Essays in International Trade

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Dedication

To my wife, Aradhya Sood.

Abstract

Chapter 1 is a literature review of heterogeneous firm models in international trade. This review starts with a summary of the models before heterogeneity was introduced to trade models. It then continues to show the evidence that heterogeneity among firms is not only a key aspect of international trade, but also that this key aspect and its effects were not being encapsulated in the economic models at the time. We discuss the models that started including heterogeneity among firms into economic models: mainly, Eaton and Kortum (2002), Melitz (2003), Bernard et al. (2003). We show the main impact these papers had in shaping how we evaluate international trade and the effects in the data that these models are able to capture versus those they are unable to capture. I end this literature review by talking about a growing literature which is tariff policy and the effect of heterogeneous firms on tariff policy.

Chapter 2 is a paper on tariffs on intermediate goods. Tariffs on intermediate goods have gained popularity around the world over the past decade, peaking with the steel and aluminum tariff proposed by the U.S. in 2018. Previous studies on tariff policies have discussed the effect of tariffs on the global value chain or on the utility of large countries (Caliendo and Parro (2015) and Flaaen and Pierce (2019)). However, these studies either investigate the effect of tariffs on final goods or the effect of tariffs on intermediate goods. They do not consider an environment with both intermediate and final goods. This paper studies the relative welfare and productivity effects in a economy with tariffs on intermediate goods versus tariffs on final goods. This paper finds that the effect of an intermediate good tariff is highly influenced by the Armington [1] elasticity of the industry. In industries that have a low Armington elasticity, there is an increase in utility from a 1% tariff on intermediate goods as compared with a tariff on final goods, however, for sectors with high Armington elasticity there is a decrease in utility due to an intermediate good tariff as compared with a tariff on final goods.

[1] Armington (1969)

Chapter 3 is a paper on international trade and the effect it has on wholesale versus customized goods. The differing effect trade has on specialized and wholesale goods is a growing literature headed by Holmes and Stevens (2014). This literature does not take into account firm decision into choosing the specialized sector versus the wholesale sector. Thus they are unable to explain the increase in specialized firm in the US with an increase in wholesale trade. For example the large increase in craft beer in the US after NAFTA. This paper gives theoretical justification for this increase in domestic production of specialized goods, when countries open up to trade. We also show that depending on certain parameters, the expenditure share on specialized goods can increase when a country opens up to trade.

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Chapter 1

Literature Review on Heterogeneous Firm Models in International Trade

1.1 Introduction

International trade has been a growing literature in trade since Adam Smith's seminal work "The Wealth of Nations". In this book, Smith argued that allowing people in different country's to freely trade across countries would promote economic prosperity and would be a better alternative to the mercantilist ideology prevalent at the time. David Ricardo in 1817 built on this idea by showing that there was a motive for countries to trade with one another: comparative advantage (Ricardo (2017)). His theory was built on the fact that some country's could produce specific goods with less inputs than other country's. For example in the 1800's, the British were more productive at producing manufactured goods than their eastern neighbors. Ricardo theorized that all country's would benefit if the British exported their manufactured goods for other goods such as agricultural goods. He theorized that this could be beneficial even if the British were more productive at producing agricultural goods than their trading partners. This theory was based on opportunity cost.

Ricardo believed that even if the British Empire was more productive in the production of all goods, if the British had a higher opportunity cost at producing agricultural good relative to manufacturing goods than their trading partners, both countries would benefit. He called this phenomenon comparative advantage. The theory went as follows: the British could either not trade and spend extra labor to produce agricultural goods, or they could spend that labor on manufacturing goods and trade away some of the manufacturing goods for agricultural goods. Ricardo found that, for the right price, the latter option was more beneficial for the British economy, even if their trading partner was relatively less productive then them.

Hekscher-Ohlin(1919), built on Ricardo's idea and claimed that this comparative advantage could be because of differences in productivity's in a given sector or because of relative factor endowments (Feenstra (2004)). Their model looked at a world where there were global imbalances: some countries had more factor endowments (or more productive) than other countries. They find that in this case, countries should export the good they can produce cheaper, and import the good that they can't produce as cheaply.

Since these great developments, there has been a vast literature on international trade. This review will focus on the heterogeneous trade literature and its effect on trade policy. The first section will describe works that led to the heterogeneous trade literature. The second section will go into detail the empirical work that showed that heterogeneity was an important characteristic in international trade. The third chapter will summarize the seminal papers that kicked off this literature. The fourth and final section will discuss the effect of the heterogeneous trade liteature on the trade policy literature.

1.1.1 The International Trade Theory before Heterogeneity in Trade

New Trade Theory

Traditional models of international trade explain the flow of goods between countries through the scope of comparative advantage. Comparative advantage can arise for multiple different reasons: productivity differences (Ricardo), differences in factor abundance (Hekscher-Ohlin). These theories implied that countries exported goods that they had a comparative advantage in (relatively higher productivity or factor abundance) and imported goods that they had a comparative disadvantage in (relatively lower productivity or factor abundance). These theories inherently implied that there was no intra-industry trade: if the home country was exporting a good to a foreign country, that foreign country, theoretically, could not be importing that same to the home country.

However, a large share of international trade occurs between relatively similar partners within industries. For example, the largest exporter to the US and importer to the US is Canada (a relatively similar country). The US's largest import from Canada is also their largest export: car and car parts. This led to the creation of a "new" trade theory that could account for this fact (Krugman (1980)). This model accounted for intra-industry trade by introducing a combination of economies of scale and preferences for variety. The production function Krugman uses to illustrate this point is:

$$L_i = [\alpha + \beta x_i] \tag{1.1}$$

This simple production equation implies that it is relatively cheaper for one country to produce the all of a certain variety, then to have both countries produce it themselves. This is because of the α term, which makes more than one country producing the variety inefficient. The Dixit-Stiglitz preferences used can be generalized as a utility function:

$$U = \sum_{i=1}^{n} v(c_i) \;\; v_i' > 0 \quad v_i'' > 0 \tag{1.2}$$

This utility function implies that the consumer has a love for variety, since to maximize this utility function, a consumer would want to consume at least a little of each good. These two mechanisms together creates an environment such that if two identical country's open up to trade, in equilibrium, each country would specialize in a specific variety and all varieties would be traded. This is because in equilibrium if one country produces a variety, it is inefficient for the other country to produce the same variety. If a variety is produced, due to the utility function, the consumer from each country will demand a non-zero quantity of the variety. Helpman and Krugman (1985) connected this "new" trade theory with the old trade theories of international trade by creating a theoretical model that had differences in factor endowments, economies of scale and gains from variety.

Eaton-Kortum Model

Krugman's framework was not able to encapsulate some of the facts about international trade. Such as (i) trade diminishes with distance, (ii) prices vary across locations, (iii) factor rewards are unequal across countries and (iv) countries relative productivities vary across industry. Eaton and Kortum (2002) introduced a model using geography and heterogeneous productivities across countries built a theoretical model to encapsulate these facts in a tractable way. Like Krugman, they employ a Dixit-Stiglitz preferences, however, they choose a specific utility function which is CES:

$$U = [\int_0^1 Q(j)^{\sigma-1/\sigma} dj]^{\sigma/\sigma-1}, \quad \sigma > 0 \tag{1.3}$$

They use a similar model to Dornbusch et al. (1977) with country and industry specific productivities and a continuum of goods; however they add geographic barriers which they call "iceberg" trade costs. This means that when a country i wants to trade a good to country n, they will have to deliver d_{ni} units of the good. Each country has a different input cost c_i and each country has a productivity in each industry j, $z_i(j)$. So delivering a unit of a good j produced in country i to country n costs:

$$p_{ni}(j) = \left(\frac{c_i}{z_i(j)}\right) d_{ni} \tag{1.4}$$

There is a perfectly competitive market for each good j. So each country decides to consume good j from the country who supplies it for the cheapest:

$$p_n(j) = \min\{p_{ni}(j);\ i = 1, \ldots, N\} \tag{1.5}$$

Technology for good j is picked from a country-specific Frechet distribution $F_i(z) = e^{-T_i z^{-\theta}}$ where $T_i > 1$ and $\theta > 0$. This distribution allows a country to have absolute or comparative advantage across a continuum of goods dependent on the exogenous parameters of the Frechet distribution. The T_i parameter reflects the country's absolute advantage across the continuum of goods, while the θ parameter governs the comparative advantage within the continuum. This methodological contribution allowed them to analyze prices in a given country by a distribution of prices available in the country. This is given by:

$$G_n(p) = 1 - e^{-\Phi_n p^{\theta}} \quad \text{where} \quad \Phi_n = \sum_{i=1}^{N} T_i (c_i d_{ni})^{-\theta} \tag{1.6}$$

The Φ_n parameter is critical to the Eaton-Kortum model as it summarizes three essential mechanisms in the model: (i) states of technology around the world, (ii) input costs around the world and (iii) trade barriers in each country n. This distribution also shows that the price distribution in each country would be the same, if there was no difference in the trade barriers to each country.

This model was able to show the opposing forces of geographic barriers and differences in productivity's and how it affected trade flows. This was also able to contribute the gravity literature into general equilibrium trade models. Work such as Anderson and Van Wincoop (2003) were able to show these opposing forces before; however this paper was able to encapsulate this mechanism in a general equilibrium model.

1.1.2 The Evidence for the Importance in Heterogeneity in Trade

In the 1980's and 1990's, micro data emerged that showed that there was a lot of heterogeneity in firm productivity, size and other economic characteristics that were not accounted for in the old theories of trade. Bernard and Jensen (1999) show that this heterogeneity between firms affected firm participation in trade. Within an industry, some of the firms exported while other firms did not. The firms that participated in trade tended to be more productive, larger in size and paid higher wages than other firms. Firms that export were found in both net exporting and net importing industries. None of these characteristics in the data could be found in the existing trade theories. The facts are as follows:

Fact 1: ***Firms Exporting is Relatively Rare*****:**
In 2000, Of the 5.5 million firms producing in the US, only 4 percent exported. If you focus on the industries that are more predisposed to exporting such as manufacturing or mining, only 15 percent of the producing firms exported. The percentage of firms that export vary widely across industry: in 2002, 38 percent of electronic product producing firms exported, while only 8 percent of apparel manufacturing firms exported. This data fact contradicts one of the results in the Krugman model, which is that every firm exports due to a preference for variety.

Fact 2: ***Exporters are Different from Non-Exporters*****:** Exporting firms are substantially different than non-exporting firms. In 2002, exporting firms, on average, had 97 percent more workers, 108 percent more shipments, 11 percent higher value-added per worker, 3 percent higher factor productivity and 6 percent higher wages than non-exporting firms in the same industry. In other words, exporting firms were substantially larger (in terms of workforce), produced more goods, were more productive and paid higher labor costs per unit. Exporting firms were also more capital and skill-intensive, than non-exporting firms.

Fact 3: *Trade Liberalization Affects Firms Differently*: In the previous theories of comparative advantage, trade liberalization led to developing countries specializing in goods that they had a comparative advantage in. Pavcnik (2002) shows in the case of Chile that approximately two thirds of the aggregate productivity increase following Chile's trade liberalization in the late 1970's and early 1980's was not due to specialization, but due to higher productivity firms surviving and growing, while less productive firms failing. They find that across-industry reallocation of resources trumps the across-industry reallocation. Therefore, in the labor market, instead of a shift in employment across industries (which would be suggested by comparative advantage) does not occur, instead there is a shift in employment within an industry.

Trade theories that relied on comparative advantage, such as Hekscher-Ohlin, described inter-industry trade and could not account for within-industry trade. These models also could not account for the heterogeneity in firms within an industry because they assumed perfect competition and constant returns to scale. Trade theories such as Krugman's New Trade Theory that relied on gains from variety, firms specialize in distinct horizontally differentiated varieties and countries trade within an industry ("intra-industry trade"); however because of the assumptions underlying Dixit-Stiglitz preferences, all firms tend to export.

Further evidence of the importance of firm heterogeneity came from the consequences of trade liberalization. After a trade liberalization shock, much of the observed reallocation happened within industry (Levinsohn (1999)). After trade liberalization, the most productive firms participate in trade, while the least productive firms exit the industry. This result is consistent both for developing countries and developed countries.

1.1.3 Introduction of Heterogeneity into Trade

As the importance of heterogeneity in terms of international trade has been uncovering, theoretical models also started developing to take these data facts into account. The two main strands of literature are from Bernard et al. (2003) and

Melitz and Redding (2014).

Bernard, Eaton, Jensen, Kortum Model

Bernard et al. (2003) extended the model from Eaton Kortum to have Bertrand competition and multiple producers of each good in each country, instead of perfect competition and one producer in each country. The only difference between these multiple producers were differences in technology: the kth most efficient producer of good j in country i can convert one input bundle into $Z_{ki}(j)$ units of good j. Using the same notation as Eaton Kortum, the kth most efficient producer of good j in country i can deliver a unit of the good to country n at cost:

$$C_{kni} = \left(\frac{w_i}{Z_{ki}(j)}\right) d_{ni} \tag{1.7}$$

As in perfect competition, in Bertrand competition each country n buys good j from the supplier with the lowest input costs. However, this supplier is constrained not to charge more than the second-lowest cost of supplying the market, which is:

$$C_{2n}(j) = \min\{C_{2ni^*}(j), \min_{i \neq i^*}\{C_{1n}(j)\}\} \tag{1.8}$$

where i^* is the country that supplies good j to country n at the lowest cost. This means that the second lowest cost supplier of good j to country n is either the second lowest cost supplier in country i^* or the lowest cost supplier in another country. This means that the price of good j in country n is:[1]

$$P_n(j) = min\{C_{2n}(j), \bar{m}C_{1n}(j)\} \tag{1.9}$$

After making these subtle changes to the model, they extend the methodological contribution of EK by having a Frechet distribution of not only the productivity of the most efficient producer of good j, but a joint distribution of the two most productive producers of good j. The CDF of this distribution can be described as:

[1] Dixit and Stiglitz (1977) shows that the lowest cost supplier would not want to charge a markup higher than $\bar{m} = \sigma/(\sigma - 1)$ if $\sigma > 1$. If $\sigma \leq 1$ then $\bar{m} = \infty$.

$$F_i(z_1, z_2) = [1 + T_i(z_1^{-\theta} - z_2^{-\theta})]e^{-T_i z_2^{\theta}} \tag{1.10}$$

The distribution of the prices with this joint distribution can be described as:

$$G_n(c_1, c_2) = 1 - e^{-\Phi_n c_1^{\theta}} - \Phi_n c_1^{\theta} e^{-\Phi_n c_2^{\theta}} \tag{1.11}$$

where the Φ_n variable is identical with the Eaton-Kortum model.

