with a sector j by the initial ratio of the precision of the importers' beliefs to the precision of the idiosyncratic productivity shock, $H_0(j) = \frac{h_{\hat{\eta}_{i0}}(j)}{h_\epsilon(j)}$, where $H_0(j) \in (0, \infty)$. As a result, when using equation (3.2.5) to update their beliefs for the next period, importers attach weights $h_{\hat{\eta}_{i0}}(j)$ and $h_\epsilon(j)$ to their prior beliefs and the exporter's signal, respectively. $H_0(j) = 1$ corresponds to the case when importers attach equal weights to their prior beliefs and the exporter's signal, while $H_0(j) > 1$ ($H_0(j) < 1$)

corresponds to when importers attach relatively more (less) weight to their prior beliefs.

Sectors in which importers place relatively more weight, $h_{\hat{\eta}_{i0}}(j)$, on their prior beliefs are those with a relatively high $H_0(j)$. Learning and reputation building occur relatively slowly over time in these sectors, as in the car example above. Sectors in which importers place relatively less weight, $h_{\hat{\eta}_{i0}}(j)$, on their prior beliefs are those with a relatively low $H_0(j)$. Learning and reputation building occur relatively faster in these sectors, as in the agricultural goods example above.

Figure 3.12 shows how the model's predicted trade patterns change with changes in H_0. The higher H_0 is, the slower is the increase in total exports. Figure 3.12 reports one measure capturing the difference in the speed at which total exports increase, namely the number of periods required to transition from 5% to 50% of the maximum level of total exports.

3.4.3 Information and Trade Policies

We now extend the basic model from section 2 to incorporate trade barriers and export subsidies. In addition to the traditional increase or decrease in the volume of trade, our model highlights another dimension of trade barriers and export subsidies, namely their effect on the extent of asymmetric information existing between importers and exporters.

In order to measure the extent of these information problems in our model, we need to identify the relation between importers' beliefs and exporters' true characteristics. After the realization of output at the end of time t, $\frac{y_{it}}{\phi_{it}} = \kappa_{it}$, which potentially may be different than 1. κ_{it} can be interpreted as a measure of informational problems among importers and exporter i at time t. The further κ_{it} is from 1, the more information problems there are between importers and exporter i. $\kappa_{it} > 1$ corresponds to the case when importers undervalue exporter i. $\kappa_{it} < 1$ corresponds to the case when importers overvalue exporter i. κ_{it} is an important dimension in international trade which we study under three different trade policy regimes: trade barriers, export subsidies, and free trade with no export subsidies.

Among other things, trade barriers can be thought of as import tariffs or transportation costs, the former incurred by importers and the latter incurred by exporters. In the context of our model, we view these trade barriers as a friction which reduces the offer received by an exporter. In the case of an import tariff, importers pay some share of their offer ϕ_{it} as a tariff. The importers' new offers including the tariff payment can be denoted as $\tilde{\phi}_{it}$ and will necessarily be lower than ϕ_{it}.[16] In the case of transportation costs, exporters pay some amount from ϕ_{it} to ship their goods to the home country, hence the portion left over as profit can be denoted $\tilde{\phi}_{it}$. Instead of drawing a distinction between these two types of trade barriers, we simply model trade barriers as some fixed payment, ψ, taken from ϕ_{it}.

Government export subsidies can also be used to affect trade patterns and the extent of asymmetric information between importers and exporters. We do not explicitly model a government's problem in this section but consider export subsidies exogenously available to the foreign country exporters. In terms of the exporter's problem, an export subsidy can be modeled as a fixed amount, ψ, subtracted from the exporter's cost of exporting, c_{it}. We can then denote the cost of exporting under an export subsidy as $\tilde{c}_{it}$, which is necessarily lower than c_{it}.

[16]Recall that importers' optimal offers without tariffs at time t for each exporter i is given by equation (3.2.4).

Figure 3.13 compares the informational environment under the three different policy regimes by reporting the κ's associated with each regime. Figure 3.13 reports an average aggregate measure of κ. Trade barriers increase information problems, since it is more difficult for exporters to enter the market to begin with. Export subsidies, however, decrease the informational problems between importers and exporters. To the best of our knowledge, this is not an aspect of export subsidies which is often considered when discussing policy implications.

3.5 Discussion

3.5.1 Proofs of Lemma 1 and Propositions 1 and 2

Proof of Lemma 1:

This result is straight forward given equation (3.2.5) of the learning process. The derivative of equation (5) w.r.t y is strictly positive. The offer (3.2.4) and learning (3.2.5) equations imply higher amounts of y exported at time t result in higher offers at time $t+1$. Clearly, profit increases with a higher offer. Finally, the exporter's objective function is strictly increasing in profits. Taken together, these imply $y_{it} = \eta_i + \epsilon_{it}$ under the decision to accept.

Proof of Proposition 1:

The sequential version of the exporter's problem can be written as follows: For $t = \tau$, given the offer (3.2.4) and the learning process (3.2.5) and (3.2.6), an exporter i solves $\max\{A_{i\tau}, R_{i\tau}\}$ subject to the constraints $A_{i\tau} = \pi_{i\tau}(y_i^{\tau-1}) + \beta E_\tau[\pi_{i\tau+1}(y_i^\tau)] + \ldots$, $R_{i\tau} = 0 + \beta E_\tau[\hat{\pi}_{i\tau+1}(\hat{y}_i^\tau)] + \ldots$, and also subject to nonnegative profits for every period.

Profits in the case when an exporter accepts are $\pi_{it}(y_i^{t-1}) = \phi_{it}(y_i^{t-1}) - c_{it}$. In the case when an exporter rejects, profits are $\pi_{it}(y_i^{t-1}) = 0$.[17] Similarly, the cost of exporting when an exporter accepts is given by $c_{it} = f - u_{it}$. When an exporter rejects, $c_{it} = 0$. At $t = \tau$, an exporter i chooses whether to accept or reject, given the beliefs and realized shocks. A and R are the expected discounted lifetime profit streams in the cases of accepting and rejecting, respectively. π and $\hat{\pi}$ refer to the profits in the cases of accepting and rejecting. Since the exporter solves the problem at $t = \tau$ conditional on the information at τ, expectations are conditional on τ.

