Quantitative Restrictions and Quality Upgrading:
The Case of the Multi-Fibre Agreement

by

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ABSTRACT

The thesis uses the end of the Multi-Fibre Agreement to test the theory of quality-upgrading, which states that firms facing quotas will export higher-quality products to generate the greatest economic rent from each individual exported good. The Multi-Fibre Agreement (MFA) is a set of quantitative restrictions placed by the US on textile exports from Asian nations that began in 1974 and ended January 1, 2005. The thesis constructs a hedonic regression to isolate the quality and price characteristics of goods exported from China, and it creates a fixed effects regression to estimate the impact of quotas on the quality and price of goods exported. The study finds that the end of the MFA led to a 9 percent decrease in the quality of goods exported in previously restricted groups and a 26 percent decrease in the price of goods exported from China. Furthermore, it is the first study to evaluate how the reinstatement of ex ante textile quotas in 2006 impacted the price and quality of Chinese goods exported and found the resulting increase in quality to be 19 percent and the increase in price to be 21 percent (all statistically significant at the 1 percent level).

The thesis also generates a theory for how quotas on Chinese textiles lead to a decrease in quality of goods produced by firms in nations that do not themselves face quotas on exports (specifically Canada, Mexico, Italy, El Salvador, and Honduras). It tests this theory using a control and a treatment group based on the groups of Chinese exports that face quotas. The study uses a similar hedonic regression and fixed effects regression analysis to evaluate the impact of Chinese quotas on other countries’ exports. The study finds a statistically significant increase in the price of exported goods after the MFA, ranging from a 4 percent to a 34 percent. Furthermore, it finds a statistically significant increase in the quality of exported goods after the MFA, ranging from 3 percent to 33 percent, for Canada, El Salvador, Mexico, and Italy. This confirms the hypothesis that firms in these countries underwent quality downgrading as a result of quotas on Chinese goods.

Keywords: Multi-Fibre Agreement, quotas, quality-upgrading, hedonic regression, fixed effect regression

JEL Classification No.: F13, F14

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1 Introduction

As 2005 dawned on China, large container ships, loaded down with Chinese-made socks, neckties, and t-shirts, started out on a journey across the Pacific. They would find their way to US ports, and, ultimately, to stores across America for mass consumption. This seemingly ordinary event signaled the end of the Multi-Fibre Agreement (MFA), a system of quantitative restrictions on textile imports. The MFA, first implemented in 1974 by developed nations like the US and EU, grew out of unilateral restrictions on cheap textile imports from developing nations in the post-WWII period. The agreement largely restricted imports on goods from Asian nations like China, Vietnam, Taiwan, and India. This asymmetrical implementation of quotas had been found to violate WTO law in 1995, and the world began a long, multi-stage phase-out of the quotas.

This phase-out process, known as the Agreement on Textiles and Clothing (ATC), began in 1995 and was set to end on January 1, 2005, eliminating the last 85 quotas on textile groupings that had been in place since the previous phase-out in 2002. As the end date neared, China and other developing nations began anticipating a world without textile quotas. Investment soared and factories worked overtime to stockpile goods for shipment to the developed world on January 1. A surge of goods hit US markets in the first few months of 2005 as the quantity of Chinese imports increased by 450 percent or more for goods that had previously been heavily restrained by quotas. In response, US textile manufacturers lobbied the US government to enact the safeguard clause of the ATC, which allowed nations to re-implement quotas on goods that would be overwhelmed by the influx of imports. The US enacted 13 safeguards that, in effect, allowed quotas to be reinstated indefinitely on 22 groups of Chinese goods.
This thesis will discuss the implications of both the end of the MFA in 2005 and the reinstatement of quotas in late 2005 and early 2006. It is the first study to estimate the level of quality upgrading performed by Chinese firms in response to the reinstatement of ex ante quotas in 2006. It is also the first study to attempt to estimate to what extent quotas on Chinese goods impact the quality considerations of firms in nations that also export to the United States but that do not face quotas on their textile exports.

1.1 Quality Upgrading

Quotas distort the incentives of exporters who come up against the quotas by reducing the total number of goods that they may produce. For example, a firm might maximize profits by producing and exporting 100 units of a good, but a quota limits its exportation to 10 units of that good. In this case, the firm would want to produce those 10 goods at a higher quality level to fetch a higher price and bring in a higher per-unit profit. Because firms cannot achieve economies of scale to as great of an extent when a quota restricts their production, they often find that they reap the greatest profits by producing higher quality goods.

This phenomenon, called quality upgrading, has been well documented in other industries like steel and automotives. The end of the MFA created an ideal environment for testing this hypothesis in the textile industry because the end of the MFA was both instantaneous and fully expected. This means that producers in Asian nations adjusted their production capacity and quality level of exports in anticipation of the elimination of quotas. A comparison of the quality and price indices of firms in 2004, prior to the end of the MFA, with the same indices from 2005 reveals how quantitative restrictions affect export choices. Furthermore, the change in these same variables between the years 2006 and 2007 reveals how the ex ante reinstatement of quotas on goods in 2006 affected the export decisions of Chinese firms.
The extensive literature on the subject of quality upgrading documents the effect of quotas on exporting countries that find their total goods’ exports limited. However, the literature remains relatively silent on the effect of one country’s limited exportation on the quality-decisions of firms in a second country. For example, if a Chinese trouser-maker decides to produce a higher quality of trouser (sold in, say Bloomingdale’s instead of Wal-Mart), this will cause the price of the lower-quality trouser to increase relative to that of the higher-quality trouser. Many nations that have preferential trade agreements with the US face no quantitative restrictions on textiles. Such nations might observe this relative shift in prices and decide to produce low-quality trousers, even if in a free market, their marginal costs of producing these trousers would fall below the trousers’ market price. I hypothesize that a quota on one nation’s exports might also impact quality considerations of exporting firms in another country.

The US uses a specific categorization system called the Harmonized Tariff System (HTS), which gives a 10-digit identifier to a very distinct type of good such as “women’s trousers 25 percent synthetic wool blend no knit” or “pure wool knit trousers.” Quotas, however, limit the quantity imports of broad categories of goods like “women’s trousers” rather than specific types of goods. Thus, within a quota group, there might be higher quality or lower quality designations of goods based on different HTS numbers. Assuming that goods within an HTS type are perfect substitutes, I then use HTS numbers as indicators of a specific type of good.

1.2 The Study Design

This thesis will make use of import data collected by the United States International Trade Commission (USITC) for every HTS number that classifies textile and apparel goods. This includes roughly 6000 observations from individual HTS numbers collected on exports to the US from six different countries. The USITC collects only basic information, specifically on the
value and quantity of imported goods, and it does not classify goods according to quality. I use this very basic information to isolate information on price and quality changes within a quota group, building off of the methodology created by Harrigan and Barrows 2006. To do this, I perform a hedonic regression to isolate the quality and price characteristic from a quota group using a weighting method. In effect, if the quantity-weighted unit price increases faster than the value-weighted unit price for a given quota group, this means that the quality has increased for that quota group. This methodology also controls for other changes that might affect the relative quality, such as the introduction of new goods to a quota group.

I use quota group data collected from the US Customs and Border Patrol (CBP) for a given country and year. In addition, to create a control group of goods are not subject to quantitative restrictions, I use textile categories created by the US Office of Textiles and Apparel (OTEXA) to measure the quality change for groups of like goods apart from those designated by the CBP. This data will all be explained in further detail in the methodology section.

Having constructed the quality index for the quota-restricted and control groups of goods for years 2002 through 2007, I then run a fixed effects regression to measure to what extent a restrictive quota will change the relative price and quality of goods. A restrictive quota is defined as one in which 90 percent or more of the total quota limit has been met by the year’s end, implying that the quota is likely reducing the total potential imports of that good. This will also be further explained in the methodology section.

This methodology will be applied to three sets of data. First, I construct the relative change in price and quality between 2004 and 2005 as a result of the end of the MFA. As mentioned above, safeguard quotas were applied in June 2005 on 13 quota groups, and this study will also
measure to what extent those safeguards led to a quality change in those groups relative to all others in 2005.

Second, I evaluate to what extent the reimplementation of regular, expected quotas in 2006 led to a change in quality and price for those groups (relative to the control group). The quotas were re-implemented in 2006, but they did not become binding until 2007, and I evaluate both the unrestrictive quotas from 2006 and the restrictive quotas from 2007 to understand whether firms change their quality as a result of any ex ante quota or only one that is likely to be restrictive.

Third, I evaluate the secondary effects of China’s quality upgrading on the unconstrained nations of Canada, Mexico, Italy, El Salvador, and Honduras, analyzing the change in quality and price between 2004 and 2005. Specifically, I will evaluate the difference in quality change for textile groups in which China is constrained in 2004 versus the control set of textile groups.