BEJK is able to derive very similar analytical results to EK: (i) the probability that country i is the lowest-cost supplier to n for any good j is just country i's contribution to the cost parameter Φ_n (ii) The price level of any country n is just $p_n = \gamma\Phi_n^{-1/\theta}$ where γ is a function of θ and σ. However, they are also able to come up with novel result: the markup is a realization of a random variable M_n drawn from a Pareto distribution that is truncated at the monopoly markup.

$$H_n(m) = \begin{cases} 1 - m^{-\theta}, & 1 < m \leq \bar{m} \\ 1, & m \geq \bar{m} \end{cases} \tag{1.12}$$

This set up is able to encapsulate a lot of the new evidence detailed in Section II. The arguments are as follows:

1. Efficiency and Measured Productivity

First of all in this model, firms that are more productive, tend to charge a higher markup. The distribution of markups conditional on productivities is:

$$H_n(m) = \begin{cases} 1 - e^{-\Phi_n w_n^{\theta} z_1^{-\theta}(m^{\theta}-1)}, & 1 < m \leq \bar{m} \\ 1, & m \geq \bar{m} \end{cases} \tag{1.13}$$

So a firm with higher efficiency Z_1 is likely to have higher markups and hence higher measured productivity. So, in Bertrand competition, variation in efficiency can generate heterogeneity in measured productivity across firms.

2. Efficiency and Exporting

This model creates two different efficiency hurdles for producers of any good j in country n. The first hurdle is to produce the good for the domestic markets. For this firm to supply the domestic market, it must have lower input costs than any other country after transportation costs. The second efficiency hurdle is to produce the good for foreign markets. For a firm to supply foreign markets, it must have a lower input cost after transportation costs than any other country including the domestic market. In this model, due to the triangle inequality of transportation costs, the second efficiency hurdle requires a higher efficiency than the first. So, some firms supply the domestic market and the more efficient firms supply both the domestic and foreign markets. This is also consistent with the data, where we find that few firms export and the firms that do export are more productive.

3. Efficiency and Size

In this model, a firm being more efficient does not only increase their probability of being an exporter, but also decreases the domestic price of their production of good j. If $\sigma > 1$, this will translate into more domestic expenditure for that firm's good j. The price can decrease for two reasons. If the markup is the monopoly markup, $\bar{m}$, then an increase in efficiency decreases the per-unit cost, which decreases the overall price. If the markup is not the monopoly markup, then even though the markup increases with productivity, the decrease in per unit cost dominates the increase in markup.

Even though this paper made large contributions by adding heterogeneity into trade literature, they were not able to encapsulate all the data facts. First of all, due to their Bertrand competition market structure, only one firm in each country could produce any good j. This restriction kept this model from analyzing intra-industry dynamics, especially when it came to trade liberalization. This is where Melitz was able to make a contribution.

Melitz Model

Melitz and Redding (2014) built on previous literature in industrial organization (mainly Hopenhayn (1992)) and explained the data facts about heterogeneous firms in a monopolistic competition framework. The demand side of the model is very similar to the Eaton and Kortum (2002) and the Bernard et al. (2003) models, however, where they differ is on the production side.

In this model, firms pay a fixed cost to produce in a sector ($f_e > 0$). Once they pay the fixed cost, the firm picks a productivity φ from a distribution $g(\varphi)$. Once the firm enters, depending on the productivity draw, a firm can choose to immediately exit or produce output. The technology that a firm uses to produce output is: $l = f + q/\varphi$ where l is the labor used, f is the fixed cost of producing and q is the quantity of output the firm decides to produce. Labor is supplied by the households and are paid a wage w. Regardless of productivity each firm faces a residual demand curve with constant elasticity of σ ($\rho = (\sigma - 1)/\sigma$). These lead to the derivation of a pricing rule, the firm revenue and the firms profits:

$$p(\varphi) = \frac{w}{\rho\varphi} \tag{1.14}$$

$$r(\varphi) = R(P\rho\varphi)^{\sigma-1} \tag{1.15}$$

$$\pi(\varphi) = \frac{R}{\sigma}(P\rho\varphi)^{\sigma-1} - f \tag{1.16}$$

where P in equilibrium is the price level of a given country

$$P = \left[\int_0^\infty p(\varphi)^{1-\sigma} M\mu(\varphi) d\varphi\right] \tag{1.17}$$

where $\mu(\cdot)$ is the PDF of firms at a given productivity. From these formulas, it is clear that in this model, firms that are more productive, are bigger, charge lower prices and collect higher profits. To define the equilibrium in this economy, it will be helpful to define the weighted average of productivities ($\tilde{\varphi}$ as the following:

$$\tilde{\varphi} = \left[\int_0^\infty \varphi^{\sigma-1} \mu(\varphi) d\varphi \right]^{\frac{1}{1-\sigma}} \tag{1.18}$$

This expression allows us to describe all of the variables in terms of aggregate variables:

$$P = M^{\frac{1}{1-\sigma}} p(\tilde{\varphi}) \quad Q = M^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}) \tag{1.19}$$

$$R = Mr(\tilde{\varphi}) \quad \Pi = M\pi(\tilde{\varphi}) \tag{1.20}$$

This also led to some drawbacks. Since in BEJK, firms all competed to produce the same variety, there were endogenously different markups across varieties within an industry, which Melitz could not replicate.

Trade Model Welfare Puzzle

In the trade literature, there is a large number of papers focused on the welfare gains of trade (such as Broda and Weinstein (2006), Feenstra and Weinstein (2017), Feenstra (1996) etc.). Arkolakis et al. (2012) find that the welfare gains from changes in trade costs in trade models were actually very small and were not able to encapsulate the empirical evidence. They looked at the new (Melitz, EK) as well as the old trade models (Krugman) and were able to show that the gains from trade were not significantly different and were small. This result shows that even though trade papers have added heterogeneity and have improved models in other significant ways, they are still far away from being able to explain the welfare gains from trade found in the data.

1.1.4 International Trade and Customization

The growing trade literature in heterogeneity extended to customization. This was not a relatively new idea: Piore and Sabel (1986) distinguished between mass production in larger plants and specialized production in smaller plants. However, with the new models that were becoming available, this idea started shedding a new light in firm dynamics with changes in trade policy. Holmes and Stevens (2014), uses the example of the furniture industry in the US to show the different effects trade has on the wholesale industry and the specialized goods industry. They find that with the entrance of the WTO, wholesale furniture manufacturers in the US saw a large decrease in production, meanwhile the specialized good industry were not affected. The second chapter of this thesis will build on this literature by looking at the beer industry in the US. Unlike Holmes and Stevens (2014), this chapter will analyze this industry through the lense of monopolistic competition (a Melitz-style model) instead of perfect competition (an Eaton-Kortum style model).

1.1.5 Optimal Tariff Policy

The optimal trade policy literature has been a focus in international trade for a long time. Kandor (1940) and Johnson (1953) studied optimal tariff policy under the possibility of retaliatory tariffs. Balassa (1965) and Ruffin (1969) studied the effect of tariffs on the world supply chain and how this affected input costs in production. The improvements done in the international trade literature has allowed economists to analyze trade theory in a new lense. Not only in terms of what is optimal, but to analyze the effects certain trade policy can have on specific industries or specific countries. For example papers such as Caliendo and Parro (2015) study the effect of NAFTA on industries in the US, Canada and Mexico. Their analysis is heavily dependent on the innovations of Eaton and Kortum and other extensions that were made on that innovation.

Tariff policy has not only been studied in terms of the effect on specific industries' production, but the effect of tariffs on prices in a certain industry. Amiti et al. (2019) and Fajgelbaum et al. (2020) study the pass-through of tariff policy on domestic prices. The importance of this literature is that, even though most papers assume that the level of pass-through exogenously, the effect of the tariff policy on domestic prices would have a large effect on tariff policy determination and the effect on production.

This literature has also been analyzed in the framework of firm decisions. Flaaen and Pierce (2019) look at the washing machine industry and find that a tariff on a specific country can lead to relocation of firms and a tariff on a group of countries can lead to a larger pass-through of tariffs on domestic prices of not only the good, but also complements of the good. Handley et al. (2020) find that firms that get affected by tariffs from a particular country react to these tariffs by demanding less intermediate inputs from that country. This literature has been heavily influenced by the innovations of Melitz when doing their analysis.

1.2 Future of Heterogeneity in Trade

Since these landmark papers, the majority of the trade literature have used models with heterogeneous firms. There have been some major and some minor changes to these models to encapsulate features of the data; however the main mechanisms in the Eaton-Kortum and Melitz models are at the core of most papers in the trade literature. The two most prominent changes in this strand of literature are: (i) the focus on global value chains and the stages of production and (ii) the study of the source of heterogeneity in goods and their effect on consumer's utility.

Global value chains have become a prominent part of the international trade literature. As the world has become more and more interconnected in production, the international trade literature have built models to study this phenomenon. A prominent paper in this literature has been Antràs and De Gortari (2020). This paper build a model with global value chains where there are firms that produce in each stage of production. Firms that are in higher stages of production find the cheapest producer of the stage below them to purchase inputs. In this model, firms are not only different in terms of productivity, but are also different in terms of the stage they produce in the value chain. They use this model to show the effect of higher trade costs on income and utility as well as the effect it has on the global value chain. They find that an increase in trade costs leads to a decrease in income and utility, but also decrease the chance of countries participating in global value chains. This is because, as trade costs increase, the goods from the domestic economy become relatively more expensive at every stage of production and so it is less likely that foreign producers would demand the domestic goods as inputs.

Recent work has also included the effect of trade policy on global value chains. Blanchard et al. (2016) build a model with global value chains and find that theoretically it is optimal for country's to fluctuate the tariff on final goods depending on the domestic content of the final good. They find that country's should set a smaller tariff on goods that have more domestic content. They also show that this theoretical result can be shown in the data. Country's tend to set higher tariffs on goods that have less domestic content.

Another way this strand of literature can extend is searching the source of heterogeneity in final goods. Hottman et al. (2016) develop a model with multi-product heterogeneous firms in which they use to decompose the firm-size distribution into the contributions of cost, taste, markups and product scope. Using this model they are able to calculate how much these characteristics contribute to the heterogeneity in production and sales. They find that taste and product scope are able to explain four fifths of the heterogeneity in sales. This paper doesn't take into account a lot of aspects that are common in international trade. International trade has used features such as high trade costs to explain some of the facts in the data that they are unable to explain. Finding the source of heterogeneity in sales across countries could allow us to have a deeper understanding of trade routes in the world and help us understand the source of international trade patterns found in the data.

1.3 Conclusion

The international trade theory literature has grown considerably in terms of complexity in the past few decades. One of dimensions of this is adding firm heterogeneity to international trade models. The introduction of economies of scale to trade models by Krugman led to a large literature that was able to address the considerable level of firm heterogeneity in international trade found in the data.

The main papers that were able to address this were Melitz (2003), and Bernard et al. (2003). These papers were able to use prior literature found in the industrial organization literature and trade literature and build economic models that accounted for firm heterogeneity in international trade. This started a series of new papers that were able to show the importance of firm heterogeneity to macroeconomic policies, as well as accurately evaluate firm behavior. Current research has started building on this and starting to consider the impact firm heterogeneity has on the welfare impact of tariff level changes.

Chapter 2

Welfare Impacts of Protectionist Policies on Intermediate Goods

2.1 Introduction

Tariffs on intermediate goods have gained popularity around the world over the past decade, peaking with the steel and aluminum tariff proposed by the U.S. in 2018. Some previous studies on tariff policies have discussed the effect of tariffs on the global value chain or on the utility of large countries. However, these studies either investigate the effect of tariffs on final goods or the effect of tariffs on intermediate goods. They do not consider an environment with both intermediate and final goods. This paper studies the relative welfare and productivity effects in a economy with tariffs on intermediate goods versus a tariffs on final goods.[1]

To compare the relative effects of tariffs on intermediate versus final goods, I build a multi-country Armington model with two identical countries which produce a unique intermediate good and a unique final good.[2] Intermediate good producing firms use labor as an input to produce their output, while final good

[1] Final goods are defined as products that are consumed by households, while intermediate goods are products that are used to produce other intermediate and final goods. For instance, steel is not directly consumed by households but rather indirectly consumed by people in uses of cars, washing machines, etc.

[2] In calibration of the model, I expand the model to include 20 identical countries.

producing firms use a CES production function of all the intermediate goods found in the economy as well as labor. The consumers demand all final goods in the economy with a CES utility function. In equilibrium there is always trade in both intermediate and final goods in this economy. This model setup allows me to study the relative effects of tariffs on intermediate versus final goods.