Given the problem above, we define $u_{\pi_{it=0}}$ as the threshold for zero profits. If $u_{it} \geq u_{\pi_{it=0}}$, then $\pi_{it} \geq 0$, and if $u_{it} < u_{\pi_{it=0}}$, then $\pi_{it} < 0$. $u_{\pi_{it=0}}$ can easily be obtained from equation (3.2.4) and the sequential problem above. $\underline{\epsilon}_{it}$ is the threshold productivity shock defined by the following: if $\epsilon_{it} \geq \underline{\epsilon}_{it}$, then $A \geq R$, and if $\epsilon_{it} < \underline{\epsilon}_{it}$, then $A < R$.

There are potentially four different cases. We first summarize the results of the different cases and then prove the results in the remainder of this section. For both of the cases when $u_{it} < u_{\pi_{it=0}}$, the nonnegative profit constraint binds, and exporter i rejects the offer. For the case $u_{\pi_{it=0}} < u_{it}$ and $\underline{\epsilon}_{it} < \epsilon_{it}$, exporter i realizes nonnegative profits during the current period and anticipates a higher expected discounted lifetime profit stream from accepting compared to rejecting. As a result, exporter i accepts the offer in this case. In the last case, $u_{\pi_{it=0}} < u_{it}$ and $\underline{\epsilon}_{it} \geq \epsilon_{it}$, exporter i has nonnegative profits during the current period, but the expected discounted lifetime profit stream from accepting will be lower than that from rejecting. Intuitively, an exporter i can make nonnegative profits by accepting the offer but will affect its reputation in such

[17] We suppress y_i^{t-1} from now on.

a way that the current gain from profits will not compensate the future loss caused by a bad reputation. Exporter i rejects the offer in this case.

In order for the decision of accepting to be optimal, two conditions have to be satisfied at time τ. Clearly, the nonnegativity condition for profits, $\pi_{i\tau} \geq 0$, must hold. The R.H.S. of the following equation also has to be greater than or equal to the L.H.S. (i.e. $R \leq A$):

$$0 + \beta \cdot E_\tau[\hat{\pi}_{i\tau+1}] + \beta^2 \cdot E_\tau[\hat{\pi}_{i\tau+2}] + ... \lesseqgtr \pi_{i\tau} + \beta \cdot E_\tau[\pi_{i\tau+1}] + \beta^2 \cdot E_t[\pi_{i\tau+2}] + ... \quad (3.5.1)$$

We now show why an exporter chooses to reject in the case $u_{\pi_{it=0}} < u_{it}$ and $\underline{\epsilon}_{it} \geq \epsilon_{it}$. Then, we show under the case $u_{\pi_{it=0}} < u_{it}$ and $\underline{\epsilon}_{it} < \epsilon_{it}$ an exporter accepts.

Given the fixed parameters, including the realized $u_{i\tau}$, and an offer at time τ, $\epsilon_{i\tau}$ determines whether the R.H.S. or L.H.S. of (3.5.1) is greater. Notice the R.H.S. of equation (3.5.1) is strictly increasing in $\epsilon_{i\tau}$, and the L.H.S. is independent of $\epsilon_{i\tau}$. Figure 3.14 shows the curves for the cumulative expected discounted profit across time under different $\epsilon_{i\tau}$'s. The final end points of the curves correspond to the finite values of the expected discounted lifetime profit streams. In figure 3.14, $\epsilon^1_{i\tau} > \epsilon^2_{i\tau} > \underline{\epsilon}_{i\tau} > \epsilon^3_{i\tau}$.

A higher $\epsilon_{i\tau}$ corresponds to a higher $y_{i\tau}$, which means, by equation (3.2.5), higher $\epsilon_{i\tau}$'s increase the offer at time $\tau + 1$. The increased offer at time $\tau + 1$ increases the probability of entering the market at $\tau + 1$ in expected terms. As a result, a higher $\epsilon_{i\tau}$ corresponds to a higher expected discounted profit at time $\tau + 1$. Given the increased offer and the higher probability of entering the market in expected terms at time $\tau + 1$, an even higher offer at time $\tau + 2$ in expected terms results. By the same reasoning, this yields a higher expected discounted profit for $\tau+2$. The same reasoning holds for future periods.

This result shows that a higher $\epsilon_{i\tau}$ corresponds to a higher cumulative expected discounted profit curve in figure 3.14. Notice that all curves begin at the same value on the y-axis in the case of accepting, since $\epsilon_{i\tau}$ does not affect the profit at time τ. The curve corresponding to $\epsilon^1_{i\tau}$ is higher than that corresponding to $\epsilon^2_{i\tau}$. As $\epsilon_{i\tau}$ becomes lower, the corresponding curve lowers in figure 3.14 as well. At some point, the curve corresponding to $\epsilon_{i\tau}$, which we denote $\underline{\epsilon}_{i\tau}$, converges to the reject curve. Recall that the reject curve is independent of $\epsilon_{i\tau}$. $\underline{\epsilon}_{i\tau}$ makes equation (3.5.1) hold with equality.

$\epsilon^3_{i\tau}$, which is lower than the threshold, $\underline{\epsilon}_{i\tau}$, makes the R.H.S. less than the L.H.S. in equation (3.5.1). The curve corresponding to $\epsilon^3_{i\tau}$ shows the acceptance case in which $\epsilon_{i\tau} < \underline{\epsilon}_{i\tau}$. Under this condition, current profits at time τ, seen in figure 3.14 as the intersection with the y-axis, are greater than zero for $\epsilon^3_{i\tau}$ and equal to zero for the reject curve. At some point, the reject curve crosses the $\epsilon^3_{i\tau}$ curve and remains above thereafter. At time $\tau+n$, at which point the reject curve crosses the $\epsilon^3_{i\tau}$ curve, the expected offer for the reject case has to be greater than the expected offer for the acceptance case. This guarantees the reject curve remains above the $\epsilon^3_{i\tau}$ curve by the same reasoning in the previous case above. Since the reject curve converges to a higher value than the $\epsilon^3_{i\tau}$ curve (i.e. higher expected discounted lifetime profit), rejecting is the optimal decision for exporter i in the case in which $u_{\pi_{it=0}} < u_{it}$ and $\underline{\epsilon}_{it} \geq \epsilon_{it}$. Similarly, for the case when $\pi_{i\tau} \geq 0$ and $\epsilon_{i\tau} \geq \underline{\epsilon}_{i\tau}$, accepting and exporting is optimal, because the discounted expected lifetime profit is greater than that when rejecting.