1.3 A Roadmap

This thesis will first explore the literature related to quota theory and quality upgrading, including a landmark study of restrictions on Japanese automobile imports. Second, it will discuss the theory behind the quality upgrading, including both why and how Chinese firms improve the quality of goods produced, how this affects the relative price of high and low quality goods, and, finally, how this adjustment in price changes the production considerations of firms in nations without quota restraints on exports. Third, it will explain the methodology of the study, including the actual implementation of quotas, the derivation of quality measurements, and the fixed effects regression used to test the hypothesis. Fourth, this thesis will summarize the results of basic quality, quantity, and price measures. It will then explain the results of the regression analysis and the implications of these results for the overall study. And finally, it will
conclude by relating the results found in the paper to the overall theory of quotas as derived in section 3.

2 Literature Review

2.1 Vertical Differentiation and Quality

The first incidence of quality considerations in economic theory explored how vertical differentiation between goods leads to differences in firm behavior. Mussa and Rosen’s (1978) game theoretic model of how firms choose quality levels and prices defines goods of different qualities as vertically differentiated with different demand functions. Rosen (1974) creates a hedonic price model that measured the quality of goods along a continuum of product types. Economic theory proposes that a change in quality may be either consumer-driven or producer-driven.

2.2 Producer-Driven Quality Upgrading

Krishna (1987) and Das and Donenfield (1989) show how firms choose to produce goods at the level of quality that will maximize their profits. Under quotas, like certain types of tariffs, foreign firms upgrade quality immediately after the ex ante imposition of the quotas. This is to increase the per-unit profit at a lower quantity level than would be equilibrium with no restriction. Rodriguez (1979) presents a partial equilibrium analysis where producers choose quality levels of production given that the price of a certain quality of good is previously determined. In this form of quality upgrading, the level of production is driven by price-taking foreign firms based on their cost structure for lower and higher-quality goods.
2.3 Consumer-Driven Quality Upgrading

Alchian and Allen (1964) theorized that if an equal tax or transaction cost were put on two substitutable goods, consumers would shift demand towards the higher quality (or premium) good. This is because the equal additional cost will reduce the relative price of the higher-quality good. This transaction cost includes transportation costs on traded goods, leading to increased demand for high-quality exports. Alchian and Allen call this “shipping the good apples out.” Hummels and Skiba (2004) applied this theory to a range of detailed international trade data, and found that it has an empirical basis in terms of shipping costs.

2.4 Japanese Automobiles and Quality Upgrading

Feenstra (1988) used the hedonic regression model from Rosen (1974) to evaluate how quantitative restrictions on imports might affect the product quality of car imports. In the late 1970s, fearing the influx of Japanese autos into US markets, the US government formed an agreement with Japan. The agreement stated that if Japan created a self-imposed limit on the number autos that it could export to US markets, the US would not place a quota on Japanese autos. This agreement, known as a Voluntary Export Restraint (VER), was not technically a quota, but it distorted incentives for firms in the same way that a quota would have. Feenstra 1988 found that the VERs on Japanese autos caused Japanese firms to export higher-quality autos to the US than it otherwise would have. Rather than exporting the cheap, small cars of the 1970s, Japanese firms began producing larger and higher quality cars that competed more directly with cars produced domestically. This finding of quality upgrading in cars led to an application of similar methodologies to other industries with quantitative restrictions on imports, including cheese (Anderson 1985), footwear (Aw and Roberts 1986), and steel (Boorstein and Feenstra 1991).
2.5 Quality in the International Context

Economists have further applied this measurement of quality to overall understanding of the differences in exports from rich and poor nations. Hummels and Klenow (2002) evaluated the difference in trading between wealthier nations and poorer nations to test whether wealthier nations exported a greater quantity of good, a wider range of goods, or a higher-quality good; they found that larger economies were more likely to produce both a wide range of product varieties and a higher absolute quality of goods. Schott and Hallack (2008) on the other hand find that the gap in quality of exports between rich and poor nations is smaller than the gap in their incomes and closes at a faster rate between 1989 and 2003. This means that the difference between rich and poor nations in their quality of output is smaller than it would be if these nations produced goods according to relative level of development.

Verhoogen (2007) explores this observation in the case of the Mexican manufacturing sector. This study finds that more-productive firms with higher wages had a larger share of exports. These firms increased their export share even more over their lower-productive counterparts during the period of the study design. Furthermore, because of the transaction costs associated with trading to the US, these more-productive exporting firms were more likely to increase quality of goods exported as a result of consumer-driven quality upgrading as put forth by the Alchian-Allen conjecture. Thus, the exporting sectors in lower-income nations like Mexico often converge with their higher-income counterparts in their level of quality produced.

2.6 The Multi-Fibre Agreement

Harrigan and Barrows (2006) applied Feenstra’s methodology for constructing a quality index to the special case of textile quotas. Specifically, their paper evaluated how a sudden and anticipated end to quantitative restrictions changed the quality levels chosen by firms in Asia
between 2004 and 2005. They found a large decrease in quality as a result of this change. Other papers, such as Whalley (2006), evaluated other aspects of the end of the MFA like how it redistributed the quantitative level of exports by country to the US.

3 The Theory Behind Quality Upgrading

3.1 Quality as Vertical Differentiation

Quality is defined as a measure of vertical differentiation between products (Mussa and Rosen 1978). In their definition, n firms produce similar goods with differences in quality. Firm i produces a good with a quality that falls within the bounds of the quality measure \( q_i \in [q^-_i, q^+_i] \) with marginal cost \( c(q_i) \). This firm charges \( p_i \geq c(q_i) \) such that the profit for firm i is based on the price, cost, and demand structure for a good of a specific quality:

\[
\pi_i(p, q) = [p_i - c(q_i)]D_i(p, q) \text{ where } D_i \text{ is the demand for that firm’s good } i.
\]

The consumer preference for a general quality level of good (as opposed to a specific firm’s good) is distributed according to density function \( f(\theta) \) where \( \theta \in [\theta^-, \theta^+] \). Consumers will buy a good of a specific quality if their utility received from a particular good is greater than or equal to the price they pay for that good, \( u(\theta, q_i) - p_i > 0 \). If this inequality holds, a higher \( \theta \) reflects a higher marginal willingness to pay for quality (Neven 1986 and Champsaur and Rochet 1989), and consumers will buy a good of a given quality, leading to the demand function mentioned above.

This is a fancy way of saying that producers often have the option of producing goods at different quality levels of goods, where the cost of production is dependent on the level of quality of the good. The producer then sets a price based on this cost, where the price is greater
than or equal to the cost. Consumers have preferences based on the quality of the good and the relative price of goods at each quality level. This leads to a game theoretic model in which consumers and multiple firms each choose to produce or consumer a certain quality level of good based on the price, cost, and utility of that good.

Mussa and Rosen conclude that firms end in a sub-game perfect Nash equilibrium in which the qualities are differentiated by price such that the highest quality good has the highest price, and that prices then fall corresponding to the decrease in quality. Each given price must be set according to the consumer’s demand \( u(\theta, q_i) - p_i > 0 \), or else consumers will choose a lower quality of good and the demand for the higher quality will fall to zero. In this scenario, goods of two different qualities may be viewed as two different goods such that the price of low quality good < price of high quality good.

### 3.2 Quota Theory

International trade theory states that when goods are traded freely, the price of a good will equal the world price of the good. Domestic consumers will produce at their optimal level given the market price, and imports will fulfill the residual market demand given the world price. This is illustrated in Figure 1. In this figure, \( P_0 \) is the world price of a good, and domestic firms will supply the good at quantity \( S_0 \). The residual demand (between \( S_0 \) and \( Q_0 \)) will be met by imports.
If a nation were to implement a quantitative restriction on imports of a good, this would drive the price up to where the residual between the supply and demand for a given good is equal to the quota on imports. In Figure 1, this means that the price rises to $P_1$, domestic firms supply at a quantity of $S_1$, and the quota is equal to the difference between $Q_1$ and $S_1$. In such a case, the producer surplus received by the foreign firms would be equal to $C + M$, which is equivalent to the product of price and quantity of imports. Of this, the quota rents (producer surplus received specifically from the implementation of quotas) would be $C$, which is the amount of additional surplus received by foreign firms as a result of the increase in price from the quota.