This paper relates to a growing literature on the effect of tariffs on world trade flows and productivity. Papers like Caliendo and Parro (2015), which focuses on the welfare effects of NAFTA, only focus on the trade of tradable goods that can be used as final goods or consumption goods. Meanwhile Flaaen and Pierce (2019) looks at how tariffs effect global value chains especially when it comes to the US. This paper differentiates itself from these because it studies the differential effects of a tariff on a final good versus an intermediate good. This is important because it is crucial to understand the recent surge in tariffs on intermediate goods, such as the tariff changes in the U.S. in 2018, the increase in tariffs on intermediates against the U.S. in the EU, and the high tariff on intermediate goods in developing countries such as Pakistan (see Pursell et al. (2011)).

This paper finds that the effect of an intermediate good tariff is highly influenced by the Armington elasticity of the industry.[3] In industries that have a low Armington elasticity, like the food manufacturing industry where food manufactured across different countries is less substitutable, there is an increase in utility from a 1% tariff on intermediate goods as opposed to a 1% tariff on final goods. For sectors with high Armington elasticity, like the petroleum industry, there is a decrease in utility due to an intermediate goods tariff as opposed to a tariff on final goods. The effect the Armington elasticity on a final goods tariff is minimal, but the higher the elasticity, the higher increase in utility is observed. This is not a surprising result. Broda et al. (2008) also find that elasticities play a key role in the effectiveness of tariffs in specific sectors. However, Broda et al. (2008) study the effect of only final goods tariff and not the intermediate goods tariff.

A complementary paper by Mary et al. (2019) estimates the cost of Trump Administration's trade policy to the U.S. economy by accounting for the increased

[3] I use Armington elasticities from Adhmad and Riker (2019).

cost for the production of intermediate goods after the 2018 tariffs. This paper complements their analysis by studying the general equilibrium effect of intermediate versus final goods tariff on not only domestic utility, consumption, and production but also world utility, consumption, and production. This paper is also closely related to the paper by Bagwell and Staiger (1999) who study a general equilibrium model of trade organizations and tariff policy. However, they do so only in the context of final goods and do not account for the tariffs on intermediate goods.

In fact, many previous studies consider optimal trade policy without considering tariffs on intermediate goods. Felbermayr et al. (2013) and Demidova and Rodriguez-Clare (2009) use firm level heterogeneity to look at the role of trade policy on country outcomes, albeit without considering the role of tariffs on intermediate goods. Costinot et al. (2015) consider optimal tariff in terms of comparative advantage, again in the context of final goods tariff only. The rest of the paper is structured as follows: Section 2 presents the model and Section 3 shows the numerical results of the model.

2.2 Model

The theoretical model is an N country Armington model with both a final good sector and an intermediate good sector. The model is an open economy model with N final goods and N intermediate goods. Each country can produce only one of those final and intermediate goods. There are two production sectors in this economy: the intermediate good sector and the final good sector. The input required for the intermediate good sector is labor. The inputs required for the final goods are the intermediate goods and labor.

2.2.1 Households

Each country has a measure L_n of representative households. Consumers have a Dixit-Stiglitz preferences over the N final goods found in the economy. Consumers supply labor to the economy and receive tariff revenue and use their income to buy both the Home final good and the Foreign final goods. The consumers utility function in country n is given by:

$$\max \ [\sum_j C_n^{j\,\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \quad s.t. \ \sum_j P_n^j C_n^j \leq w_n L_n + T_n \tag{2.1}$$

Households of country n pay for their consumption goods with their income. They receive income from their labor, which they get paid a wage w_n for each unit of labor. They also receive income from tariff revenue accumulated by the country through tariffs on foreign intermediate and final goods. Note that in this equation, P_n^m encapsulates not only the cost of production, but also the tariff levied by the domestic country.

2.2.2 Intermediate Good Producers

Firms use the labor supplied by the households to produce the intermediate good. The production technology is linear: $M_n = l_n/\varphi_n$. After production takes place, the intermediate good producers pay the households for their labor. Production of intermediate good produced in country n is denoted as M_n and the price of the intermediate good produced in country n is denoted as P_{M_n}. The intermediate good producers maximize the following equation:

$$\max \quad P_{M_n} M_n - \frac{w_n}{\varphi_n} L_n^m \tag{2.2}$$

2.2.3 Final Good Producers

The firm from country n uses the home intermediate good and the $N-1$ foreign intermediate goods to produce the final good for country n. They produce using a CES production function:

$$M_n^d = \left(\sum_j M_n^{j\,\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \tag{2.3}$$

The final good producers also use labor to produce the final good. This is also referred to as “the value added” from the final good producers. The production function for the final good producers is the following:

$$Y_n = \left(M_n^{d\,\frac{\epsilon-1}{\epsilon}} + L_n^{f\,\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}} \tag{2.4}$$

After production takes place they pay for the intermediate goods to the intermediate good producers. Since the technology is constant returns to scale, their profits will also be zero. The amount country n produces of their final good, is denoted Y_n and the price of country n's final good is denoted as P_{Y_n}. The final goods producer in country n solve the problem:

$$\max \quad P_{Y_n} Y_n - P_{M^1} \tau_n^{M^1} M_n^1 - P_{M^2} \tau_n^{M^2} M_n^2 \tag{2.5}$$

2.2.4 Equilibrium

Given the prices w_n, P_{Mn} for each country n and P_{Yn} for each country n, the equilibrium allocation for this economy is solved by:

1. Consumers solve their maximization problem
2. Intermediate good producers solve their profit maximization problem
3. Final good producers solve their profit maximization problem
4. The labor markets and the goods markets clear:
    - $l_n = L_n$ for all countries n
    - $M_n = M_n^m + M_n^n$ for all countries n
    - $Y_n = C_n^n + C_m^n$ for all countries n

2.3 Results

In this section, I first highlight the role of elasticity of substitution (σ) on the effects of tariffs, fixing intermediate and final goods tariff at 1%. I then show the effects of different tariff rates on utility, production, consumption, demand

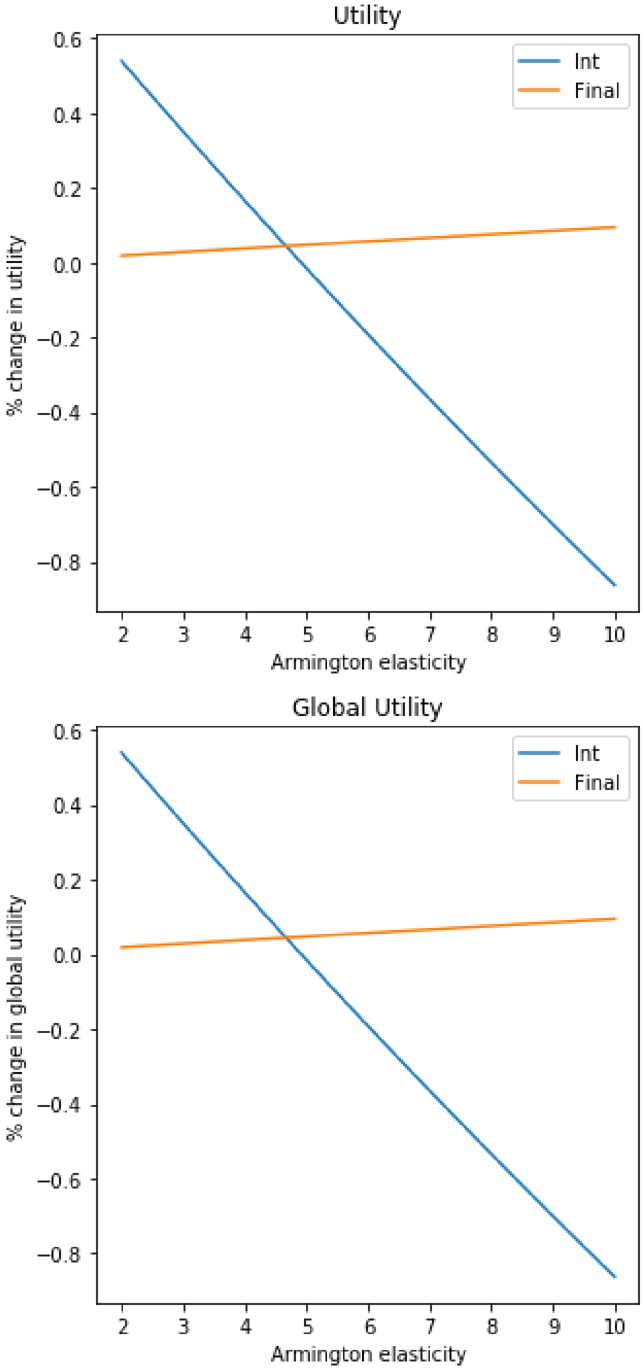
and terms of trade for the Petroleum industry and Food Manufacturing Industry, fixing σ.

This section outlines the effect of different intermediate and final goods tariff rates on various macroeconomic outcomes of interest. The three key parameters in this model: σ, ρ (elasticity of substitution between intermediate goods from different countries) and ϵ(elasticity of substitution between bundle intermediates and labor). This paper uses the estimates from Atalay (2017) for $\epsilon = 0.15$ and $\rho = 0.05$. This implies that intermediate goods are complements to each other in production of the final good and that the labor and bundle of intermediate goods are complements in the production of the final good. In the experiment, I consider 20 countries (N = 20) of same size and productivity.

2.3.1 The Effect of Elasticity of Substitution (σ) on Tariff Effectiveness

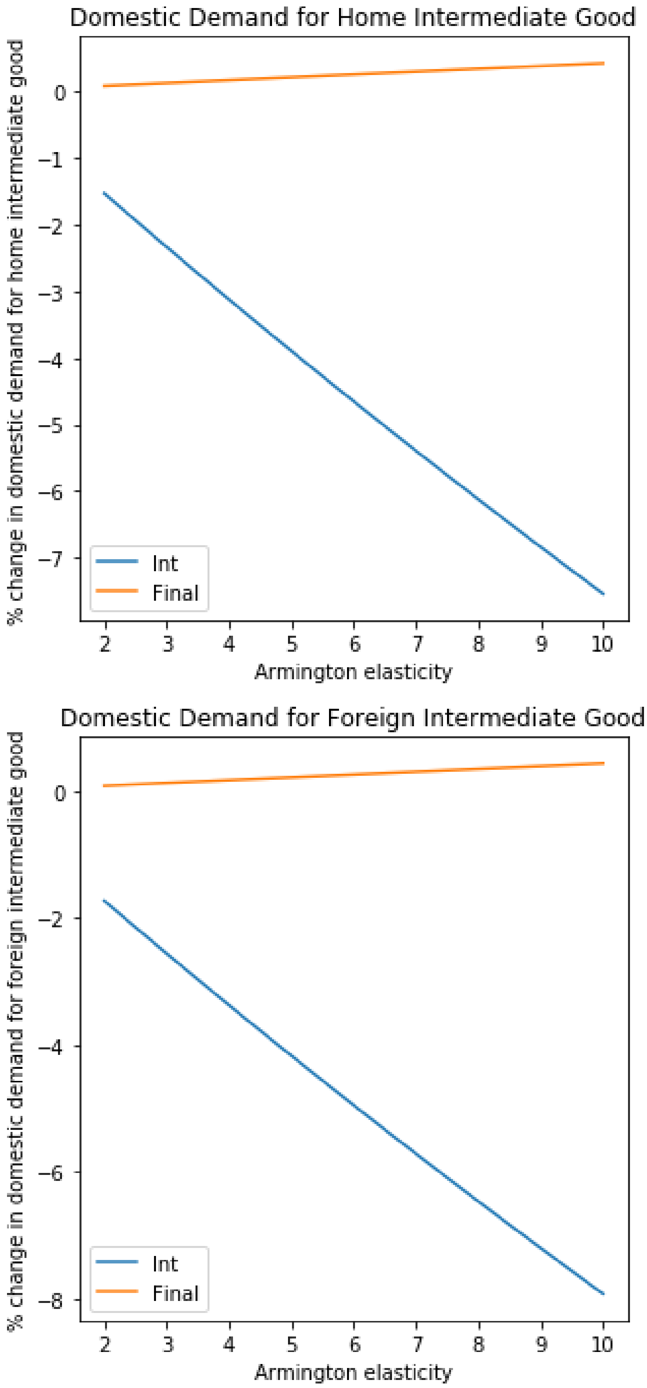
Figure 2.1 shows the effect of the elasticity of substitution (σ) on the response of utility and world utility in the model to a 1% tariff on intermediate and final goods. The effect σ has on τ^m are more prominent. As can be seen from Figure 2.1, the elasticity of substitution (σ) between final goods has a large effect on the efficacy of the two policies–intermediate and final goods tariff. When the elasticity of substitution (σ) is around 2, there are utility gains from an increase in the tariff on intermediate goods (τ^m) if increased from 0 to 1%. However, for industries that have a σ greater than 4.4, a zero to 1% increase in τ^m will lead to a utility decrease. Meanwhile, both a tariff on intermediate goods and final goods are welfare costly on world utility at all levels of $sigma$ (tau^m being more costly than τ^f). However, as $sigma$ increases, the welfare impact on world utility of the tariff increases for both final and intermediate good tariffs.

Figure 2.1: Effects of a 1% Tariff on Utility for different levels of σ



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the effect σ has on the changes due to a 1% increase in the tariffs of both final and intermediate goods on utility and world utility.

Figure 2.2: Effects of a 1% Tariff on domestic Intermediate good demand for different levels of σ



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the effect σ has on the changes due to a 1% increase in the tariffs of both final and intermediate goods on domestic demand of the foreign and domestic intermediate good.