Proof of Proposition 2:

To prove proposition 3, we already know that given the offer and the fixed parameters, including the realized $u_{i\tau}$, there exists a threshold $\epsilon_{i\tau}$ which equates equation (3.5.1). We also know that increasing the mean of the beliefs, $\mu_{\eta_{i\tau}}$, at time τ, increases the offer at time τ by equation (4). An increase in the offer $\phi_{i\tau}$ at τ increases the R.H.S. more than the L.H.S. at time τ. Hence, the new threshold equating equation (3.5.1) is smaller.

3.5.2 Japanese and French Numerical Simulations

This section explains how to choose parameters to run example simulations to compare with data on United States imports of Japanese and French cars over the years 1961-2005. Data used in determining the parameters of the model are collected from the OECD's International Trade by Commodity Database, the Japan Automobile Manufacturers Association, and corporate websites of individual Japanese and French manufacturers. For simplicity, we set the variances of the productivity shocks, σ_ϵ^2; cost shocks, σ_u^2; and initial prior beliefs, $\sigma_{\hat{\eta}0}^2$, equal to one another and denote them by σ^2 for both simulations. Dropping this simplification does not change any of the results.

There are two crucial relations for these simulations. The first relation is between the actual productivity level, η, and the mean of the prior beliefs, $\mu_{\hat{\eta}0}$:

$$\eta = \mu_{\hat{\eta}0} + \theta_1, \tag{3.5.2}$$

where $\theta_1 \in R$. $\theta_1 > 0$ (< 0) corresponds to the case where the importers undervalue (overvalue) exporters. $\theta_1 = 0$ corresponds the case with no informational asymmetries.

The second crucial relation is between the mean of the initial prior belief, $\mu_{\hat{\eta}_0}$, and the mean of the initial ex-ante cost distribution, μ_c:

$$\mu_{\hat{\eta}_0} = \mu_c + \theta_2, \tag{3.5.3}$$

where $\theta_2 \in R$. We refer to the cost distribution before the realization of u_{it} as the ex-ante cost distribution. Note that given the distributions of the cost shocks and prior beliefs, the initial ex-ante cost distribution will be normally distributed with mean f and variance σ^2. The more negative (positive) θ_2 is, the lower (higher) is the probability of getting an initial offer greater than cost and, thus, having the chance to enter the market. For both simulations, we set $\eta_i = \eta$.

For the Japanese case, in order to identify θ_1 and θ_2, we first use the average of the last 15 data of U.S. imports of Japanese cars to identify η: $\eta = \frac{\text{Avg. } y_{\text{data}} \text{ of } 91-05}{I}$, where $I = 9$ is the number of Japanese exporters seen in the data. Given that importers initially undervalue the Japanese cars such that there are almost no imports before the oil crises, we have $\theta_1 > 0$ and $\theta_2 < 0$. We set $\theta_1 = 10\sigma$ in order to capture the dramatic difference between the prior beliefs and the actual productivity of Japanese exporters. We set $\theta_2 = 3\sigma$ to capture the fact that there were almost no imports before the oil crises. For the years during the oil crises, we exogenously set u to be sufficiently high so that an exporter can enter the market. We also ran our simulations using an alternative method other than fixing the shocks for the years of the oil crises. We used a maximum likelihood method to find the optimal θ_1 and θ_2. We found θ's such that firms were most likely to enter the market during the years of the oil crises.

We obtain similar results with both methodologies. Clearly, before and after the oil crises, u is again a random shock in the model simulation.

Since $\sigma_\epsilon^2 = \sigma_{\hat{\eta}0}^2 = \sigma_u^2 = \sigma^2$, which implies the variance of the initial ex-ante cost distribution, σ_c^2, is also equal to σ^2, the choice of σ is just a normalization. We set σ equal to 200. Then, we calculate the exact values of θ_1 and θ_2. We set $\beta = 0.99$. Now we have all the parameters used in the Japanese simulations: $\eta = 3122$, $\mu_{\hat{\eta}0} = 1122$, $\sigma = 200$, $\beta = 0.99$, $\mu_\epsilon = 0$, $\mu_u = 0$, $f = 1722$, $T = 45$, and $I = 9$.

For the French case, we follow a similar method to that used in the Japanese case. The only differences are as follows: First, importers overvalue the French cars, and, as a result, $\theta_1 < 0$. Second, $I = 5$, which we take from data as before. We again set exogenous shocks for the French case during the years of the oil crises and relax this before and after the oil crises. We use the following set of parameters for the French case: $\eta = 2$, $\mu_{\hat{\eta}0} = 1122$, $\sigma = 200$, $\beta = 0.99$, $\mu_\epsilon = 0$, $\mu_u = 0$, $f = 1722$, $T = 45$, and $I = 5$.

For robustness, we repeat the simulation 10000 times, reporting the average of each year's 10000 simulation results. We also calculate the standard deviation for each year's 10000 simulation results and, then, add and subtract 2 standard deviations from each year's average to construct bands.

3.5.3 Numerical Simulations

This section explains the details of the simulations in section 4 and presents the parameters used in each simulation. In all the simulations, there is a set of benchmark parameters with which to compare different situations. The benchmark case will be compared with overvalued beliefs (figure 3.10 from section 4.1), under different H_0's (figure 3.12 from section 4.2), and with trade barriers and export subsidies (figure 3.13 from section 4.3).

For the benchmark case, the number of time periods is set to $T = 100$ in order to show the potential differences in the short and long run. We set the potential number of exporters to $I = 15$, where the number of actual exporters is determined endogenously. We choose the discount factor $\beta = 0.99$. The parameters of the prior belief distribution are $\mu_{\hat{\eta}0} = 1000$ and $\sigma_{\hat{\eta}0} = 100$. We set the actual productivity to $\eta = 2000$. For simplification, all the exporters have the same actual productivity level, η. Dropping this simplification does not change any of the results. Note that the benchmark case corresponds to the case where importers undervalue exporters. Posterior beliefs are determined endogenously. We set the parameters for productivity shocks and cost shocks to be the same: $\mu_\epsilon = \mu_c = 0$ and $\sigma_\epsilon = \sigma_u = 100$. As a result of this parametrization, $H = 1$ in the benchmark case, i.e. importers give equal weight to their beliefs and their experience in each period. Finally, the parameter of the cost function is set to $f = 1300$.