This model simplifies the model of quotas, however, because it assumes that the given nation would restrict imports from all importers equally, not just specific nations. In reality, however, nations implement quotas asymmetrically, which means changes the impact of quotas on markets. Furthermore, this model simplifies the quota by assuming that it is implemented on one given good when, realistically, an individual quota is implemented on multiple qualities of a good that are vertically differentiated in the eyes of consumers.
3.3 China’s Quota Rents

Hypothetically, a quota group might restrict the overall export of two vertically differentiated goods, one low quality and the other high quality. As shown above, these goods have different cost structures dependent on their relative quality, and the lower quality good will be sold at a lower price than the high quality good. Higher quality goods often have a marginal cost of production that increases rapidly as quantity increases whereas lower quality goods often achieve economies of scale (a decrease in the per-unit cost of production as quantities increase.

In a nation like China, with low wages and lower relative productivity and training of the workforce, firms would, in absence of any restrictions, choose to produce large amounts of low-quality goods at a low marginal cost. This is shown in Figure 2, where free-trading Chinese firms choose to produce at quantity M0 and price P0. At this level of production, they receive the producer surplus of areas F+E+PS. These areas are equal to the price received for these goods minus the cost of producing these goods (indicated by the supply curve).

Figure 2
If a quota were placed on China’s export of this good (to the level MQ, for example), this would drive the price of goods up to P1 (as illustrated in Figure 1). In this situation, China’s marginal cost of producing these goods would fall to P2. The area between P2 and the supply curve (denoted PS) would be the producer surplus received for this good. Because of this increase in the price of the good, the quota rent may be defined as C+E, which is the additional profit that the firm receives beyond the standard producer surplus as a result of the quota (similar to area C in Figure 1).

To overcome this decrease in total producer surplus from quotas on low-quality goods, producers may choose to instead produce a higher quality product. Higher quality goods require workers with better training and technical abilities, which necessitates higher wages. Furthermore, the care that must go into producing each individual article of clothing causes difficulty with producing such clothing in large volumes at lower costs; economies of scale is more difficult to achieve with this product. However, at lower volumes, high-quality goods often have a larger profit margin than their low-cost counterparts. This is because such goods require more training to produce, and because of the demand structure of consumers: their utility from a higher quality of clothing is large enough to overcome the price of this additional level of quality. In such a situation, textiles that will garner the highest profit margin per unit of clothing are a better choice for quantity-restricted producers.
This quality upgrading is illustrated in Figure 3 for the case in which the original quantity of high quality of goods produced is very low (below the quota-restricted level). The switch from producing low quality to high quality goods will shift the supply of high quality goods (HQG) outward, reducing the price of these goods slightly (to P1). The supply will shift to Q1, and the producer surplus for these goods will be given by the area of the triangle above the supply curve at quantity Q1 and price P1.

The remainder of analysis will evaluate how this change in the relative price of goods will cause producers to change their level of production. I use an international trade diagram similar to the one shown in Figure 4. This diagram uses a production possibilities frontier (curved line) to show the comparative advantage of goods from a given country. In Figure 4, China has a comparative advantage in producing low-quality goods because given a set level of resources (denoted by the production possibilities frontier or PPF), it can produce a greater quantity of low-quality goods. At a free market level, China will produce at quantities of LQG0 and HQG1, with a budget line (denoted by the relative price of low to high quantity goods) that lays tangent to that point on the PPF.
With the implementation of a quota, China restricts its level of low quality goods and increases its production of high quality goods to LQG1 and HQG1, respectively. This corresponds to a change in relative price of the two sets of goods so that they form a tangency with that point on the PPF.

### 3.4 Change in relative price of goods

Quality upgrading has vast implications for producers in other exporting nations as well, regardless of whether their export levels are restricted. The decrease in supply of low-quality goods (and subsequent increase in the supply of high-quality goods), leads to a change in the relative price of each of low and high quality goods. As the supply of low-quality goods contracts, the price of each of these good is driven upwards. Conversely, the increase in supply of high-quality goods leads to a decrease in the price of these goods.

This relationship may be viewed from the perspective of firms in two different types of countries. The first country (Nation A) is a developed nation in which labor costs are relatively higher than they are in the developing world, but where labor is also more productive and better trained than in poorer nations. Such a nation has a comparative advantage in producing higher
quality goods, which fetch higher prices but have higher unit labor costs. This is illustrated in Figure 5 by the production possibilities frontier, which shows that this nation has a comparative advantage in producing higher quality goods. Under free trade, this nation will produce goods where the budget line (relative Price LQG/Price HQG) is tangent to the PPF. Thus, under free trade, this developed nation will produce its low quality goods at LQG0 and a higher quantity of high-quality goods at HQG0.

Figure 5

As the relative price of low quality goods increases, this will shift the developed nation’s budget curve such that its production of high-quality goods falls to HQG1 and its production of low-quality goods rises to LQG1 in Figure 5. From the perspective of Nation A, if the price of low quality goods were to increase above the marginal cost of production of these goods for its firms, then Nation A’s firms would begin to produce low quality goods. If the profitability of producing higher quality goods were to decrease below the profit margin for low quality goods (because of an influx of these goods from China), then firms in Nation A would abandon their production of these higher quality goods in favor of their lower quality counterparts. This would
continue until the profit margin for each type of good for Nation A was to equalize. This shift in production would lead to a quality downgrading effect.

The second type of nation is developing, with less productive but less expensive workers (Nation B). Such a nation is, in many ways similar to China (our quota-constricted case), but it has less of a potential for economies of scale because of the relative size of the country and its workforce. For this reason, nation B does not achieve a marginal cost structure that is as low as China’s. In this hypothetical situation where free trade exists between all nations, China would produce the majority of low quality goods and nation B would fight for a portion of the market share by exploring niche markets and export incentives for local industries. As shown in Figure 6, this developing nation would have a large comparative advantage in low-quality goods, with a PPF that leans towards the x-axis. Under free trade, this nation would produce many low-quality goods (denoted by LQG0) and few high-quality goods (HQG1).

**Figure 6**

If quotas were implemented on Chinese exports, Nation B would also make use of this increase in the price of its low quality exports. Firms would increase production to take advantage of this price increase, and would potentially sacrifice any production of higher quality
goods in favor of expanding low-quality production. This would lead to an expansion in exports of the low quality goods in which it has a comparative advantage (moving its low-quality production to LQG1), and a small decrease in high-quality goods (to HQG1).

Of course, the actually shift in production is dependent on the extent to which China’s quality upgrading affects the relative price of different qualities of goods. However, assuming that China’s exports are severely restricted and that under free trade China would have a large market share among world exports, this leads to a large shift in prices.

3.5 Finding a new equilibrium

When quotas are repealed, previous shifts between high and low quality production in countries with quantitative restrictions will be undone. This means that China’s firms, which under quantitative restrictions had invested in the production of high quality goods, will overnight shift its production to the mass production of low cost, low quality goods. The fallout from this will be immense for nations represented by both nation A and B. Reacting to the increase in price of high quality goods and the drop in prices of low quality goods, developed nations will shift back to the free trade production level, which will be seen as in the data as an increase in quality over time. Developing nations will have less of a shift towards high quality goods (since their cost structures do not give them a comparative advantage in this type of good), but their supply of lower quality goods will contract.

This effect will take place over a period of years rather than immediately. Unlike Chinese, which perceives the end of quotas and makes the choice to switch the production makeup, these other nations (which face no constraints) will be reacting to a price change and thus a change in their overall profits. Since prices are sticky over time, this new equilibrium will not be immediately reached.
Within the specific case of Chinese quotas, a wrinkle exists in the movement towards this new equilibrium. The elimination of the most restrictive quota groups led to such an influx of goods that the US enacted safeguard measures, effectively re-implementing the quotas for the next three years. This complicates the measurement of the effect of these quotas on the overall change in quality because the most restrictive quota groups would be most likely to quality upgrade.

For China, the year between the end of the MFA and the enactment of safeguards (2005) serves as an excellent predictor of the overall potential for Chinese firms to quality upgrade; such firms understood only that quotas would end in 2005, and they did not anticipate the subsequent safeguards, so at the end of 2004, they adjusted their production levels for a new quality. When then faced with restrictions in 2006, these firms would resume quality upgrading.

For firms in unconstrained nations, this scenario could lead to a few different outcomes. Nations might immediately respond to the shifts in exports by Chinese firms and adjust price, quantity, and quality of goods within the first year to the non-quota equilibrium. If this were the case, that would mean that firms in developed nations would increase quality and price and decrease quality in 2005, and would do the reverse in 2006. Likewise, this would mean that firms in developing nations would have a minimal change in price and quality but would see a large contraction in quantity exported in 2005 and a subsequent expansion of exports in 2006 in quota-constrained groups. However, since, as mentioned above, prices are sticky, and these firms change output in response to a change in prices, one would expect the overall effect to lag behind China’s movement in exports.