The Effect of Elasticity of Substitution on the Intermediate Good Tariff

The driving force of the effect of an intermediate good tariff shown in Figure 2.1 is that intermediate goods are complements in production ($\rho < 1$), and the value-added and a country's intermediate goods bundle are complements ($\epsilon < 1$). This means that as the price of the foreign intermediate good increases due to a tariff, not only will the domestic firm decrease the demand for the foreign intermediate, but also decrease its demand for the home intermediate as shown in Figure 2.2.

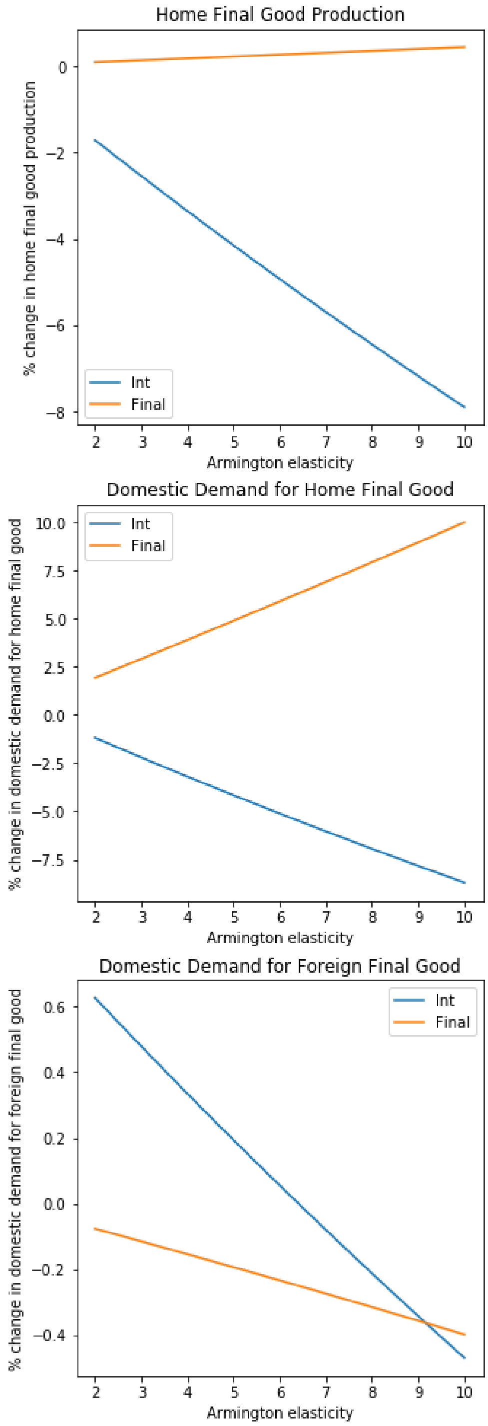
As elasticity of substitution (σ) increases, the final goods for countries are more substitutable. Thus, an increase in the price of a country's final good will have a greater impact on the quantity it produces shown in Figure 2.3. Since the τ^m makes the foreign intermediate good more expensive, as σ increases, countries will demand relatively less of the home good due to the increase in prices. Since there is relatively less demand, this leads the final good producers to demand relatively less of the home and foreign intermediate goods.

A 1% intermediate goods tariff, results in price of the domestic final good to increase. The higher the σ, the more sensitive the effect on the quantity domestic goods. Thus, as σ increases, the demand for the home and foreign intermediate good would decreases since they are gross complements in production. This results in a sharp drop in home utility, as can be seen from Figure 2.1. In contrast, 1% tariff on final goods results in a slight increase in home utility as σ increases.

The Effect of Elasticity of Substitution on the Final Good Tariff

A 1% final good tariff has a welfare cost on world utility and this cost increases as σ becomes larger. Meanwhile there is a small utility gain from this tariff domestically and this grows as σ grows larger. This is because as σ increases, final goods are more substitutable, which means the final good tariff has a greater impact on domestic consumption. This leads the domestic consumers to consume more of the domestic final good and less of the foreign final goods as shown in Figure 2.3.

Figure 2.3: Effects of a 1% Tariff on Home Final Good Production and Demand for different levels of σ



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the effect σ has on the changes due to a 1% increase in home production of the final good and domestic demand for the home and foreign final good.

This effect leads to a greater level of labor devoted to creating the domestic final good, which leads to an increase in demand for the intermediate good as well as a decrease to the supply of the domestic intermediate good. These two simultaneous effects leads to an increase in the price of the domestic intermediate good as well as a terms of trade advantage to the home country in the intermediate good market. This leads to this unusual result that with a large σ a 1% tariff on final goods is utility improving.

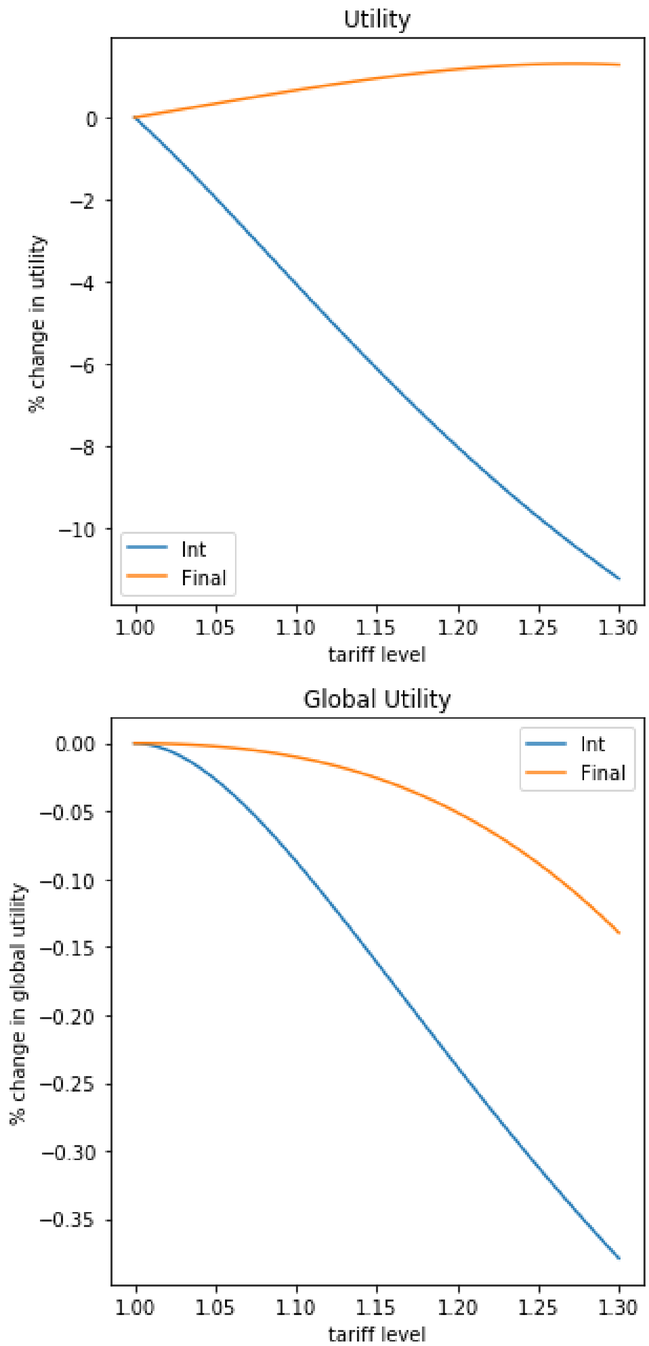
The Effect of Tariffs on the Petroleum Industry ($\sigma = 7.0$)

I first consider the effect of the intermediate and final goods tariffs on the Petroleum industry, that has an elasticity of $\sigma = 7.0$ (see Adhmad and Riker (2019)). This industry is considered because petroleum is a key intermediate product for other manufacturing industries and it is an example of a industry with high degree of substitutability of products across different countries.

As can be seen from Figure 2.4, a tariff on intermediate goods is worse for both home and world utility as compared to tariff on final goods. In fact, the world utility decreases much more with an increase in intermediate good tariff as opposed to an increase in tariff on final goods. While home production increases with increase in tariffs on final goods, there is a sharp decline in home production with increase in tariffs on intermediate goods. This implies that an increase in petroleum tariffs will result a sharp drop in home production of final goods.

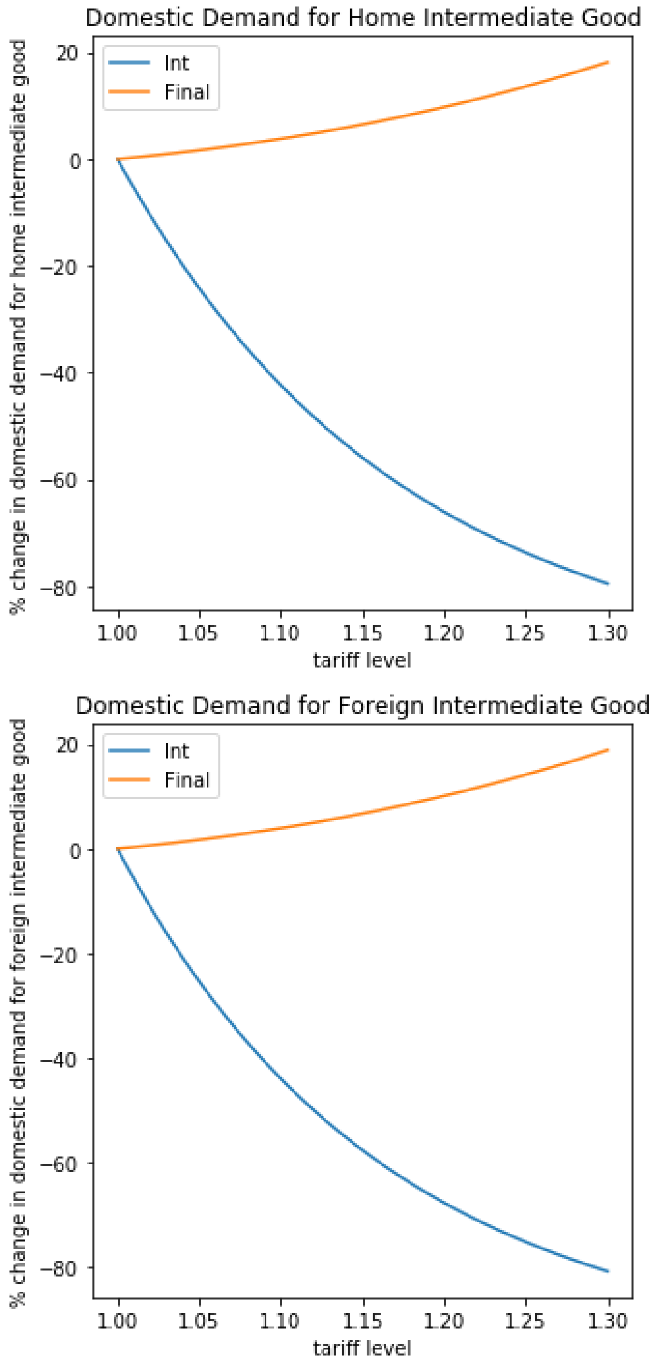
There is also a sharp drop in home consumption of final goods with an increase in intermediate good tariff as seen in Figure 2.6 . This contrasts with the effect on home consumption when tariffs on final goods are increased. In terms of drop in consumption of foreign final good, the effect is higher with an increase in final goods tariff as opposed to intermediate goods tariff. An increase in intermediate goods tariff results in a sharp drop in both domestic and foreign demand for intermediate goods (Figure 2.5), while an increase in final goods tariff results in a slight increase in both domestic and foreign demand for intermediate goods as expected. Furthermore, while the an increase in the final goods tariff has a limited impact on terms of trade on final good, an increase in the intermediate goods tariff

Figure 2.4: Percentage change in Utility and World Utility at Different Tariff Rates in the Petroleum Industry ($\sigma = 7.0$)



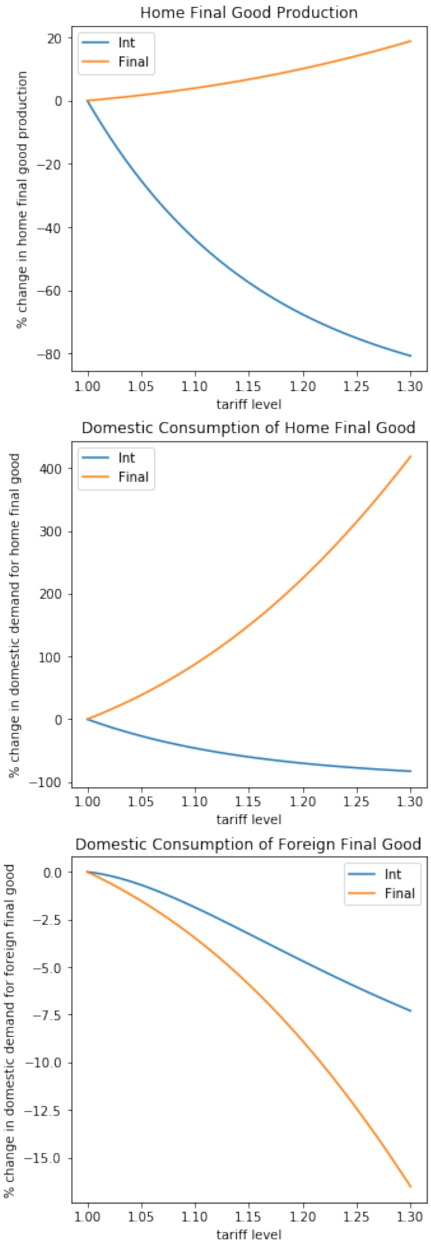
Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in utility and world utility from different intermediate good and final good tariff levels respectively. In this case, we are looking at the petroleum industry, so $\sigma = 7.0$