In the first simulation (figure 3.10), we compare two cases, one in which importers undervalue exporters (benchmark) and another in which importers overvalue exporters. We choose two opposite examples of importers' beliefs in order to highlight the effect of asymmetric information and the importance of learning, reputation building, and signaling. The parameters of the benchmark case are described above. For the case when importers overvalue exporters, we just change the parameters $\mu_{\hat{\eta}0}$ and η and keep all the other parameters the same. We set $\mu_{\hat{\eta}0} = 2000$ and $\eta = 1200$. We run the simulations 10000 times and present the average values of these simulations in figure 3.10.

In the second simulation (figure 3.12), we compare different H_0's, fixing all the other parameters to be the same as the parameters in the benchmark case above. We let $H_0 \in [1, 45]$ to show the results under different values for H_0. We change the precision of the prior beliefs, $h_{\hat{\eta}_{i0}}$, in order to get different values of H_0 in the simulations. Again, we run the simulations 10000 times and present the average values.

In the third simulation (figure 3.13), we compare the benchmark case with two other cases. The first case is the one with trade barriers, and the second case is the one with export subsidies. The benchmark case can be interpreted as free trade with no export subsidy policies. In the trade barriers case, $\psi = +50$ and all the remaining parameters are the same. Recall, $\psi = 0$ corresponds to the benchmark case. In the export subsidies case, $\psi = -50$ and, again, all the other parameters are the same as those in the benchmark case. Figure 3.13 shows how the extent of asymmetric information, κ, changes under different policy regimes. We take the average over I exporters in a given simulation, and, then, we run the simulations 10000 times and present the average values over the simulations. Since we run the simulations 10000 times, the effects of productivity shocks are washed out of κ.

3.6 Conclusion

Asymmetric information impacts the decisions of importers and exporters engaged in international trade; as such, learning and reputation building are some of the key determinants of the dynamics of international trade patterns. We have attempted to enrich the study of international trade theory by developing a framework which casts asymmetric information, learning, and reputation as the leading roles. In our framework, international trade takes place when exporters accept belief-based offers from importers in exchange for shipments of exporters' goods. Importers then update their beliefs according to signals derived from the arrival of the exporters' goods. These new beliefs determine the new offers made to exporters and, consequently, affect the subsequent decision of whether to export. As a result, learning and reputation building change the informational environment in which importers and exporters interact and, thus, have a direct effect on the determination of international trade patterns.

The most obvious, yet important, implication of our framework for the study of international trade is that a firm's ability to export depends not only on its characteristics but also on what importers believe about those characteristics. The history of Japanese and French car exports to the United States reflects this main idea. Existing literature and available evidence create a compelling case for asymmetric information, learning, and reputation to be at the heart of any explanation of Japanese and French car imports. We show our model is capable of replicating the experience of United States car imports from Japan and France over the period 1961-2005.

In addition to deepening our understanding of these events, we discuss further implications of our framework. Since learning and reputation building require time, our model forces us to also take seriously the difference in short run and long run trade patterns. The long run results of our model match those of Melitz (2003), but the short run results can be quite different. We show how sectorial differences in the speed of learning and reputation building affect predicted trade patterns. The extent of asymmetric information existing between importers and exporters also changes under different trade policies, and we compare the free trade, trade barrier, and export subsidy cases of our model.