Furthermore, the re-implementation of quotas would lead firms to view their interests based on the expectation of future quota levels. The WTO has agreed to the use of a safeguard to
prevent domestic industries in the US from falling prey to the influx of cheap foreign goods, but these safeguards are ultimately illegal under WTO law, and they will be permitted for an indeterminate amount of time. If firms in other nations perceive that the quotas will be removed after a short period of time, they might choose to adjust their current production levels and qualities to the long-term equilibrium once China’s quotas have been removed. This would lead them to upgrade quality and decrease quantity in the short-run regardless of the current price ratio of goods. If firms instead decide that the quotas on China’s goods will remain for a longer period of time, they will likely choose to remain at the quota-based equilibrium in which they produce at a greater quantity and lower quality of output than they would under a completely free system. Thus, much of the current choice on whether to continue quality upgrading by the firms in unconstrained countries relates to their expectation of the time frame for removing the current safeguards on quotas.

4 Methodology

This thesis evaluates the effect of quantitative restrictions on the price, quantity, and quality of textile imports from China to the United States using a Feenstra Price Index and a Unit Value Index to construct a quality index of goods. This quality index is a hedonic regression that isolates the per-unit increase in value of a particular good. It eliminates secondary causes of unit value increase for goods over time, such as the introduction of new goods into the set.

The study evaluates the impact of quotas during two time periods. First, it will evaluate the change in quality, price, and quantity between the years 2004 and 2005. On Jan 1, 2005, all quota groups were eliminated as part of a long-term process of ending quantitative restrictions on quotas. Thus, the change between these two years reveals how quotas affect the level and quality of imports. Second, it will evaluate the change in these same characteristics during the period
between 2005 and 2006 and between 2006 and 2007. The flood of goods from China during 2005 led to the implementation of a smaller set of quotas on certain Chinese goods in 2006. These quotas began restricting goods in these quota groups in 2007. This change between 2005 and 2007 reveals how the re-implementation of quotas on Chinese exporters affects the quality and price considerations on export goods to the US.

4.1 Classification Systems

Quota groups are designated by the Office of Textiles and Apparel of the US government to classify goods based on similar attributes. These goods are categorized using a system of numerical identifiers called the Harmonized Tariff Schedule (HTS), in which uses a 10-digit code to designate specific types of goods. For example, HTS number 6204.69.2010 designates women’s and girl’s trousers made with artificial fibers with 36% wool that is not knit, and HTS number 6211.20.6400 designates women’s and girl’s ski-suit trousers and breeches, not knit. Within the 10-digit code, each number represents some identifier for the overall code. The first number within the code indicates the broad type of good. For example, HTS numbers 5 and 6 broadly represent processed fabrics and manufactured apparel, while HTS number 0 represents raw materials and HTS number 1 represents agricultural goods. Each subsequent number represents some other aspect of the good, such as (for textiles) whether it is knit or crocheted, wool, silk, or synthetic, or the thread count of the material or use of the good.

The US Office of Textile and Apparel (OTEXA) then groups these very specific goods into larger categories based on type. This US Textile and Apparel Category System uses 3-digit numbers to group like items. For example, category 448 denotes women’s and girl’s trousers, breeches, and shorts and is made up of all HTS numbers associated with women’s pants. The
OTEXA categories only make use of HTS 2-digit categories of 39, 42, 70, 94, 96, and 50-65 because these are the relevant HTS textile classifications.

The US government uses these 3-digit textile systems to create quotas in two ways. First, OTEXA might restrict one broad category of goods, such as category 335. This category is made up of women and girls’ coats, of which the US states that China, for example, may only export 422,319 DOZ to the US (the quota limit). In 2002, China ended up exporting 397,534 DOZ, which was 94 percent of the overall quota. Second, the US might choose to restrict only a portion of the goods in the overall category, such as Quota group 224-V. 224-V is a smaller subset of textile category 224, which is made up of pile and tufted fabric. The overall textile category includes 31 HTS numbers, but the quota group only limits the export of 14 of these HTS numbers. In 2002, China was limited to exporting 4.3 million square meters of these 14 restricted goods and filled the quota limit 94 percent. Third, the US might establish a quota across groups that restricts portions of each group, such as quota group 347/348, which creates restrictions on both men’s and boys’ trousers, breeches, and shorts (category 347) and on women’s and girls’ trousers, breeches, and shorts (category 348). In this category, China is limited to exporting 2.5 mil DOZ trousers, breeches, and shorts to the US, and it exports within 99 percent of that limit.

In addition to quota group designation, this study makes use of data reported by the US International Trade Commission (USITC), which collects data classified by HTS numbers on the value and quantity of imports from a given country. I obtained the yearly value and quantity rates for years 2002 through 2007 on all HTS Numbers associated with textile categories. Then, using a bridge between HTS Numbers and Textile categories, acquired from OTEXA, I was able to classify the information on value and quantity of imports by the associated textile category.
4.2 The Quota Groups

US Customs and Border Patrol (CBP) keeps all information on quota groups for a given country. Quota groups are assigned by a given country, and prior to the end of the MFA, 15 of the top 20 exporters of textiles to the US faced some level of quota coverage. While countries like China had quota coverage on 18 percent of imported textile categories to the US, nations like Mexico and Canada with preferential trade agreements with the US have no quotas on goods. The CBP information included the textile category and HTS number designation of all quota groups, as well as the yearly limit, released number, and fill rate for a given quota group. The yearly limit indicates the total predetermined quantitative restriction for a quota group, while the release number shows the actual imported amount of exported goods to the US for a given quota group. The fill rate is the ratio of released goods to the yearly limit, which specifies what percentage of the quota was filled in a given year. Binding quotas are generally defined as those having a fill rate of greater than or equal to 90 percent (Evans and Harrigan 2005). This fill rate indicates that the quota is restrictive or “constraining” on the level of imports because of the complexity of aggregating goods by their group and HTS number.

This study uses the quota group structure to derive the price indices. Because one group restrains the total imports of a specific set of products, the group as a whole may be used as the unit of analysis. When establishing price indices and quality indices, the study evaluates how the quality of a group as a whole changes as a result of the quotas. China was subject to 73 unique quotas in 2004, a number that was reduced to zero quotas on Jan 1, 2005. The influx of Chinese goods was so great, however, that in mid-2005, emergency quotas were placed on key groups of goods to restrict further importation of these goods from China. This set of emergency quotas was placed only on Chinese goods. Though this reduced the level of imports below what it
would have been without a quota, the increase in goods in the early part of 2005 allows us to analyze the overall change when quotas are removed.

The use of quota groups allows us to evaluate the change in price, quantity, and quality of goods between 2004 and 2005 as compared to the change within a quota group during the 2002-2003 period and the 2003-2004 period (when quotas remained constant), and during the 2005-2006 and 2006-2007 period when quotas were reinstated. However, this analysis does not reveal how textile imports changed for goods that were not subject to quotas during any of these periods. I compare quota-restricted goods to those that were not restricted by quotas by using general textile categories to create a counterfactual of groupings of goods that were not restricted by quotas: this group of goods will serve as a constant within the analysis.

### 4.3 Constructing a Quality Index

A basic measure of how goods change over time within a quota group would use a simple unit value index. Such an index simply divides the total value (in dollars) of goods in a quota group imported from a single country by the quantity of those goods. This method estimates the overall price of goods imported from that country (e.g. China) in one year. Doing the same in the subsequent year yields an average of the prices paid in two different years on goods imported from a single country. From that, I can estimate the change in price for a set of goods between two years.

This is shown in the equation below, where $v_{it}$ is the overall value of an individual set of goods (e.g. wool socks) in a given year, and $x_{it}$ is the quantity of that set of goods in that time period. The unit value index takes the overall value of these wool socks, sums them with the value of cotton socks and the value of cashmere socks and knee-high nylon socks. In this and all future analyses in this paper, $i$ denotes the goods within a particular HTS number contained in
quota group $I$, such that $i \in I$. The unit value index then divides this value by the sum of the quantities of these goods to construct an average unit value of socks:

$$UV_{cgt} = \frac{\sum_{i \in I_{ct}} v_{cit}}{\sum_{i \in I_{ct}} x_{cit}}$$ \hspace{1cm} (1)

However, this simple measure of price changes does not take into account certain changes in the composition of goods between two years. One good might be completely left out of the calculation one year but included the subsequent year. For example, if in one year, the US decided that latex socks should be included in the socks group, but previously it had not been included, the overall change in price for socks would reflect this addition of a good that had not been included in the price in the previous year. This would reveal a shift in the average price even if the price of all goods included in the first remained the same in the following year.