Figure 2.5: Percentage change in Intermediate Good Demand at Different Tariff Rates in the Petroleum Industry ($\sigma = 7.0$)



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in domestic demand in the foreign intermediate good and the domestic intermediate good at different intermediate good and final good tariff levels respectively. In this case, we are looking at the petroleum industry, so $\sigma = 7.0$

Figure 2.6: Percentage change in Final Good Production and Demand at Different Tariff Rates in the Petroleum Industry ($\sigma = 7.0$)



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in domestic production of the final good and the demand for the home final good both domestically and from abroad at different intermediate good and final good tariff levels respectively. In this case, we are looking at the petroleum industry, so $\sigma = 7.0$

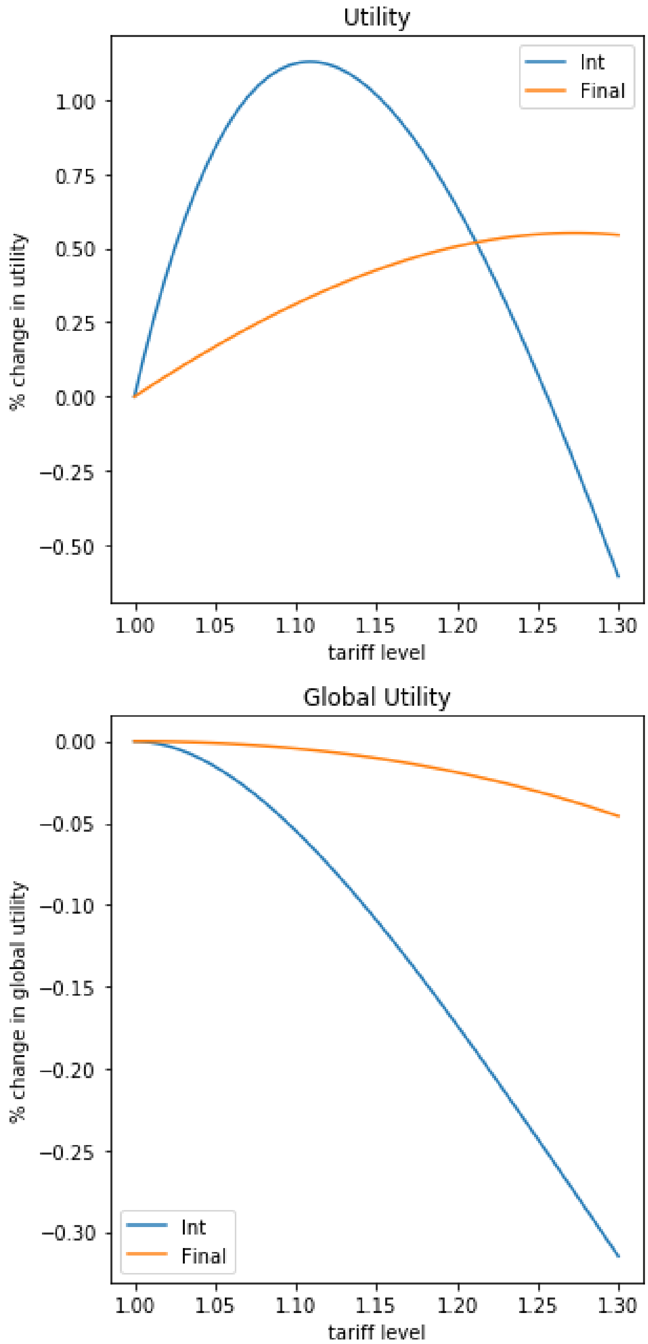
results in a significant increase in terms of trade of the final good.

The Effect of Tariffs on the Food Manufacturing Industry ($\sigma = 3.7$)

I next consider the effect of the intermediate and final goods tariffs on the Food manufacturing industry, that has an elasticity of $\sigma = 3.7$ (see Adhmad and Riker (2019)). This industry is considered because food produced across different counties may have a lower degree of substitutability, perhaps due to cultural differences. As can be seen from Figure 3, a low tariff on intermediate goods is better for both home utility; however is worse for world utility as compared to tariff on final goods. In fact, the world utility decreases much more with an increase in intermediate good tariff as opposed to an increase in tariff on final goods. While home production increases with increase in tariffs on final goods, there is a sharp decline in home production with increase in tariffs on intermediate goods. This implies that an increase in food manufacturing tariffs will result a sharp drop in home production of final goods.

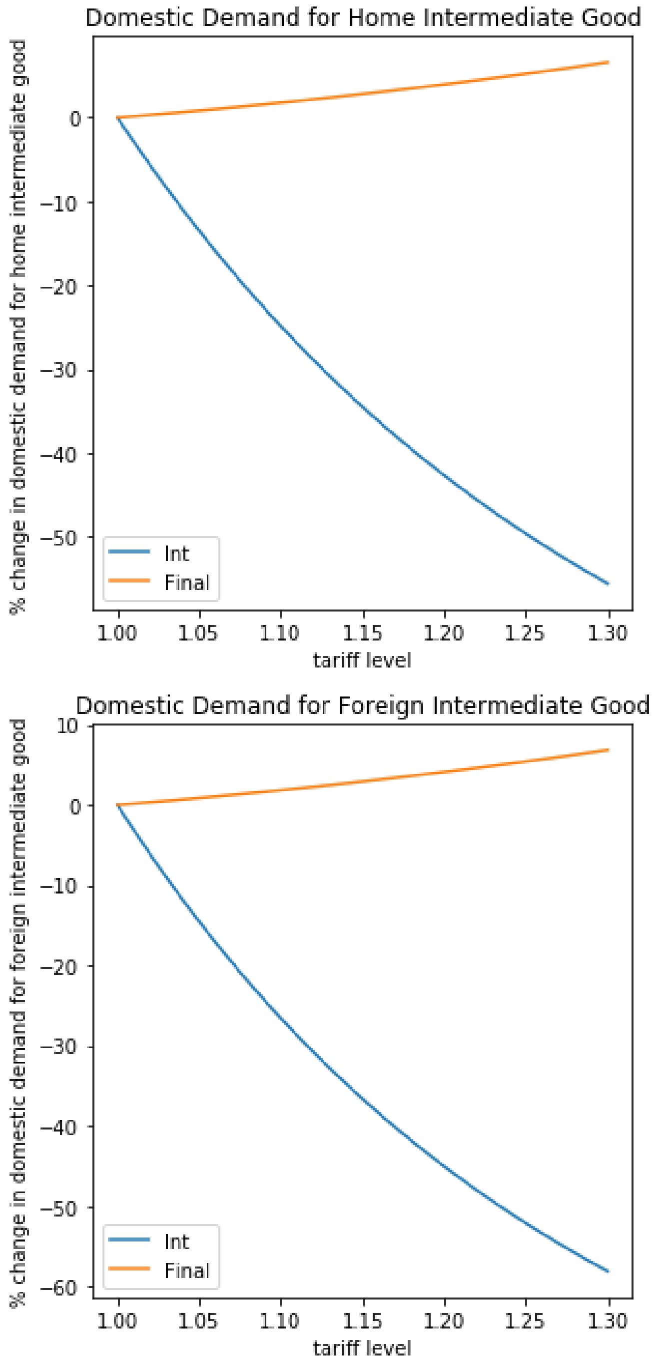
There is also a drop in home consumption of final goods with an increase in intermediate good tariff. This contrasts with the effect on home consumption when tariffs on final goods are increased. The big difference between high and low σ cases is the consumption of the foreign final good. When σ is low enough, there is an increase in the foreign final good consumption with a tariff on intermediate goods. On the other hand, there is a decrease in foreign final good consumption with a tariff on final goods. An increase in intermediate goods tariff results in a sharp drop in both domestic and foreign demand for intermediate goods, while an increase in final goods tariff results in a slight increase in both domestic and foreign demand for intermediate goods as expected. Furthermore, while an increase in the final goods tariff has a limited impact on terms of trade on final good, an increase in the intermediate goods tariff results in a significant increase in terms of trade of the final good.

Figure 2.7: Percentage change in Utility and World Utility at Different Tariff Rates in the Food Manufacturing Industry ($\sigma = 3.7$)



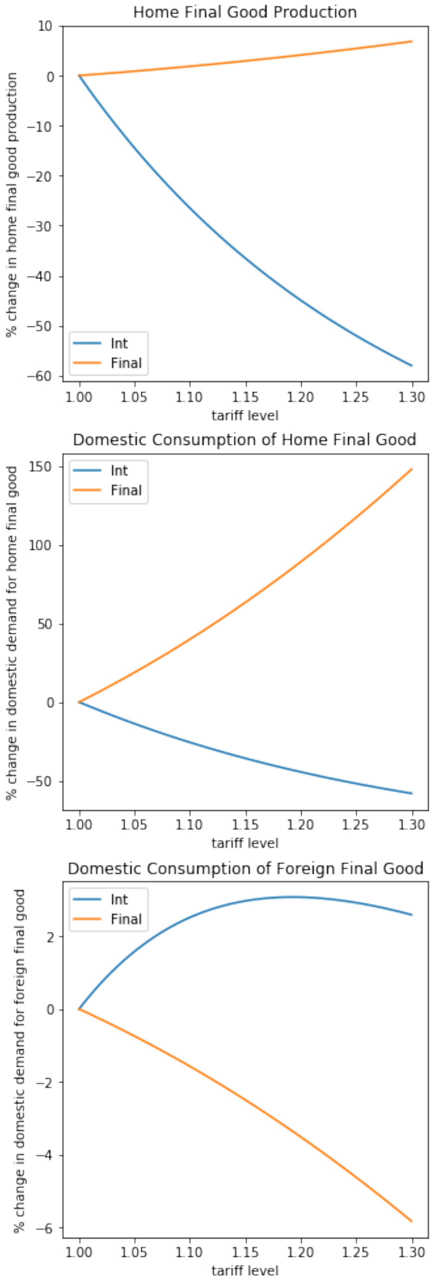
Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in utility and world utility from different intermediate good and final good tariff levels respectively. In this case, we are looking at the food manufacturing industry, so $\sigma = 3.7$

Figure 2.8: Percentage change in Intermediate Good Demand at Different Tariff Rates in the Food Manufacturing Industry ($\sigma = 3.7$)



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in domestic demand in the foreign intermediate good and the domestic intermediate good at different intermediate good and final good tariff levels respectively. In this case, we are looking at the food manufacturing industry, so $\sigma = 3.7$

Figure 2.9: Percentage change in Final Good Production and Demand at Different Tariff Rates in the Food Manufacturing Industry ($\sigma = 3.7$)



Note: Int: Intermediate Goods Tariff, Final: Final Goods Tariff. This shows the percentage change in domestic production of the final good and the demand for the home final good both domestically and from abroad at different intermediate good and final good tariff levels respectively. In this case, we are looking at the food manufacturing industry, so $\sigma = 3.7$

2.4 Conclusion

Tariffs on intermediate goods have gained popularity around the world over the past decade peaking with the steel and aluminum tariff proposed by the US in 2017. I find that, given the production elasticites from Atalay (2014), the effect of an intermediate good tariff is highly influenced by the Armington elasticity of the industry. In industries that have a low Armington elasticity there will be an increase in utility from a 1% tariff on intermediate goods, however, for sectors with high Armington elasticity there can be a decrease in utility due to an intermediate good tariff. The effect the Armington elasticity has on a final good tariff is minimal. The intuition behind this is, since the production elasticities are less than 1, intermediate goods are complements with one another as well as with labor. So the intermediate good tariff will have a greater impact on foreign demand for the home final good, the larger the sector's Armington elasticity.

The immediate next step is to build this model to expand this model to analyze trade data through this lense. It would be interesting to see whether the increasing use of global value chains to produce goods has affected the relative gains between a tariff on intermediate goods and final goods. Eventually, setting up a multi-country, multi-sector model would be helpful to analyze the impact of these two tariffs on the broader economy.

Chapter 3

The Effect of International Trade in Wholesale Goods on Customized Good Sector

3.1 Introduction

The differing effect trade has on specialized and wholesale goods is a growing literature headed by Holmes and Stevens (2014). This literature does not take into account firm decision into choosing the specialized sector versus the wholesale sector. Thus they are unable to explain the increase in specialized firm in the US with an increase in wholesale trade. For example the large increase in craft beer in the US after NAFTA. This paper gives theoretical justification for this increase in domestic production of specialized goods, when countries open up to trade. We also show that depending on certain parameters, the expenditure share on specialized goods can increase when a country opens up to trade.

In this paper, I study what effect does international competition have on the range of product characteristics of the products produced in the U.S.?. This question is motivated by the effect of trade on the beer sector in the 1990s. As NAFTA came into effect in 1994, the US started importing large quantities of beer from Mexico. The amount imported from Mexico has increased, and now Mexico exports 66.71% of beer that the US imports. During this time period, beer production in the US has witnessed major changes. During the 1990s and the early 2000s, the craft beer revolution began. The share of beer produced and consumed in the US, went up drastically. Some people have argued that these are two different phenomenons and they are not related. This paper aims to show that in fact, they are related and that the international competition that arose with NAFTA led to beer producers in the US to focus more on specialized beer rather than wholesale beer.

The mechanism goes as follows: Firms choose either to pay a fixed cost to add characteristics to their beer, or they choose not to pay any fixed costs and they decide to sell wholesale beer (Schlitz, Budweiser, etc.). In autarky, as there will be heterogeneous firms, they will produce a distribution of beer. When this country opens up with trade, foreign countries (which will export wholesale beer) will compete with the wholesale beer producers in the domestic country. These firms will have to decide whether to exit, or whether to add characteristics to their beer (specializing in domestic tastes) and gain market power. Hence this pushes beer producers to specialize in domestic tastes rather than selling wholesale beer. Our intuition is that this effect started this craft beer revolution.