Figure 3.1: United States Imports of Japanese Passenger Cars

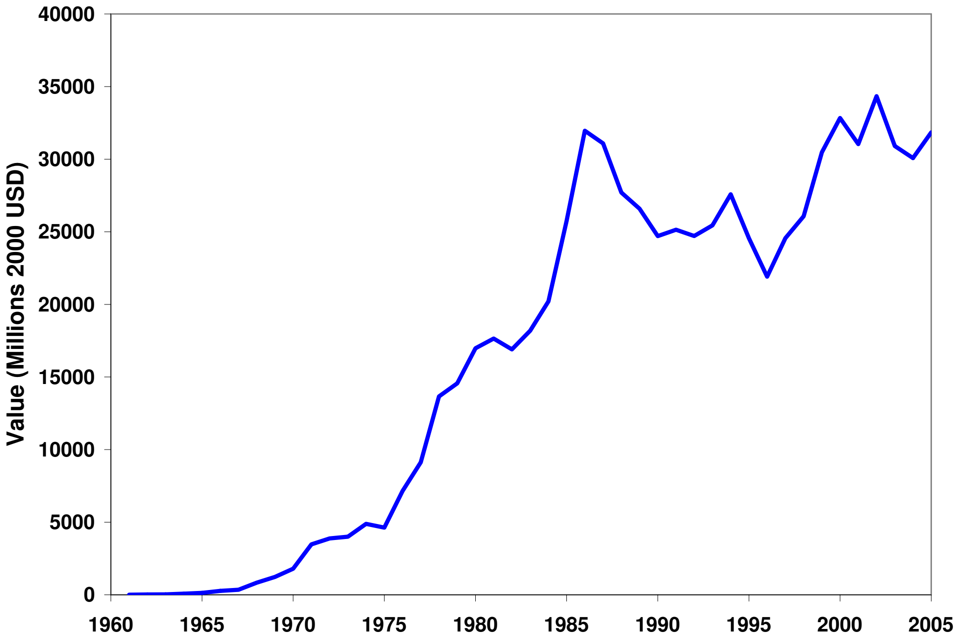


Figure 3.2: United States Imports of French Passenger Cars

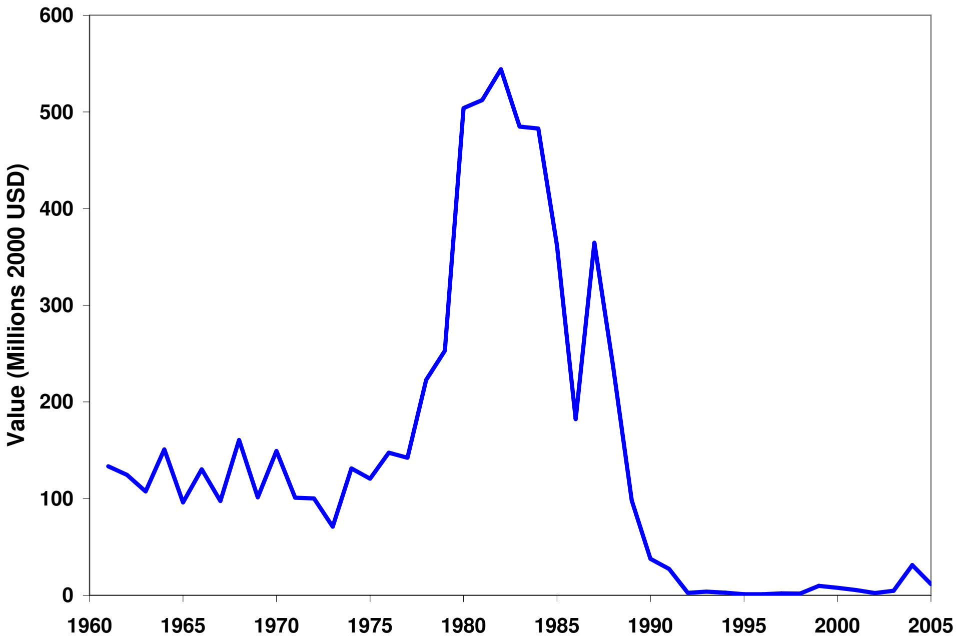


Figure 3.3: Timing Within a Period

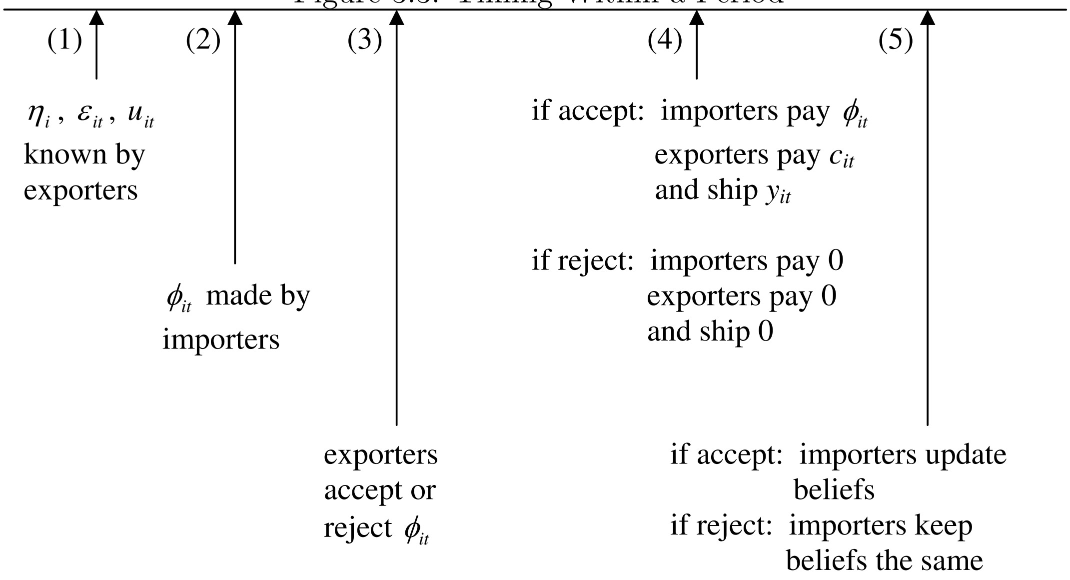


Figure 3.4: Model Simulation: United States Imports of Japanese Passenger Cars