This basic unit value measure actually uses a quantity weight to construct the price. This is shown in the formula below:

$$UV_{gt} = \sum_{i \in I_{g}} \omega_{it} p_{it} \hspace{1cm} \text{where} \hspace{1cm} \omega_{it} = \frac{x_{it}}{\sum_{i \in I_{g}} x_{it}}$$ \hspace{1cm} (2)

If $P_{it}$ is the price of an individual set of goods in a given year, the weight, $\omega_{it}$ is the weight of each individual price in the total unit value. This price is weighted by the share of each individual quantity value in the total sum of the quantities. Thus, this unit value construction is a quantity-weighted price index. This means that the unit value index does not show how changes in value over time affects the price weighting because it does not include a weight by the value-shares as well as the quantity-shares.

To account for the aspects of quality left out by the unit value index, I construct a hedonic price index that isolates the effect of quotas on quality. I first create a Feenstra Price Index for
the group of goods to account for the introduction of new goods into the system. This methodology value-weights the price change and accounts for the elasticity of substitution between types of goods within a textile group. For example, a quota group might be comprised of two pairs of trousers, one made from synthetic material and the other from wool. The elasticity of substitution takes into account how interchangeable these goods are in the eyes of consumers. Following the lead of Harrigan and Barrows (2006), this study uses an elasticity of substitution of 5, which was found to be an approximate value across classes of goods by Broda and Weinstein (2006). The Feenstra method of estimating price changes is delineated below.

### 4.4 Constructing the Feenstra Price Index

#### 4.4.1 The Expenditure Function

In “New Product Varieties and the Measurement of International Prices”, Robert Feenstra derives a price index that takes into account the introduction of new goods into the model and that uses a value-weighted index. The derivation begins with an expenditure function, which gives the minimum cost of obtaining a set of goods.

$$c(p_t, I, b_t) = \left( \sum_{i \in I} b_{it} p_{it}^{-\sigma} \right)^{1/(1-\sigma)}$$

(3)

In this equation, \( b_{it} \) is a taste parameter associated with the product \( i \) in time \( t \). The variable \( p_{it} \) is the price associated with the product \( i \) in time \( t \). The elasticity of substitution is denoted \( \sigma \) where \( \sigma > 1 \). This function corresponds to the amount paid for the vector of goods \( i \in I \).

To use this expenditure function to construct this index, I must make a few key assumptions about consumption patterns and demand for goods. First, I assume that imports
from a given country that fall within a given HTS code are perfect substitutes for each other. Because HTS codes classify data into specifics (thread count, fabric material, type of textile or apparel), the goods in a given code are very similar, and I assume that consumers do not differentiate between them. Second, I assume taste parameters remain unchanged over time. While styles do change over time, I assume that between 2002 and 2007, the demand for blue jeans, socks, and wool sweaters remains roughly the same. Third, I assume that the elasticity of substitution $\sigma$ is the same across goods in the quota group, and, as stated above, may be approximated as $\sigma = 5$.

This expenditure function is then used to develop an exact price index as defined by Diewert (1976), where the exact price index $P(p_{t-1}, p_t, x_t, I)$ is the change in expenditure functions between period $t - 1$ and $t$:

$$\frac{c(p_t, I, b)}{c(p_{t-1}, I, b)} = P(p_{t-1}, p_t, x_t, I) \quad (4)$$

### 4.4.2 Lambda Ratios

Feenstra modifies the original price index to account for the introduction of new goods into the expenditure function, as denoted by $\frac{\lambda_{it-1}}{\lambda_{it}}$:

$$c(\pi_t, I_t, b_t) = \left( \sum b_i \left( \frac{\lambda_{i,t-1}}{\lambda_{i,t}} \right) p_t^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (5)$$

In this equation, the lambda ratios allow for the introduction of new goods into a quota group. In this equation, $I_t$ stands for the entire set of goods imported in a quota group from a given country in year $t$. $I_{t-1}$ stands for the set of goods imported in a quota group in year $t - 1$, and $I_{t,t-1}$ stands
for the set of overlaps imported in both of these years in a given quota group. Then, I define the lambda ratios as such:

$$\lambda_i = \frac{\sum_{i \in I_t} v_{it}}{\sum_{i \in I_t} v_{it} \leq 1}$$

Thus, $\lambda_i$ is the value of overlap goods in $t$ / total value of goods in $t$. Because quota groups are relatively unchanging, this number will be relatively close to 1. Then, the lambda ratio is defined as:

$$\lambda_{t,t-1} = \frac{\lambda_i}{\lambda_{t-1}} \quad (6)$$

In the specific case of China, almost all lambda ratios are 1 because the quota groups as defined by OTEXA remain the same between 2002 and 2004. Furthermore, because quota groups disappear entirely for the first portion of 2005, I define the quota groups during that period as being the same as those from 2004. This is because the study aims to evaluate the change in quality for a quota group as the quotas end, so I must artificially construct the quota using the previous year’s groupings. In this special case, the lambda ratios will equal one.

The previous definition of the conventional price index and the new Feenstra expenditure function $c(\pi_t, I_t, b_t)$ yields this equation, which is essentially the Feenstra Price Index:

$$\frac{c(p_t, I_t, b_t)}{c(p_{t-1}, I_{t-1}, b_{t-1})} = \pi(p_{t-1}, p_t, x_{t-1}, x_t, I) = P(p_{t-1}, p_t, x_{t-1}, x_t, I) \left( \frac{\lambda_t}{\lambda_{t-1}} \right)^{1-\sigma} \quad (7)$$

The natural log of the Feenstra price index yields:

$$\ln \pi(p_{t-1}, p_t, x_{t-1}, x_t) = \ln P(p_{t-1}, p_t, x_{t-1}, x_t) + \frac{\ln \left( \frac{\lambda_t}{\lambda_{t-1}} \right)}{\sigma - 1} \quad (8)$$
The conventional price index, \( P(p_{t-1}, p_t, x_{t-1}, x_t) \), has been shown to not rely on the unknown taste parameter \( b_t \). Theorists have shown that it may also be defined as the geometric mean of the individual price changes (Sato (1976) and Vartia (1976)):

\[
P(p_{t-1}, p_t, x_{t-1}, x_t, I) \equiv \prod_{i \in I} \left( \frac{p_i}{p_i} \right)^{w_i} \quad (9)
\]

\subsection*{4.4.3 Value-Weighting the Price Change}

In this equation, \( w_i \) serves as the weights, computed using the cost shares in the two periods. The cost shares are shown here:

\[
s_i(I) \equiv \frac{p_i x_i}{\sum_{i \in I} p_i x_i} \quad (10)
\]

The cost share is essentially the value of imports of one type of good within the quota group over the sum of values of all types of goods within the quota group (i.e. value of good 1/(value of good 1 + value of good 2 + ... + value of good n)). Because this value share changes over the course of two years (as both the value of the good changes and the value of the overall quota group changes), I use information from both years \( t \) and \( t - 1 \) to construct the weight. Feenstra uses the logarithmic mean of the cost-shares in the two time periods for the weight, which results in this exceedingly complex equation:

\[
w_i(I) \equiv \frac{\left( \frac{s_i - s_{i-1}}{\ln s_i - \ln s_{i-1}} \right)}{\sum_{i \in I} \left( \frac{s_i - s_{i-1}}{\ln s_i - \ln s_{i-1}} \right)} \quad (11)
\]
However, using L’Hopital’s rule, \( s_i t-1 \rightarrow s_i t \) for all \( i \), meaning that there is very little variation between the two years in the cost shares. Thus, the weights \( w_i t \) approach \( s_i t \), and the logarithmic mean of cost shares will be very close to the arithmetic mean. For simplicity’s sake, I use an arithmetic mean, shown here:

\[
 w_i t \approx \frac{s_i t + s_i t-1}{2}
\]

This is the arithmetic mean of the cost shares from equation 10, and this number may be plugged in for \( w_i t \) in equation 8. Since the geometric mean of equation 9 is analogous to

\[
P(p_{t-1}, p_t, x_{t-1}, x_t, I)
\]

from equation 8, the natural log of the geometric mean from equation 9 may then be used for equation 8. The natural log of the geometric mean of the individual price changes yields

\[
\sum_{i \in I} w_i t \ln \frac{p_{it}}{p_{it-1}}
\]

This leads to an overall Feenstra price index:

\[
\ln F(p_t, p_{t-1}, x_t, x_{t-1}) = \sum_{i \in I} w_i t \ln \frac{p_{it}}{p_{it-1}} + \frac{1}{\sigma - 1} \ln \frac{\lambda_t}{\lambda_{t-1}}
\]

(12)

where \( w_i t \approx \frac{s_i t + s_i t-1}{2} \) is a weight based on the cost-shares from equation 9, \( \ln \frac{p_{it}}{p_{it-1}} \) is the natural log of the change in unit value for an individual good between two years, and \( \frac{1}{\sigma - 1} \ln \frac{\lambda_t}{\lambda_{t-1}} \) is a broad term allowing for the introduction of new goods into the model.