This subject is not especially novel. Holmes and Stevens (2014) observe this same fact in the furniture industry. China entering the WTO, leads to Chinese furniture manufacturers to compete with wholesale furniture manufacturers in the US and leaves specialty furniture manufacturers alone. This research is separate from this paper in the sense that it will encapsulate the effect this paper mentions, while also adding that international competition affects the decision of potential entrants and current firms in terms of their product characteristics.

3.2 Literature Review

This paper is connected to two strands of literature: heterogeneous firms in international trade and customized vs. wholesale good literature. This paper is an offshoot of Holmes and Stevens (2014) as they look at the same question. The main difference between this paper and theirs is that they view this question in a Eaton-Kortum model. This leaves out firm decisions as well as views the wholesale and customized goods markets as two separate markets. In this paper, we study the firm-level decisions in a Melitz-style model as well as view these two markets as subsets in a broader market.

This paper is also tied to the international trade papers such as Bernard et al. (2009), Melitz (2003), Bernard et al. (2003) and Melitz and Redding (2014). Even though these papers look at different questions, this paper uses a similar model that broadly looks to answer the impact of international trade on the domestic economy. This paper is more closely associated with Melitz (2003) in terms of the construction of the model. The main difference is that in this paper we split the producing firms into two submarkets: wholesale producers and customized producers.

3.3 Theoretical Model

3.3.1 Closed Economy Model

This is a theoretical model based off of Bernard et al. (2009). In this model there is a single industry where firms choose between producing two different types of good within the industry. The type 2 good will denote the wholesale good, while the type 1 good will denote the customized good. Consumers in the country consume a bundle of these two types of goods.

Demand

The consumers utility is defined by:

$$U = [a_1 C_1^{\nu} + a_2 C_2^{\nu}]^{1/\nu} \tag{3.1}$$

where $a_i > 0$ and we assume that these types of goods are imperfect substitutes $\psi = 1/(1-\nu) > 1$. Firms produce differentiated C_i and therefore each product i has a consumption index defined over their varieties ω:

$$C_i = \left[\int_\omega q_i(\omega)^\rho d\omega\right]^{1/\rho}, \quad P_i = \left[\int_\omega p_i(\omega)^\sigma d\omega\right]^{1/\sigma} \tag{3.2}$$

where P_i is the price index for varieties of product i, and $\sigma = 1/(1-\rho)$ is the elasticity of substitution between varieties of the same product. This allows us to calculate the share of expenditure allocated to product 1 and product 2 characterized by:

$$\alpha_1(P) = \left[1 + \left(\frac{a_2}{a_1}\right)^\psi P^{1-\psi}\right]^{-1}, \quad \alpha_2(P) = 1 - \alpha_1(P) \tag{3.3}$$

The share of expenditure allocated to product 1 is increasing in relative price of product 2, $P = P_2/P_1$ (since they are imperfect substitutes ($\psi > 1$) and increasing in relative weight of product 1 in consumer utility a_1/a_2. Solving the consumers problem gives us the equation for equilibrium expenditure on a variety ω for product i:

$$r_i(\omega) = R_i\left(\frac{p_i(\omega)}{P_i}\right)^{1-\sigma} = \alpha_i(P)R\left(\frac{p_i(\omega)}{P_i}\right)^{1-\sigma} \tag{3.4}$$

This is increasing in aggregate expenditure ($R = \int_\omega r_1(\omega)d\omega + \int_\omega r_2(\omega)d\omega$), increasing in the share of expenditure allocated to product i ($\alpha_i(\omega)$), decreasing in the varieties price ($p_i(\omega)$) and increasing in the products price index P_i. The last two relationships are due to the fact that the products 1 and 2 are imperfect substitutes ($\sigma > 1$).

Production

There is one factor of production labor , L. The production technology follows Melitz (2003) where firms have heterogeneous productivities; however the marginal and fixed cost will depend on the decision between producing product 1 or product 2. We assume that product 1 has a lower fixed cost, but a higher marginal cost than product 2. In the example of customized goods and wholesale goods, product

1 will exemplify customized goods, while product 2 will be wholesale goods. The production technology for a firm with productivity φ producing product i is the following:

$$l_i = f_i + \frac{q_i b_i}{\varphi} \tag{3.5}$$

Firms will produce a unique variety of the product they choose to produce. The profit maximization problem gives us that equilibrium prices are a constant markup over marginal cost, with the size of the markup a function of the elasticity of substitution between varieties within the product:

$$p_i(\varphi_i) = (\frac{\sigma}{\sigma - 1})\frac{wb_i}{\varphi} \tag{3.6}$$

The function for prices allows us to solve for the revenue and profits for a firm with productivity φ producing product i:

$$r_i(\varphi) = \alpha_i(P)R\left(P_i\rho\frac{\varphi}{wb_i}\right)^{\sigma-1} \tag{3.7}$$

$$\pi_i(\varphi) = \frac{r_i(\varphi)}{\sigma} - f_i \tag{3.8}$$

These equations allows us to solve for the relationship between any two firms revenues with productivities φ' and φ'' producing products j and i respectively:

$$r_i(\varphi'') = \left(\frac{\alpha_i(P)}{\alpha_j(P)}\right)\left(\frac{\varphi''}{\varphi'}P\frac{b_j}{b_i}\right)^{\sigma-1} r_j(\varphi') \tag{3.9}$$

Firm Entry and Exit

Firms need to pay a sunk cost $f_e > 0$ to produce either good. After paying the sunk cost, the firm receives its productivity φ from a distribution $g(\varphi)$ with a cumulative distribution of $G(\varphi)$. Firms face a constant exogenous death probability of δ. After firms enter the industry, firms decide whether to produce or exit. If they decide to produce, they decide which product to produce. So the value of a firm with a productivity of φ is a maximum of exiting the industry (which gives a value of

0), the stream of profits obtained producing product 1 and the stream of profits obtained producing product 2.

$$v(\varphi) = \max\left\{0, \frac{\pi_1(\varphi)}{\delta}, \frac{\pi_2(\varphi)}{\delta}\right\} \tag{3.10}$$

Product Choice

Once firms realize their productivity, firms make the above choice to produce in the industry or exit. The firms that decide to produce, they make a decision on what product to produce. The fixed cost of producing product 1 is lower than the fixed cost for product 2 ($f_1 < f_2$), so a firm that has a productivity of 0 ($\varphi = 0$) would make more losses producing product 2:

$$0 > \pi_1(0) = -f_1 > \pi_2(0) = -f_2 \tag{3.11}$$

Since profits are monotonically increasing in productivity for both products, there exists a zero-profit productivity cutoff φ^* where any firm with a productivity below this cutoff will exit and any firm with productivity above this threshold will produce. A necessary condition for both goods to be produced is product 2 must increase faster than produce 1. Otherwise $\pi_1(\varphi) > \pi_2(\varphi)\forall\varphi$ and product 2 would not be produced. This means that (from equation (29):

$$\left(\frac{\alpha_2(P)}{\alpha_1(P)}\right)\left(P\frac{b_1}{b_2}\right)^{\sigma-1} > 1 \Rightarrow \left(\frac{a_2}{a_1}\right)^{\psi}\left(\frac{b_1}{b_2}\right)^{\sigma-1} P^{\sigma-\psi} > 1 \tag{3.12}$$

which gives us that the relative rate at which profits increase with productivity is dependent on parameters like the elasticity of substitution between varieties and products, the relative weight on utility and relative marginal cost.

The point at which the two profit functions intersect is where the firm is indifferent between producing product 1 and product 2 and this is called the product-indifference productivity cutoff (φ^{**}). These assumptions give us the result that lower productivity firms will produce the product with a lower fixed cost and a higher marginal cost, product 1; meanwhile the more productive firms will produce the product with a higher fixed cost and a lower marginal cost, product 2. The zero-profit cutoff, which is the lowest productivity in which a firm produces product 1 is defined by:

$$r_1(\varphi^*) = \sigma f_1 \tag{3.13}$$

while the product-indifference productivity cutoff, which is the lowest productivity in which a firm produces product 2 is defined by:

$$\frac{r_1(\varphi^{**})}{\sigma} - f_1 = \frac{r_2(\varphi^{**})}{\sigma} - f_2 \tag{3.14}$$

This means that firms that draw a productivity φ such that

1. $\varphi < \varphi^*$ exit the market
2. $\varphi^* < \varphi < \varphi^{**}$ produce good 1
3. $\varphi^{**} < \varphi$ produce good 2

Note that this model is easily compressed into the Melitz (2003) model if we allow $a_1 = a_2 = 1$, $f_1 = f_2 = f$, $b_1 = b_2 = 1$ and $\psi = \sigma$.

Free Entry

The ex-ante probability of successful entry is $[1 - G(\varphi^*)]$, with the ex-ante probability of producing product 1 being $[G(\varphi^{**}) - G(\varphi^*)]$ and the ex-ante probability of producing product 2 being $[1 - G(\varphi^{**})]$. The ex-post distribution for each product, $\mu_i(\varphi)$ is conditional on successful entry and product choice:

$$\mu_1(\varphi) = \begin{cases} \frac{g(\varphi)}{G(\varphi^{**})-G(\varphi^*)} & \varphi \in [\varphi^*, \varphi^{**}) \\ 0 & \text{o.w.} \end{cases} \tag{3.15}$$

$$\mu_2(\varphi) = \begin{cases} \frac{g(\varphi)}{1-G(\varphi^{**})} & \varphi \in [\varphi^{**}, \infty) \\ 0 & \text{o.w.} \end{cases} \tag{3.16}$$

The free entry condition is:

$$v_e = \left[\frac{G(\varphi^{**}) - G(\varphi^*)}{\delta}\right]\overline{\pi}_1 + \left[\frac{1 - G(\varphi^{**})}{\delta}\right]\overline{\pi}_2 = f_e \tag{3.17}$$

where the expected value of entering the industry v_e is the probability of producing product 1 times the expected profits of producing product 1 plus the same for product 2.

Product and Labor Markets

The steady state equilibrium is characterized by a fixed mass of firms entering the market each period M_e and a constant mass of firms producing in each product market M_i. The steady state stability conditions are:

$$[G(\varphi^{**}) - G(\varphi^*)]M_e = \delta M_1, \quad [1 - G(\varphi^*)]M_e = \delta M_2 \tag{3.18}$$

where the first equation denotes that the mass of firms entering that will produce product 1 must equal the mass of firms dying that produced product 1. The second equation denotes the same fact but for product 2. Using a technique from Melitz (2003), we can characterize the price levels for product 1 and product 2 as:

$$P_1 = M_1^{1/1-\sigma} p_1(\tilde{\varphi}_1), \quad P_2 = M_2^{1/1-\sigma} p_2(\tilde{\varphi}_2) \tag{3.19}$$

where $\tilde{\varphi}_i$ is the average productivity among the firms who produce product i. The labor market clearing condition is simply labor used in production plus the labor used to pay the sunk cost must equal the total labor supply in the economy:

$$L_p + L_e = L \tag{3.20}$$

3.3.2 Open Economy Model

This paper's addition is opening this economy to international trade. Suppose now, we open this economy up to trade with another country that also produces the wholesale good and the customized good. The pricing rule for the domestic market for good i would stay the same as it was in the closed economy model: $p_i^d(\varphi_i) = (\frac{\sigma}{\sigma-1})\frac{b_i}{w^n\varphi}$. However exporting firms will now have a new pricing rule for the foreign country: $p_i^d(\varphi_i) = (\frac{\sigma}{\sigma-1})\frac{\kappa_i^{nm} i b_i w^n}{\varphi} = \kappa_i^{nm} p_i^d(\varphi_i)$ where $\kappa_i^{nm} = d_i^{nm}\tau^{nm}$ is the good specific iceberg transportation cost d_i^{nm} and the trade policy between country's n and m. Thus, we can also show that revenues from domestic sales stay the same as the closed economy model $r_i^d(\varphi) = \alpha_i(P)R\left(P_i\rho\frac{\varphi}{b_i}\right)^{\sigma-1}$, while the exporting firms revenue can be characterized by $r_i^x(\varphi) = \kappa_i^{nm} r_i^d(\varphi)$. We can then determine the revenue of any individual firm producing good i as:

$$r_i(\varphi) = \begin{cases} r_i^d(\varphi) & \text{if firm doesn't export} \\ r_i^d(\varphi) + \kappa_i^{nm} r_i^x(\varphi) & \text{if the firm exports} \end{cases} \tag{3.21}$$

Firm Entry and Exit

The exogenous factors affecting firm entry and exit do not change in the open economy model. An exporting firm pays a fixed cost f_x each period to export. In a stationary equilibrium, if a firm with productivity φ exports then they receive variable profits $r(\varphi)/\sigma$ in every period from their export sales. In equilibrium, no firm will export without supplying goods to the domestic market. So we can divide the profit for the firms as domestic profits ($\pi_d^i(\varphi)$) and export profits ($\pi_x^i(\varphi)$):

$$\pi_d^i(\varphi) = \frac{r_d^i(\varphi)}{\sigma} - f^i, \quad \pi_x^i(\varphi) = \frac{r_x^i(\varphi)}{\sigma} - f_x^i \tag{3.22}$$

So a firm exports if $\pi_x^i(\varphi) \geq 0$. This gives us cutoff productivity's for exporting for each sector i, φ_x^* and φ_x^{**}. This means that firms draw a productivity φ such that:

1. $\varphi < \varphi^*$ exit the market
2. $\varphi^* < \varphi < \varphi_x^*$ produce good 1 only for domestic market
3. $\varphi_x^* < \varphi < \varphi^{**}$ produce good 1 for the domestic market and foreign market
4. $\varphi^{**} < \varphi < \varphi_x^{**}$ produce good 2 only for domestic market

5. $\varphi_x^{**} < \varphi$ produce good 2 for the domestic market and the foreign market.