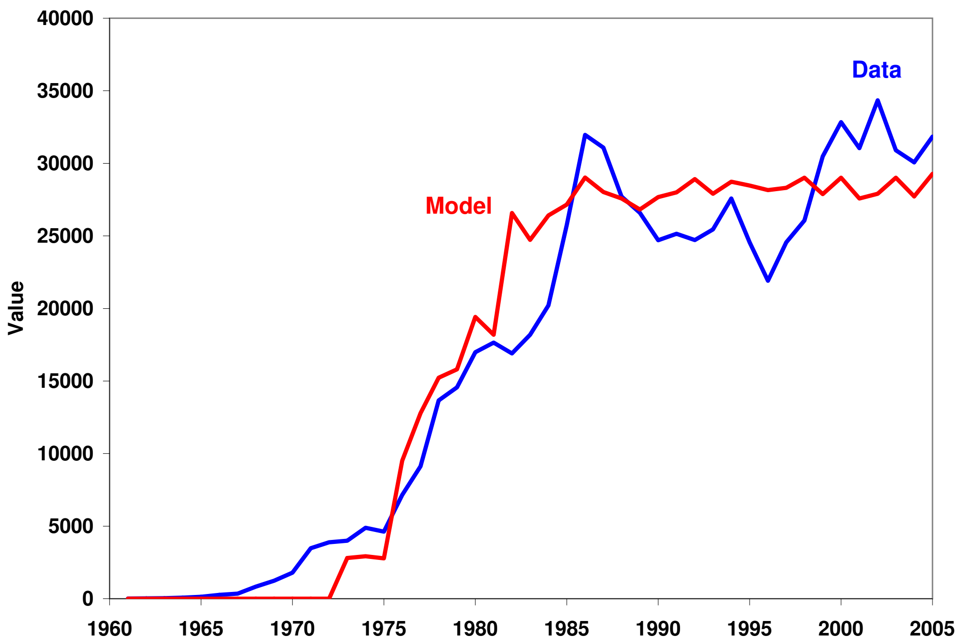


Figure 3.5: Model Simulation: Japanese Robustness

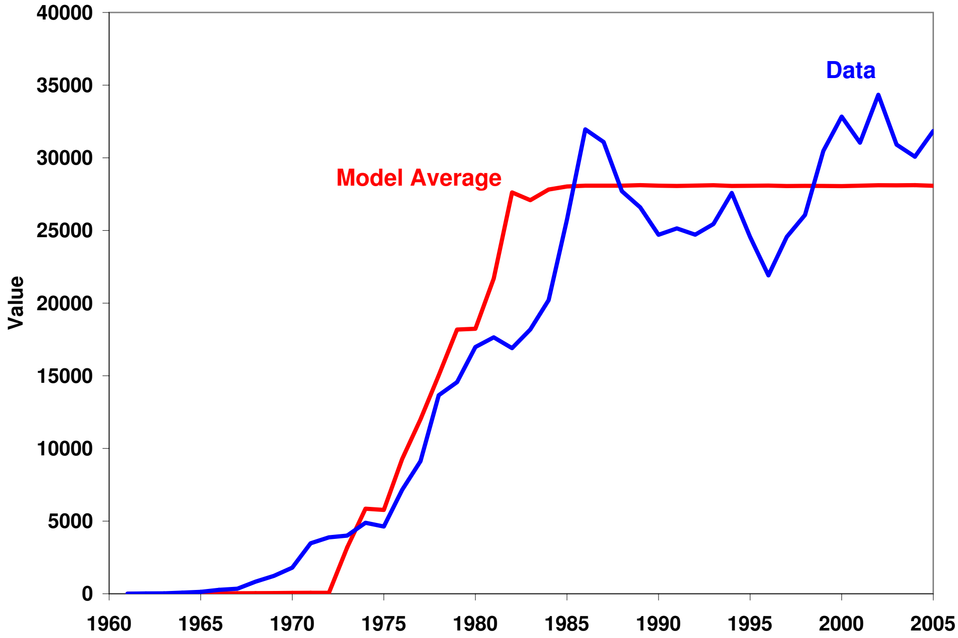


Figure 3.6: Model Simulation: Japanese Robustness

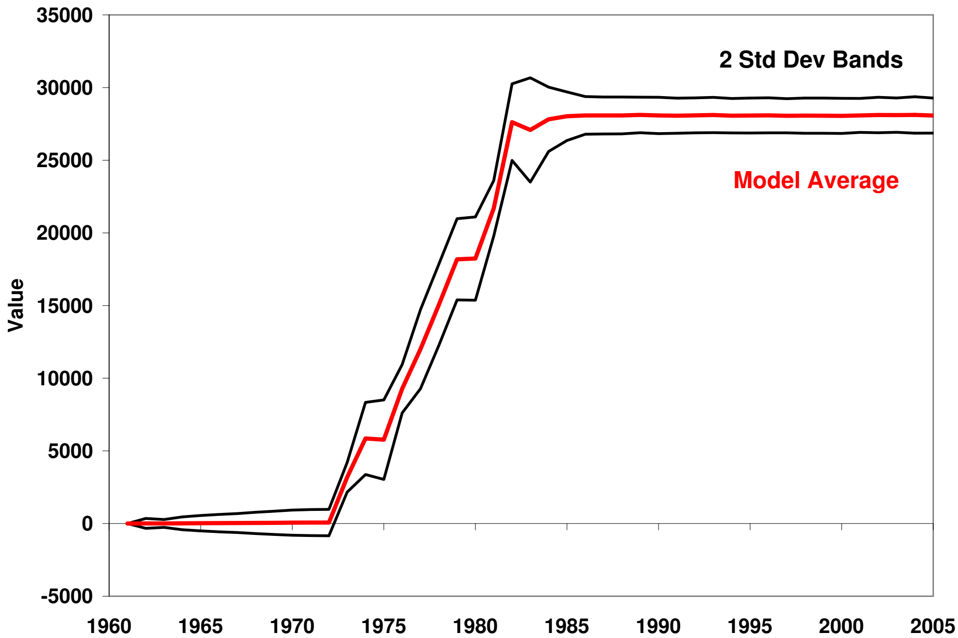


Figure 3.7: Model Simulation: United States Imports of French Passenger Cars

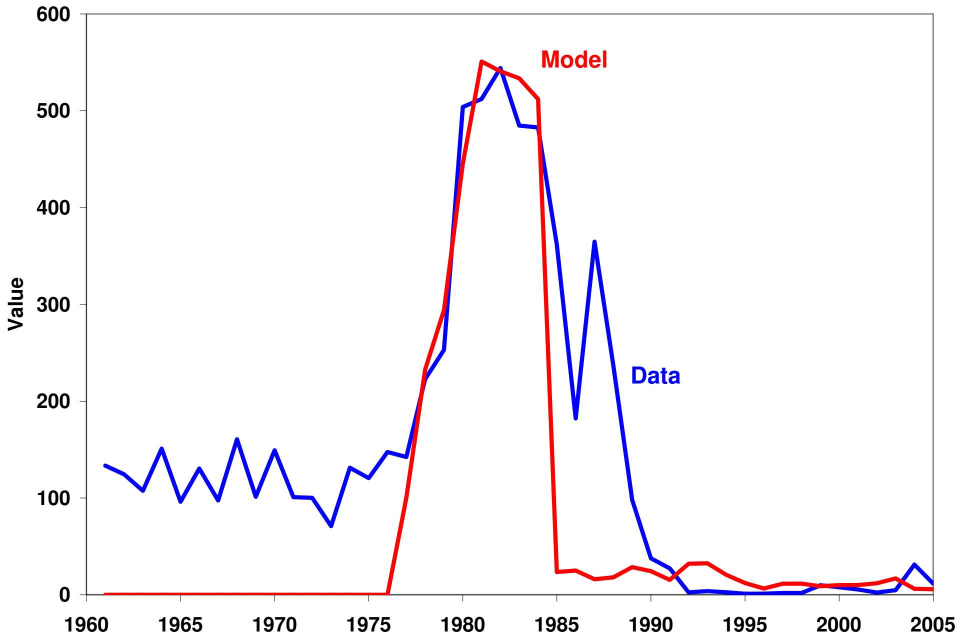