### 4.5 Whew, so what does that all mean?

Imagine a quota group for socks made up of 10 HTS numbers identifying 10 different types of socks in the year 2002. The quota group restricts the total import of socks rather than the imports of an individual good. Then, imagine that in 2003, another HTS number was added to the mix. The Feenstra Price index first calculates the value-share of each individual good in
the quota group. This means that for \( i = \text{sock 1} \), the weight equals the value of sock 1 imports in 2002 over the total value of socks in the quota group for 2002. This is then averaged with the 2003 weight to give an overall value weight. This weight is then multiplied by the natural log of the price change between 2002 and 2003 for that first sock. This number is then summed with the same calculation for each of the other 10 socks in the quota group. This final value-weighted price change of the quota group corresponds to \( \sum_{i \in I} w_{it} \ln \frac{P_{it}}{P_{it-1}} \) in the equation.

However, this price change doesn’t yet account for the additional of the 11th type of sock in 2003, which changes the overall composition of goods without actually affecting the price of any individual good. For this, I calculate the lambda ratio of the quota group. This corresponds to equation (6). In this case, the value of overlap goods in \( t \) will be less than the value of total goods in \( t \) for the quota group, so the lambda ratio will be less than 1. This number is then multiplied by \( \frac{1}{1 - \sigma} \), where \( \sigma = 5 \) to include the elasticity of substitution between goods in a quota group. This leads to the overall construction of the Feenstra Price Index.

### 4.6 Constructing the Unit Value Index

I also construct a unit value index to arrive at the overall quality index. The unit value index is far simpler than the Feenstra index. It simply sums the value imports in a quota group in a given year. It then divides this by the sum of the quantity of imports in that quota group in a given year. This means that for quota group 224-V, I sum the value of each individual HTS number for that quota group. I then divide this sum of values by the sum of the quantity of imports. This gives the unit value of an entire quota group rather than individual goods:
This might seem like an overly simple equation, but it implicitly takes the price of an individual HTS number, $p_{it}$ and weighs it by the quantity-share of the overall quota group:

$$UV_{gt} = \sum_{i \in I_{gt}} \omega_{it} p_{it}$$  \hspace{1cm} \text{where} \hspace{1cm} \omega_{it} = \frac{x_{it}}{\sum_{i \in I_{gt}} x_{it}}$$

The quantity-share weight is equivalent to the quantity of good $i$ in time $t$ ($x_{it}$) over the sum of all quantities in the quota group ($I$) in time $t$. In that way, it corresponds to the cost-share index of equation 10.

### 4.7 Constructing the Quality Index

The quality index may then be created by subtracting the change in Feenstra Price Index (equation 12) from the change in the unit value index (equation 13).

$$\ln \frac{Q_t}{Q_{t-1}} = \ln \frac{UV_t}{UV_{t-1}} - \ln F(p_t, p_{t-1}, x_t, x_{t-1})$$  \hspace{1cm} (14)

The difference between these two indices lies in their differences in weights. The unit value index uses a quantity-share weight, while the Feenstra price index uses a value-share weight. If the unit value index increases more than the exact price index, this indicates a rise in the quality index. This signifies that consumption patterns have shifted to more expensive goods within a quota group. This is because the quality index shows the rate of growth of import prices that does not result from a price increase in any particular product. By subtracting the Feenstra price index from the unit value index, the quality index eliminates the change in unit value that results from either (1) new products added to the quota group or (2) a price increase that leads to a
corresponding change in value. It is thus left with an index that only results from change in consumption patterns.

4.8 Do China’s Quotas Affect the Production of Other Exporters?

China holds a large market share of textiles imported to the US, around 20 percent in 2004 and 28 percent in 2005. The next largest textile exporter, Mexico, has a market share of only 8-9 percent, and other top exporters, India, Canada, Hong Kong, Korea, Honduras, and Vietnam, accounted for 5 percent or less of textile imports to the US. International trade theory holds that China’s large market share will affect the overall world price of goods: if China upgrades the quality of its products, this will lead to a higher price for lower-quality products because of a decrease in supply. This change in the price of low-quality goods leads to increased incentive for other nations without quota constraints to change their ratio of low quality to high-quality textile production as a result of an increase in the price of low quality goods to price of high quality goods.

The methodology will thus evaluate how the removal of China’s quotas leads to a change in quality, price, and quantity of goods in nations without constraints (like Mexico, Canada, Honduras, and Italy. This will be done using the methodology delineated above. It will use the value and quantity export data collected by the USITC for each of these four nations. However, it will use China’s quota groups in place of a Mexican or Canadian quota group (since such quota groups do not exist). The results will reveal whether China’s quality upgrading caused other nations to begin exporting the lower-quality (foregone) goods in China’s quota group. It will further reveal how the aftermath of the MFA will affect the production choices of these nations.
4.9 Regression Analysis: Two-Way Fixed Effects

The quality index alone tells us quite a bit about the overall change in exports based on quotas, but it does not reveal anything about the statistical significance of the finding. To do evaluate this, I construct a two-way fixed effects regression that will hold all other variables constant for the countries in question between two time periods. It will then evaluate the effect of the end of quotas on the change in quality and change in price for these countries. The same regression analysis will be used for two different dependent variables, \( F_{cg} \) and \( Q_{cg} \), which stand for price (from equation 12) and quality (from equation 14) respectively. Price and quality are both important measures for our model, but they ultimately reveal different attributes about the overall change in the makeup of exports. Thus, I use the same test for both dependent variables to measure the effect of different variables on each of these dependent attributes:

The fixed effect regression measures the effect of quotas on price:

\[
\ln F_{cg} = \alpha_{cg} + \delta_t + \beta' c_{cg} + \gamma' q_{cg} + \epsilon_{cg}
\]  

(15)

While the fixed effect regression measures the effect of quotas on quality:

\[
\ln Q_{cg} = \alpha_{cg} + \delta_t + \beta' c_{cg} + \gamma' q_{cg} + \epsilon_{cg}
\]  

(16)

These equations both use the same independent variable. \( \alpha_{cg} \) is the fixed effect for each country-quota group, while \( \delta_t \) is the time fixed effect. The variable \( \epsilon_{cg} \) stands for the error term. In addition, I construct two dummy variables, \( c_{cg} \) and \( q_{cg} \). The dummy variable \( c_{cg} \) takes the value 1 for all HTS numbers in quota groups that were binding (defined as a fill rate of greater than 90 percent) for the period prior to the end of 2004. Otherwise, it takes the value 0, indicating that that HTS number did not face a restrictive quota in 2004. The second dummy variable \( q_{cg} \) takes the value 1 if the quota group also had a binding
quota re-implemented in 2005. Otherwise, it takes the value 0. These dummy variables are each preceded by coefficients, $\beta^F$ and $\gamma^F$ respectively for the regression of price change.

The coefficient $\beta^F$ stands for the average reduced form effect of eliminating a binding quota on the price, using only variations within a specific quota group within a specific country over a period of time. It controls for the average price change in each year and evaluates how prices changed in quota-restricted categories (binding quota groups) versus prices in unconstrained categories, meaning that it is a difference-in-difference variation.

The coefficient $\gamma^F$ then measures how the reimplementation of quotas in 2005 affected goods in those quota groups relative to the baseline (which includes all textile categories). In 2005, a safeguard was enacted on 13 quota groups, meaning that 13 groups faced quotas in both 2004 and 2005. Of these, 11 groups faced binding quotas, and of these 11 groups, 9 faced binding quotas in both 2004 and 2005. These 9 categories serve as an indicator for how prices changed when binding quotas for 2004 were reenacted in 2005 relative to those categories that had been unconstrained in both years and relative to those categories that faced binding quotas in 2004 that were subsequently dropped in 2005. The total average effect of the reimplementation of binding quotas on price might be measured as $\gamma^F + \beta^F$. The coefficients for $\beta^Q$ and $\gamma^Q$ would measure the same effect as those of $\gamma^F$ and $\beta^F$, and they would be derived using the same process.

4.10 A Caveat

As noted in Harrigan and Barrows (2006), these regressions cannot measure with great precision the effect of quotas on the change in price and quality; this model is severely limited in that it only evaluates the impact of the US quotas, when the EU also eliminated many quantitative restrictions during the same time period. Likewise, the impact of Chinese quotas on
Mexican, Canadian, or any third-party production level and quality level may not be measured with great accuracy. The intent of the regression analysis, instead, is to statistically compare the change in price and quality for the quota group products with that of a larger baseline of all textile exports. By comparing the difference between these two groups, I establish that some factor is leading to a movement in price and quality in the quota-restrained categories that is not impacting the overall textile groups. I then extrapolate that such a difference must be due to the elimination of quota groups. This comparison of a treatment group with the overall baseline or control group allows us to establish variation between treatment and control groups of China, but also of the interesting cases of Canada, Mexico, Italy, and El Salvador.