This means that the probability of a firm to export good 1 given that the firm is producing good 1 is $p_x^1 = [G(\varphi^{**}) - G(\varphi_x^*)]/[G(\varphi^{**}) - G(\varphi^*]$ and the probability of a firm to export good 2 given that the firm is producing good 2 is $p_x^2 = [1 - G(\varphi_x^{**})]/[1 - G(\varphi^{**})]$. The mass of firms that will be exporting good 1 will be $M_x^1 = p_x^1 M^1$ and the mass of firms that will be exporting good 2 will be $M_x^2 = p_x^2 M^2$. So the variety of good 1 available to the domestic market will be $M^1 + nM_x^1$ and the variety of good 2 available to the domestic market will be $M^2 + nM_x^2$.

Aggregation

Using the same notation as the closed economy model, let $[\tilde{varphi}^i$ be the average productivity for sector i and let $[\tilde{varphi}_x^i$ be the average productivity of exporters in sector i. The price level P and the expenditure level R for each sector i can be written in terms of the average productivity in sector$i$:

$$P^i = M^{\frac{1}{1-\sigma}} p_i(\tilde{\varphi}_i) = M^{\frac{1}{1-\sigma}} \frac{wb_i}{\rho\tilde{\varphi}}, \quad R_i = Mr_i(\tilde{\varphi}_i) \tag{3.23}$$

The averages $\tilde{\varphi}^i$ and $\tilde{\varphi}_x^i$ can also be used to calculate average domestic profits $\pi_d^i(\tilde{\varphi}^i)$ and average export profits $\pi_x^i(\tilde{\varphi}_x^i)$ for all sectors i as well as average domestic revenue $r_d^i(\tilde{\varphi}^i)$ and average export revenue $r_x^i(\tilde{\varphi}_x^i)$ which is given by:

$$\bar{r}^i = r_d^i(\tilde{\varphi}^i) + p_x^i n r_x^i(\tilde{\varphi}_x^i), \quad \bar{\pi}^i = \pi_d^i(\tilde{\varphi}^i) + p_x^i n \pi_x^i(\tilde{\varphi}_x^i) \tag{3.24}$$

3.4 Results

In this section, we will discuss what happens in this economy when there is a decrease in the tariff rate for wholesale goods. The main results can be described as the following:

1. The cutoff level of productivity for the customized good decreases
2. The cutoff level of productivity for the wholesale good decreases

3. The total level of output for the specialized sector and the wholesale sector increases

4. The share of income spent on domestic specialized goods decrease; however they are produced by relatively fewer firms so the amount produced per firm increases.

We will go through these results one by one.

3.4.1 Cutoff Level for Wholesale Goods

The equation for the cutoff level productivity for exporters is the following:

$$\varphi^x = (\frac{\sigma f^x}{X_j^2(P^1(w\tau^{ij}/b^2(1-\sigma)))^{\sigma-1}})^{1/\sigma-1} \tag{3.25}$$

This shows as the tariff level decreases, the cutoff productivity for exporters will decrease. This means that more firms will export in this economy. This is consistent with Melitz (2002). The following equation is the cutoff productivity for wholesale goods:

$$\varphi^{**} = (\frac{\sigma(f^2-f^1)}{(A-1)X_j^2(P^2(w/b^2(1-\sigma)))^{\sigma-1}})^{1/\sigma-1} \tag{3.26}$$

As in Melitz (2002), as the tariff level decreases for wholesale goods, more foreign wholesale goods enter into the domestic market. This leads to the least productive wholesale producers to exit the wholesale market and enter the customized market. In essence, these firms are being priced out of the wholesale market. In this model, we see this as a shift in the cutoff productivity in the wholesale good market.

3.4.2 Cutoff Level for Customized Goods

The cutoff productivity for customized goods can be defined as the following:

$$\varphi^* = (\frac{\sigma f^1}{X_j^1(P^1(w/b^1(1-\sigma)))^{\sigma-1}})^{1/\sigma-1} \tag{3.27}$$

The shift in the cutoff level of the wholesale good market affects the cutoff of the customized good market. The entrance of more productive customized goods producers leads the least productive customized goods producers to leave the market. As tariff levels go down and higher producivity producers enter the customized goods sector, leading to lower overall prices in the customized goods market, which prices out the lowest customized goods producers. These producers end up leaving the market altogether and they choose to not produce.

3.4.3 Consumption share of Customized Goods

The consumption share of customized goods relative to wholesale goods is dependent only on relative prices. If customized goods get relatively cheaper then consumers will increase their relative customized good consumption and vice versa. The relative price of customized goods in this economy can be defined as:

$$P = P_1/P_2 = (\tau_{ij})^{1-\sigma} \frac{M_1}{M_2} \left(\frac{\tilde{\varphi}_1}{\tilde{\varphi}_2} \right)^{1-\sigma} \tag{3.28}$$

This equilibrium object can increase or decrease depending on a variety of factors.

3.5 Numerical Exercise

Parameter values for the baseline model are listed in Table 3.1. The elasticity of substitution between the sub-markets is greater than the elasticity of substitution within the sub-markets ($\psi > \sigma$) as the model dictates. The Pareto distribution has a curvature parameter of 3 and 5% of the firms die at each period. The marginal cost for customized goods producers is greater than that of wholesale good producers ($b_1 > b_2$); however wholesale good producers need to pay a higher fixed cost to produce than the customized good producers ($f_1 < f_2$). To simplify this example, we have set the taste parameters to be equal. In this section, we will look at these variables from the tariff range of 0% to 20%.

3.5.1 The Effect of Tariffs on Model Variables

The Cutoff for Customized and Wholesale Goods Producers

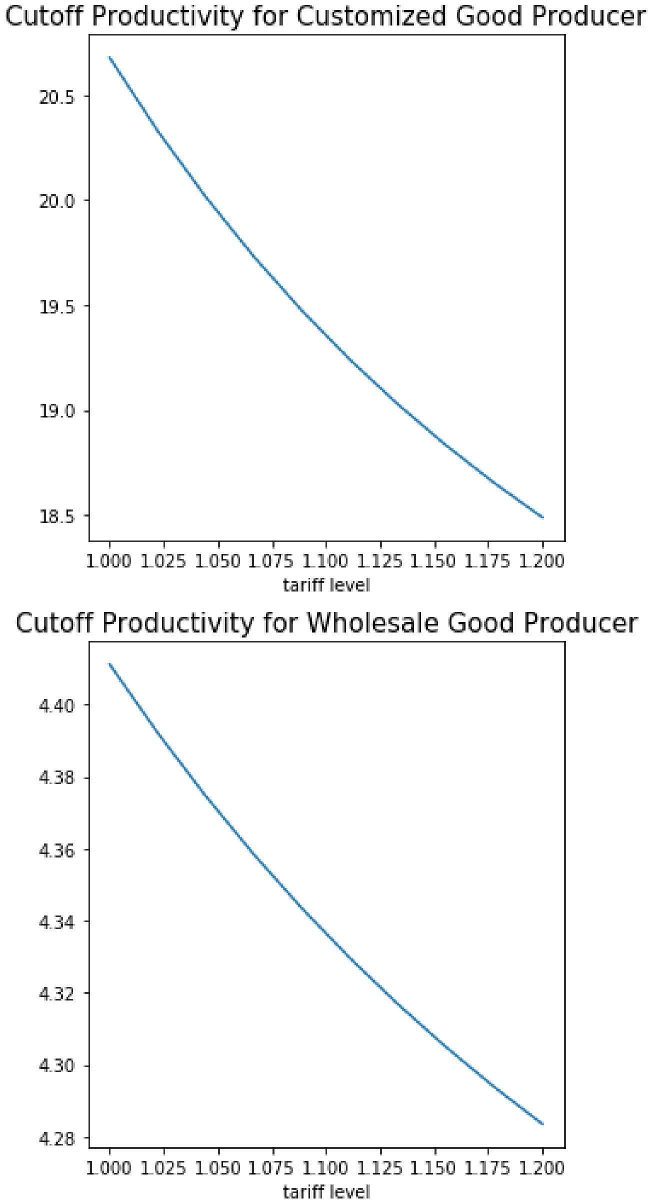
Figure 3.1 shows the cutoff productivity levels for the customized good producers and wholesale good producers at different tariff levels. It shows that as the tariff level increases, the cutoff level of productivity decreases for both the wholesale and the customized sector. So, as tariff levels increase, less productive producers who would not have produced at lower tariff levels will enter the customized good market, and the most productive customized good producers will switch to producing wholesale goods. Note that in the example of the US Beer sector, where NAFTA dropped the tariff level on beer in the 1990's, the opposite is true. With NAFTA, tariffs decreased, so the least productive customized beer producers left the market completely. The least productive wholesale producers could not afford to compete with foreign competitors and more productive wholesale producers domestically and switched to producing in the customized good sector. These results are consistent with that of Melitz (2003)

The Average Productivity for Customized and Wholesale Goods Producers

Figure 3.2 shows the average productivity levels for the customized good producers and wholesale good producers at different tariff levels. It shows that as tariffs decrease, the average productivity levels increase in both the wholesale and the customized good sector. This increase is driven by the shift in cutoffs that we described in the previous chapter. As the tariff level decreases, the least productive participants in the market leave, which increases the average productivity in the market. This increase is even more drastic in the customized good sector because not only are the least productive firms leaving, but more productive firms that had produced the wholesale good at higher tariff levels, switch to producing customized goods. This increases the averages even more.

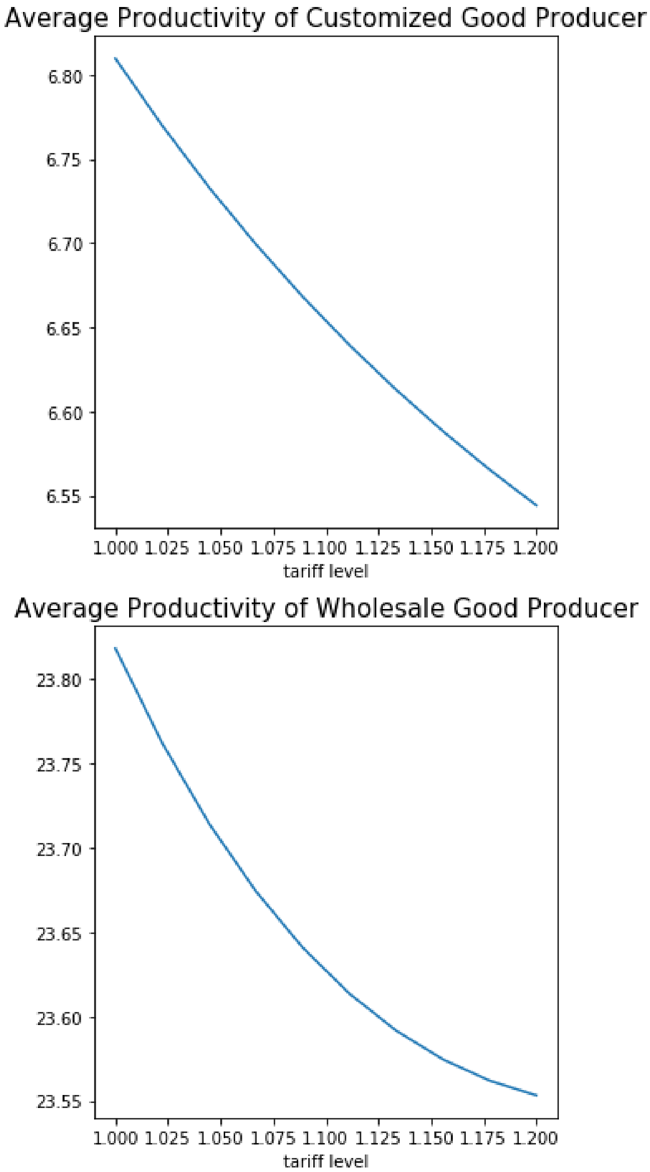
This increase in averages mean that there is an increase in a lot of different variables in this model. This means that the total revenue increases in the cus-

Figure 3.1: The Cutoff Productivity levels for Customized Goods Producers (ϕ^*) and Wholesale Goods Producers (ϕ^{**})



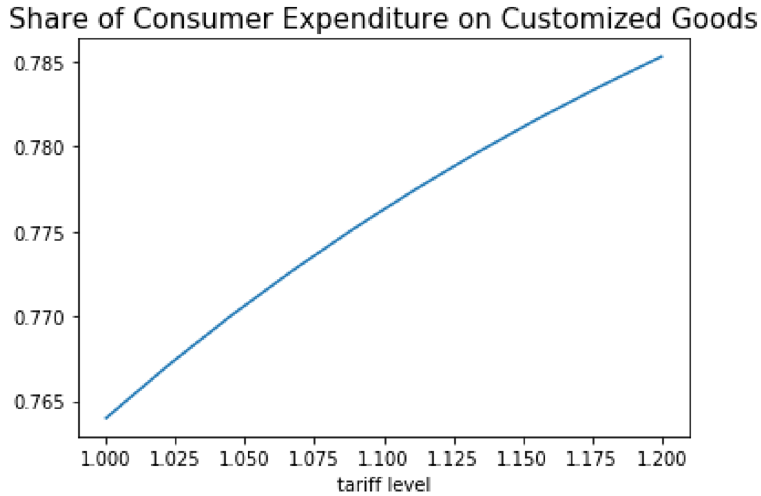
Note: These graphs show the cutoff productivity levels for the customized good producers and wholesale good producers at different tariff levels.