Figure 3.8: Model Simulation: French Robustness

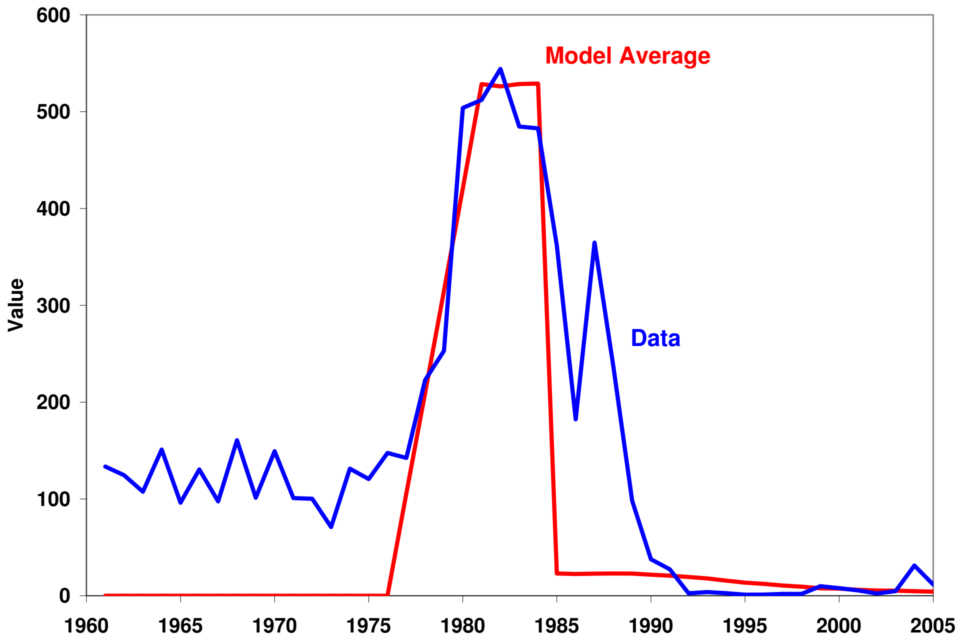


Figure 3.9: Model Simulation: French Robustness

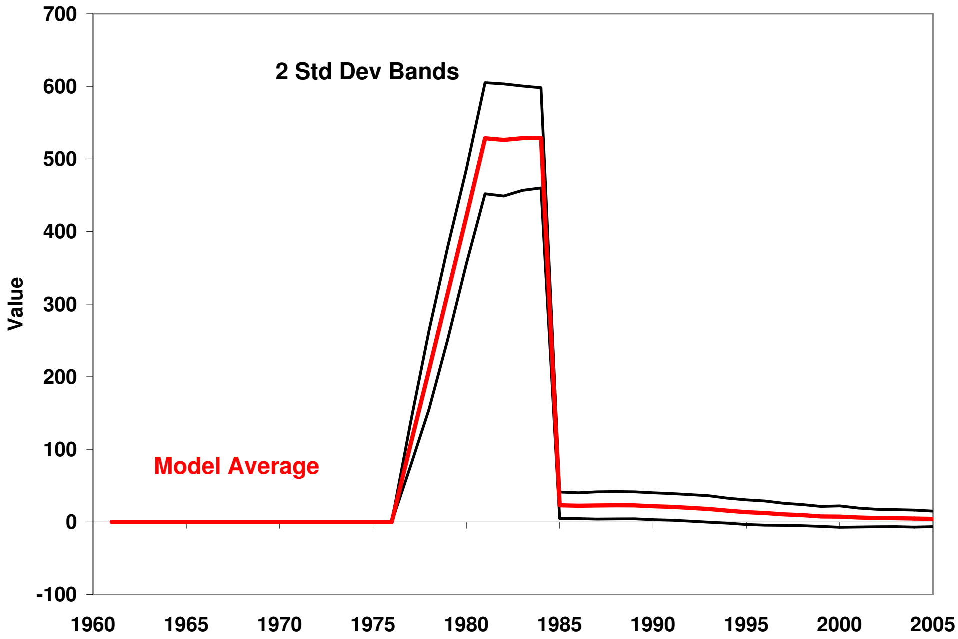


Figure 3.10: Model Simulation: Total Exports, High vs. Low Productivity

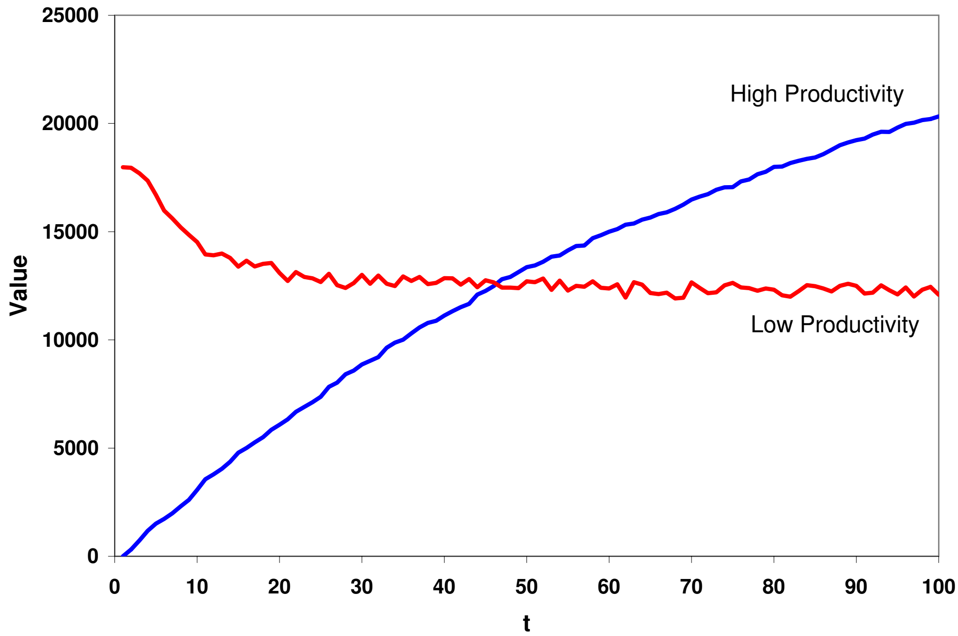


Figure 3.11: American and Japanese Market Share of Car Sales in the United States