5 Results

As outlined in the methodology section, this thesis isolates the characteristics of quality and price from a group of goods to determine how they change over time as a result of quantitative restrictions. The results section will first evaluate these findings from a non-statistical perspective, evaluating the weighted average of the change in quality, price, and quantity for both the treatment and control group of goods. This section will then analyze the results of the fixed effects regression that was explained in the methodology section. The results section will then use a series of histograms to evaluate the relative difference in distribution of quality and price changes for treatment versus control groups.

5.1 The Weighted Averages

After isolating the change in quality and price through a hedonic regression, the simplest presentation of these changes is by showing their average, as weighted by the value of imports in 2004 and 2005. Table 1, below, does this by dividing the data into three groups: bound quotas,
unbound quotas, and no quotas. The classification of “bound quota” isolates those goods that faced constraining restrictions (greater than 90 percent of the total quota filled) in 2004. Ex ante, one would expect this group to experience the greatest shift in price and quality between 2004 and 2005 as these restrictions are eliminated. The classification of “unbound quota” implies that these goods were subject to a quota, but the total number of exports from China did not come close to filling the total allowable quantity of exports. In theory, this group would be expected to have a smaller change between 2004 and 2005 that more closely mimics that of groups with no quotas.

As the title implies, the classification “no quotas” indicates that this was the control group that did not face a quota during 2004 and thus did not lead to quota-related modifications in production for these goods. In an ideal environment, all other factors would be held constant, causing the change in this set of goods to be around zero. However, this is not an ideal environment, and other factors often cause an overall change in the composition of textile exports. However, assuming that these other factors affect the treatment and control groups equally, I evaluate the difference between the “bound” and “no quota” groups as caused by the end of quantitative restrictions.

As one minor caveat prior to analysis, this weighted average is an aggregation and simplification of many data points and pieces of information. It works well as an overview of the results and how they are defined, but it contains many imperfections and simplifications of data. The fixed effects regression tables, while less immediately understandable, will provide a far stronger analysis of the general trends and statistical significance of the information below.
Table 1
Weighted Average: Change Between 2004 and 2005

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Price</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>355.1</td>
<td>604.7</td>
</tr>
<tr>
<td>Mexico</td>
<td>-8.7</td>
<td>-7.7</td>
</tr>
<tr>
<td>Honduras</td>
<td>2.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Italy</td>
<td>103.2</td>
<td>-14.7</td>
</tr>
<tr>
<td>El Salvador</td>
<td>-2.4</td>
<td>10.1</td>
</tr>
<tr>
<td>Canada</td>
<td>-17.0</td>
<td>-18.4</td>
</tr>
</tbody>
</table>

The change in quantity of imports for China, shown in Table 1, reveals a vast difference between the “bound” and “no quota” group (604.7 percent versus 15.3 percent change). This is expected, as it indicates that there was a much larger increase in quantity for those goods that had previously been constrained. Likewise, the price change for Chinese goods was far greater for the treatment (bound) group than for the control (no quota) group (around 36 percent greater). The results for the percent change in quality for Chinese firms likewise indicates that the average firm produced a good with a higher quality level under quota constraints: treatment groups had around a 9 percent decrease in quality as a result of the end of the MFA relative to the control group.

The results from other nations do not create nearly as clear of a picture of the change in quantity, quality, and price as those from China. However, comparing the control with the treatment group for these five nations, one can see a few general trends in Table 1. First, in Canada, Italy, Honduras, and Mexico, quantity decreased by far more in groups where quotas...
were removed. Conversely, El Salvador experienced an increase in quantity exported for those groups relative to others.

Price and quality information from Table 1 do not point to nearly as strong of a trend among this data. According to our theory, the change in prices for the treatment groups relative to the control groups should be greater and positive, but it is often negative, working against the theory. This could be because of the lack of trend, or it could be due to flaws in the aggregation system of this weighted average. Only the statistical tests will show which this is the case. The quality data reveals a slightly greater trend than that in the pricing data: quality changes for Mexico, Italy, and especially Canada, the quality change for the treatment group was less negative (or a larger positive) than that of the control group.

An interesting auxiliary result from this table reveals that the level of quality upgrading for Chinese firms was comparable in bound and unbound categories. The decrease in quality in unbound categories as a result of the end of the MFA was 10 percent (see Table 1), which is roughly equivalent to the 9.85 percent decrease in bound categories. This makes sense in relation to the production decisions of firms: they choose quality and quantity levels of their goods ex post, unsure as to whether a quota group will be bound in December of that year, or sooner.

Each firm must choose production levels without any information from other firms, though the category binds the aggregation of the production of all firms. Each profit-maximizing firm has two choices. First, it can either produce at a lower quality and higher quantity of good for that year, hoping that all other firms will reduce their level of production so that so that the quota will not become filled before December. This option carries with it the risk that other firms will do the same and the category will become filled prior to December, lowering the
potential profit of each individual firm that hoped to maximize the quantity of goods produced. The second option is to expect that the quota will become filled (not knowing the quantity chosen by other firms) and choose to quality upgrade starting in January to maximize the quota rents for a reduced quantity of goods. If all firms decide to do this, the quota group will indicate quality upgrading comparable to that of all other quota groups, regardless of whether the quota group was bound at the year’s end. The results of this study reveal this second option to have been the choice of Chinese firms during the MFA.

This finding that firms choose a level and quality of production that is comparable for bound and unbound categories allows us to estimate the level of quality upgrading that occurred in 2006 as a result of quota re-implementation. Though no quota groups became bound during 2006, quotas were re-implemented on 13 groups of goods during that time. These quotas served as a safeguard for US industries, and they targeted categories of goods that had been especially constraining prior to the end of the MFA. For this reason, I expect that the quality upgrading was greater in these specific categories than in the overall constrained groups under the MFA, and the reimplementation of these quotas might lead to an immediate movement towards quality-upgrading again. The weighted average data from this specific piece of the study are in Table 2 below:
Table 2
Weighted Average of Price, Quality, and Quantity Change for China, 2005-7

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quotas Unbound</td>
<td>19.97</td>
<td>2.98</td>
</tr>
<tr>
<td>Quotas Bound</td>
<td>N/A</td>
<td>4.18</td>
</tr>
<tr>
<td>No Quota</td>
<td>4.09</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quotas Unbound</td>
<td>13.88</td>
<td>-0.25</td>
</tr>
<tr>
<td>Quotas Bound</td>
<td>N/A</td>
<td>1.8</td>
</tr>
<tr>
<td>No Quota</td>
<td>0.61</td>
<td>-0.6</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quotas Unbound</td>
<td>-6.24</td>
<td>27.3</td>
</tr>
<tr>
<td>Quotas Bound</td>
<td>N/A</td>
<td>37.53</td>
</tr>
<tr>
<td>No Quota</td>
<td>24.24</td>
<td>17.19</td>
</tr>
</tbody>
</table>

The above table is divided by the years 2006 and 2007. For 2006, it simply shows the difference between unbound quota groups and groups without quotas for quality, quantity, and price change, excluding a category for bound quotas because there were none in this year. In 2007, the three familiar categories, for bound, unbound, and no quota reappear, with the unbound category in this year containing the same set of quota groups as in the previous year, 2006.

As you can see on the graph, the greatest change in quality, quantity, and price occurs in 2006 between the unbound group and the group without quotas. This movement towards quality upgrading of 13.8 percent is larger than the respective downgrade had been for the broad range of bound quota groups in 2004. The difference in quality change between the bound category and that without quotas in 2007 is also much smaller, 1.8 percent, indicating that the shift in production patterns for restricted firms occurred ex ante when the quotas were re-implemented rather than during the year when they again became “bound.”
5.2 The Fixed Effects Regression Estimates

The fixed effects regression provides a far more accurate interpretation of the overall impact of the quotas on the change in price and quality. These results are based on equations 15 and 16, which were defined below for change in price and change in quality (respectively):

\[
\ln F_{cgt} = \alpha_{cg} + \delta_t + \beta F_{cgt} + \gamma Q_{cgt} + \epsilon_{cgt}
\]

\[
\ln Q_{cgt} = \alpha_{cg} + \delta_t + \beta Q_{cgt} + \gamma Q_{cgt} + \epsilon_{cgt}
\]

To evaluate the change in quality, this regression uses the index of “change in quality” as the dependent variable. It holds all other factors constant and views this index as a panel of data by quota group and year.