Figure 3.2: The Average Productivity levels for Customized Goods Producers and Wholesale Goods Producers



Note: These graphs show the average productivity levels for the customized good producers and wholesale good producers at different tariff levels.

Figure 3.3: The Share of Expenditure on the Customized Sector



Note: This graph shows the consumer's expenditure share of customized goods at different tariff levels.

tomized and the wholesale sector. This means there are lower average prices in the wholesale and the customized good sector. This means there is more production in both the wholesale and the customized good sectors.

The Share of Expenditure on Customized Sector

Figure 3.3 shows the consumer's expenditure share of customized goods at different tariff levels. It shows that, with the given parameters, a decrease in the tariff level leads to a lower expenditure share on customized goods. This means that even though with lower tariffs the customized goods sector has lower prices and higher average revenue, the decrease in these variables for the wholesale sector leads to lower expenditure on customized goods. As we discussed before, this result is not necessarily true for all cases, but in this numerical exercise this is the case.

3.6 Conclusion

This paper tries to evaluate the effect of trade on the wholesale and customized sector of an economy. Previous literature finds that trade has a large impact on the wholesale sector; however, has little impact on the customized sector. We find that international trade in wholesale goods has an impact both on the customized sector and the wholesale sector. International trade leads to the least productive wholesale producers to exit the wholesale market and start producing the customized good. This increases the average productivity of the customized market as well as decreases the average price. This pushes the lowest productivity customized good producers to exit the market. Hence international trade in the wholesale goods market leads to lower prices as well as higher productivities both in the wholesale and the customized goods markets. The effect on the share of consumption between customized and wholesale goods is ambiguous as this is dependent on the values of exogenous variables. In future work, we plan to use this model to evaluate the US beer sector in the 1990s and measure the impact of NAFTA on the US craft beer industry.

Table 3.1: Parameters to the Model

Parameter	Value	Description	Source
ψ	4	Elasticity of substitution between wholesale and customized goods	Donnelly et al. (2004)
σ	3	Elasticity of substitution between goods within their own submarket	Donnelly et al. (2004)
θ	3	Pareto parameter	
δ	0.05	Firm death rate	
b_1	1.1	Marginal cost for customized good producers	
b_2	1.0	Marginal cost for wholesale good producers	
a_1	1.0	Taste parameter for customized good	
a_2	1.0	Taste parameter for wholesale good	
f_1	1.0	Fixed cost for customized good producers	
f_2	5.0	Fixed cost for wholesale good producers	
f_x	20.0	Fixed cost for exporters	
f_e	0.5	Firm entry cost	

These are the list of parameters used in the numerical exercise. The elasticity of substitutions were deduced by Donnelly et al. (2004). The other parameters were used as seen fit.

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Appendices

Appendix A

Appendix for Chapter 2

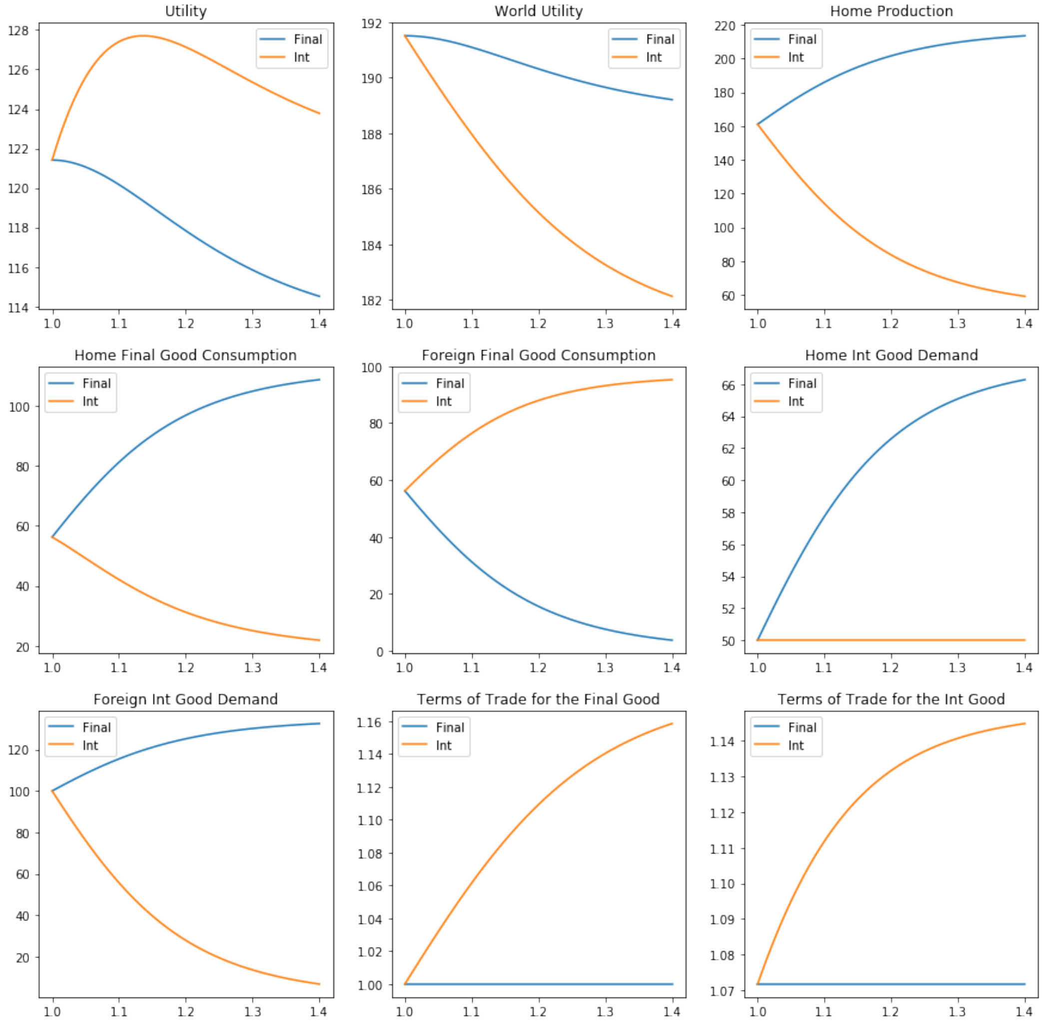
A.1 Scenario where $\sigma > 1$ and $\rho > 1$

The results of this section is threefold: (i) In the free trade scenario, the domestic country receives more utility by enacting a tariff on intermediate goods rather than final goods, (ii) the optimal tariff in this environment is a mix of both tariffs and (iii) at the optimal tariff bundle, it is more costly in terms of utility for the country to adjust the tariff on intermediate goods rather than final goods.

A.1.1 Free Trade Scenario

In equilibrium, there is always trade going on since both country's firms need the other country's intermediate goods to produce and gain utility from other country's final goods. Figure 1 shows the marginal effects of tariffs in the free-trade scenario:

Figure A.1: Equilibrium Allocations at Different Tariff Rates



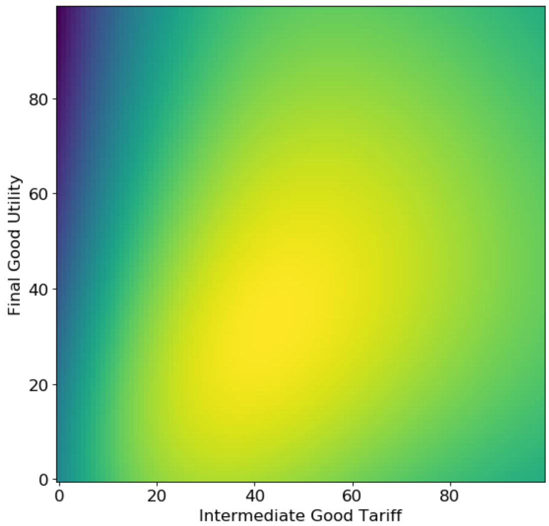
Note: This shows the effect of both tariffs on utility, world utility, production in the home country, consumption of home and foreign goods in the home country, the demand at home for the international good, the foreign demand for the foreign good and the terms of trade on the intermediate good and the final good.

As can be seen in this figure, when there are no tariffs, a marginal increase in a tariff on foreign intermediate goods or on foreign final goods will have a net positive impact on the country's utility; however the impact of the tariff on intermediate goods will be greater. The main reason for this difference is the changes in the terms of trade. With an increase in the tariff on intermediate goods, the positive effect of the terms of trade are much larger than the positive effect due to an increase in the tariff for final goods.

In the case of the increase in the intermediate good tariff this leads to the country consuming more of the foreign final good and consuming less of the home final good. Firms will still demand the same amount of the home intermediate good; however they will demand less of the foreign intermediate good. This will end up with the home country producing less output. In the case of the increase in the foreign final good, this will lead to the country consuming more of the home final good and less of the foreign final good due to the increase in price of the foreign final good. Firms will demand more of the home intermediate good and more of the foreign intermediate good. This is because with the decrease in demand for the foreign final good by the home country, these intermediate goods will become relatively cheaper. This will lead the home country producing more output than in the no-tariff scenario.

A.1.2 Optimal Tariff Scenario

Figure A.2: Heat Map of Home Country's Utility

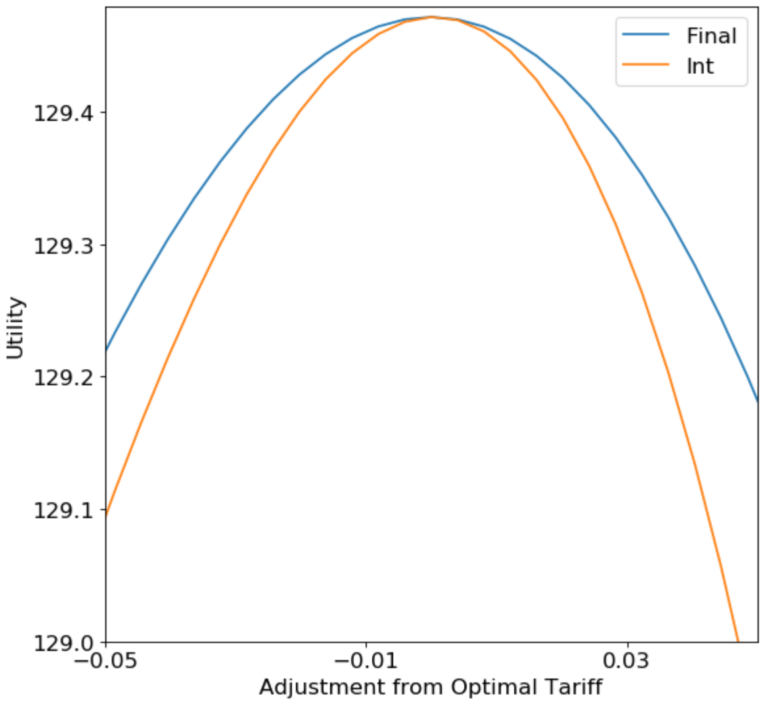


Note: This shows that the utility maximizing tariff is a mix of a tariff on intermediate and final goods. The scale of the axis is 0.4%. The lighter the color, the higher the utility at that tariff bundle. So, the bundle spot being yellow indicates that at that tariff bundle there's high utility meanwhile a dark blue color indicates that at that tariff bundle there's a low utility.

In Figure 2, the lighter the color, the higher the utility at that tariff bundle. So, the bundle spot being yellow indicates that at that tariff bundle there is high utility meanwhile a dark blue color indicates that at that tariff bundle there is a low utility. As can be seen in Figure 2, the optimal tariff in this model is a mix of a positive tariff on the intermediate good ($\tau_m > 0$) and the final good ($\tau_f > 0$). This is because even though the tariff on intermediate goods gives the home country a higher terms of trade, the tariff on the foreign final good leads the country to produce more of the home final good.

A.1.3 Deviations from Optimal Tariff Scenario

Figure A.3: Adjustment from Optimal Tariff



Note: This shows that the utility cost of deviating from the optimal tariff is a larger with the intermediate good tariff than the final good tariff. The units of the x-axis is a one percent shift in the optimal tariff.

As can be seen in Figure 3, at the optimal tariff, a marginal change in the tariff on intermediate goods leads to a larger decrease in utility than a change in the tariff on final goods.

A.2 Parameters across Industries

Industry (NAICS Code)	σ	τ^f	τ^m
Food Manufacturing (311)	3.7	0.03%	0.22%
Beverage and Tobacco Manufacturing (312)	1.9	0.01%	0.56%
Textile Manufacturing (313)	3.6	0.03%	0.24%
Apparel Manufacturing (315)	3.4	0.03%	0.28%
Leather and Allied Product Manufacturing (316)	3.9	0.04%	0.18%
Wood Product Manufacturing (321)	4.1	0.04%	0.15%
Paper Manufacturing (322)	2.8	0.03%	0.39%
Petroleum and Coal Products Manufacturing (324)	7.0	0.07%	-0.36%
Chemical Manufacturing (325)	2.5	0.02%	0.44%
Plastics and Rubber Products Manufacturing (326)	3.2	0.03%	0.31%
Nonmetallic Mineral Product Manufacturing (327)	2.6	0.03%	0.46%
Primary Metal Manufacturing (331)	4.2	0.04%	0.13%
Machinery Manufacturing (333)	3.1	0.03%	0.33%
Computer and Electronic Product Manufacturing (334)	2.7	0.03%	0.41%
Electrical Equipment, Appliance, and Component Manufacturing (335)	2.9	0.03%	0.37%
Transportation Equipment Manufacturing (336)	4.1	0.04%	0.15%
Furniture and Related Product Manufacturing (337)	2.9	0.03%	0.37%

Table A.1: The Effect of Tariffs on Different Industry's