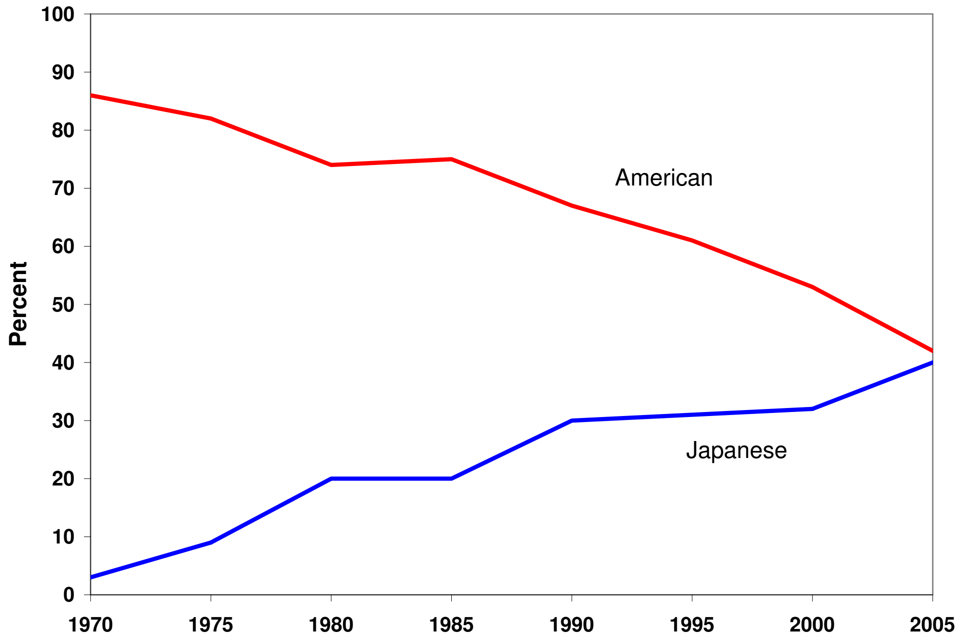


Figure 3.12: Model Simulation: Transition from 5% to 50% of Max. Exports

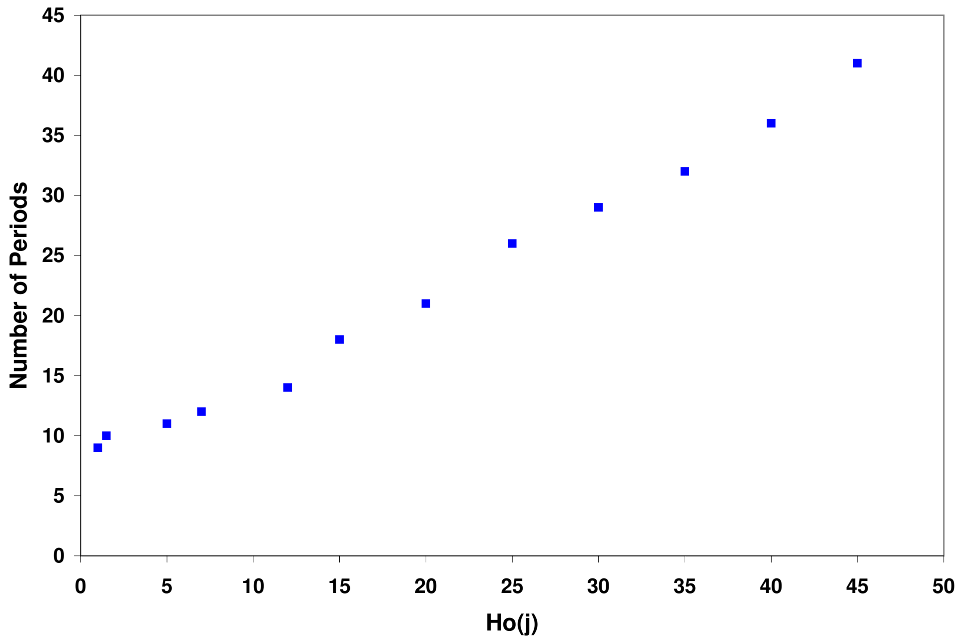


Figure 3.13: Model Simulation: Kappa, Different Trade Policies

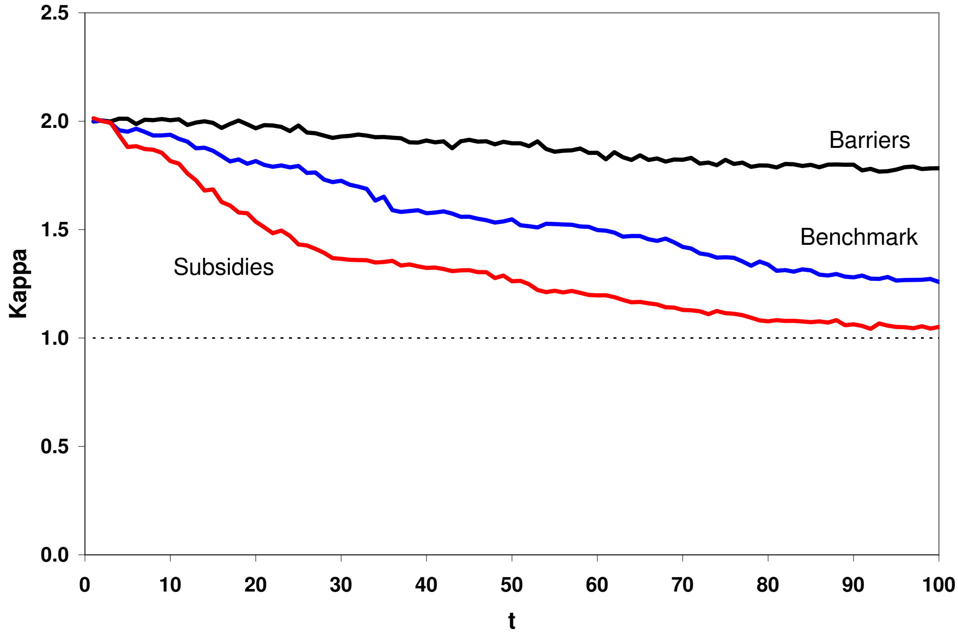
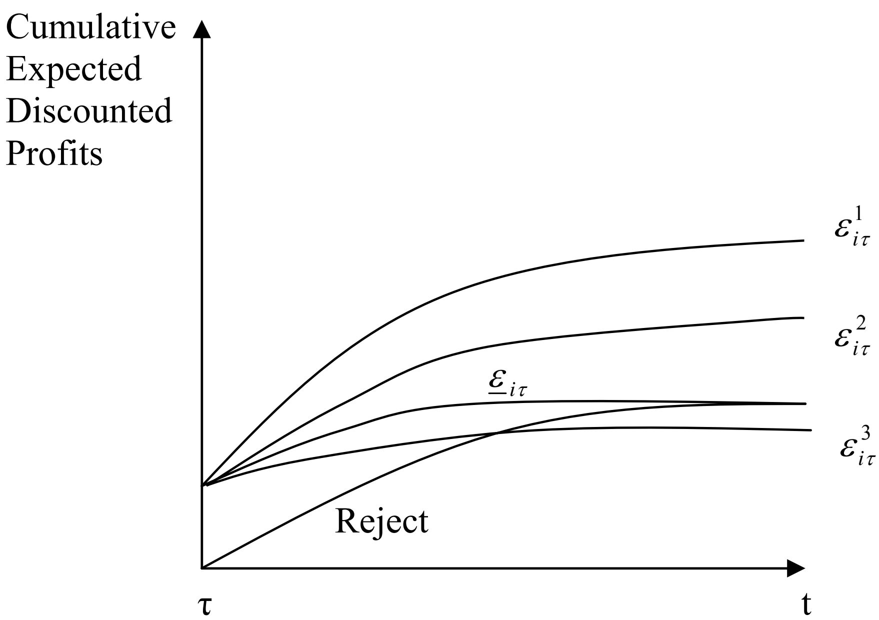


Figure 3.14: Cumulative Expected Discounted Profits Under Different $\epsilon_{i\tau}$'s



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