The independent variables are “filled_04” and “filled_05,” which are both dummy variables taking the quantity 0 if there was no bound quota in that quota group in that year. The variable “filled_04” then takes the value 1 if that specific quota group was bound (restrictive) prior to the end of the MFA, so in the years 2002, 2003, or 2004, and it takes the value 0 for all quota groups after 2004. This variable measures to what extent a bound quota on a group of goods will cause that group to have an increase in quality.

The variable “filled_05” takes the value 1 for quota groups in 2005 that had a bound quota re-implemented for them. This measures, effectively, the result of quota reimplementation in 2005 in terms of quality changes. This second variable might be expected to have a very minor effect since the quotas were not redeployed under late in 2005, leaving over half of a year without any sort of restriction on China’s exports.

Similarly, I create a second regression with the dependent variable “change in price” and independent variables that remain the same that evaluates the impact of quotas on the relative
price of goods in quota-restricted categories. Overall results from both regressions are shown in Table 3 here:

### Table 3

**Fixed Effects Regression Estimates: 2004-2005**

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta_F$</td>
<td>Robust $t$-stat</td>
</tr>
<tr>
<td>China</td>
<td>.263****</td>
<td>14.55</td>
</tr>
<tr>
<td>Canada</td>
<td>-.340****</td>
<td>-9.19</td>
</tr>
<tr>
<td>Italy</td>
<td>-.326****</td>
<td>-8.18</td>
</tr>
<tr>
<td>Mexico</td>
<td>-.073*</td>
<td>-1.47</td>
</tr>
<tr>
<td>Honduras</td>
<td>-.041*</td>
<td>-1.45</td>
</tr>
<tr>
<td>El Salvador</td>
<td>-.110***</td>
<td>-2.04</td>
</tr>
</tbody>
</table>

*Note: * significant at 15%; ** significant at 90%; *** significant at 95%; **** significant at 1%

The coefficients $\beta_F$ and $\beta_Q$ show the coefficient on the independent variable filled_04, and the coefficients $\gamma_F$ and $\gamma_Q$ show the coefficients for filled_05. This analysis is effectively a two-tailed hypothesis test with the null hypothesis that the coefficients on filled_04 and filled_05 are equal to zero.

The table above shows that quantitative restrictions in prior to the end of the MFA led to an increase in quality of goods for China, and this upgrading led to a corresponding decrease in quality for nations that did not face similar restrictions. This is shown by the positive coefficient $\beta_Q$ for China and the negative coefficient for the five other nations for $\beta_Q$. The regression estimates the impact of quotas on China’s quality to be around 9 percent, which is equal to the roughly 9 percent change indicated by the weighted average. This number is statistically significant at the 99 percent level.
The other nations tested ranged in both the coefficient estimate and the statistical significance of the result. Canada and El Salvador both had strong, statistically significant coefficients for the 2004 quota, with a quality change from filled_04 estimated to be around 8 percent for Canada and 22 percent for El Salvador. Mexico also saw a large change in quality and price, with results that were statistically significant at the 90 and 85 percent level, respectively. This confirms the theoretical hypothesis that firms in other countries were producing lower-quality goods in response to the upgrade in quality by Chinese firms. However, it disproves the hypothesis that firms in developed nations would see a larger shift in quality than those in developing nations.

Italy, interestingly, showed a large, statistically significant change in price (32 percent), but this was not accompanied by a large change in quality (3 percent and statistically significant at the 85 percent level). This could be due to the nature of the textile industry in Italy. The Italian textile industry is long established and famous worldwide for the quality of its products. Its designers rank among the finest in the world, and its silks and other fine cloth is used to produce premium clothing worldwide. Thus, it follows that Italian firms would not respond immediately to the same market forces as those in other countries; one might make the case even that Italian textile products are horizontally differentiated from goods of a similar quality in other nations because of the success that Italian producing have had in branding their products by national origin. Consumers willingly pay more for Italian wool, silk, and leather just as they pay a premium for other name brand products because of the associated quality guarantee. For this reason, Italy would not see as large of a shift in the quality of its goods as a result of distorted prices on the world market.
Honduras is also an unusual case, though without an interesting or unusual associated hypothesis. The textile industry in Honduras is relatively young, having been largely established as a result of US trade preferences that eliminate tariffs on its textile exports. This nascent industry likely has a volatility in its export levels that does not allow us to perceive a strong reaction to the end of the MFA, though its estimated (statistically insignificant) coefficient does reveal a slight quality decline during the period of the MFA. Furthermore, as the theory advocated in Section III states, developing nations often are unable to produce at a high level of quality, and thus their reaction to changing prices is through a change in quantity levels.

The results of both $\gamma^p$ and $\gamma^q$ do not show a real trend. This confirms the hypothesis that firms decide the quality level of their goods ex ante as a result of an expected quota restriction. Firms in China in 2005 did not expect a quota to be implemented, and they flooded the market with low quality goods. A quota, then implemented in June, caused them to alter their production levels and quality levels. However, because of the volume of exports from January-June, this would overwhelm the results of the data from later in the year, making a trend difficult to detect. The fact that the other five countries are reacting to China’s change in export levels means that there would be a lag in their production change that would not be detected by this data or this econometric model. Further work into this subject might create a more sensitive model to determine if a lag effect did exist in the choice of production levels for countries like Canada and Mexico and by how much. However, the relative paucity of this sort of incident might make detection of such a trend somewhat difficult.

5.3 Regressions Estimate for the Re-implemented Quotas in 2006-7

When the ex ante safeguard quotas were implemented in 2006 on a select range of products, this would indicate that Chinese firms begin again to upgrade the quality of their goods
in response. I ran a regression for the 2006-7 quotas similar to the one for the 2004-5 quotas. However, rather than used the independent variables filled_04 and filled_05, this regression used the variables unbound_06 and bound_07 to estimate to what extent the implementation of new quotas (unbound in 2006 and bound in 2007) led to a change in the quality and price of goods subject to this constraint. The regression was run only on Chinese products, since, as mentioned in the theory section, an expected short-term quota implementation might or might not have an impact on the quality considerations of firms in other countries. That information is found in Table 4 below:

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta^F$</td>
<td>$\gamma^F$</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>Robust t-stat</td>
<td>Robust t-stat</td>
</tr>
<tr>
<td>China</td>
<td>0.207****</td>
<td>13.56</td>
</tr>
<tr>
<td></td>
<td>0.187****</td>
<td>4.18</td>
</tr>
</tbody>
</table>

Note: **** significant at 1%.

The coefficient $\beta^F$ is large, positive, and statistically significant for 2006, indicating that the unbound quota for 2006 led to a 20 percent increase in the price of goods in the treatment group. The statistically significant but smaller increase in 2007 (3 percent) signifies that the change for bound quotas in 2007 was smaller than the initial movement as a result of an indeterminately restrictive ex ante quota being applied. For quality as well, the movement in 2006 as a result of the unbound quota is large and statistically significant, implying that firms began upgrading the quality of goods subject to quotas immediately by roughly 18 percent. An insignificant level of quality upgrading occurred subsequently in 2007.
5.4 **Density Distributions of the Change in Quality and Price**

To further illustrate the difference between textile groups that faced restrictive quotas in 2004 and those that did not, I use a kernel density plot, which estimates the probability density function using the given data. I use the dependent variable from the fixed-effects regression equation (15 and 16) as the x-variable in the kernel density plot. In this case, the x-variable is either price or quality. Then, I divide the observations (individual textile categories) into two groups dependent on whether they faced a binding quota in 2004. I then plotted the distribution density of price or quality change using the kernel density command. This creates two density functions, one for the treatment group and the other for the control group, dependent on whether the category faced a quota in 2004.

5.4.1 **China**

These graphs (Figure 7) depict the difference between quota-restricted and unrestricted groups in their change in quality and price between 2004 and 2005. The distribution for restricted groups leans leftward because of the negative change in price and quality. The change for unrestricted groups has a normal distribution centered at zero percent change. This distribution function confirms the findings from Table 3 above that the percent change between 2004 and 2005 in both quality and price for the quota-constrained group was statistically very different from the percent change for the control group.
Figure 7

5.4.2 China 2006-2007

A similar density distribution holds true for the 2005-6 changes in quality and price for China as shown in Figure 8. This function may be predicted to be the reverse of that from Figure 7 because it reveals the change between the unconstrained period of 2005 and the constrained period of 2006. One would thus expect the percent change to be positive for price and quality in the constrained group relative to the unconstrained group, confirming the upgrade in quality. The change for unrestricted groups again has a normal distribution centered at zero percent change. In this case, the distribution for restricted groups leans rightward because of the relative quality upgrading for these groups as a result of the reimplementation of quotas, leading to a positive change in quality and price for these groups.
5.4.3 Canada

Canada’s distribution also reveals a smaller difference in the distribution of quality and price changes for restricted groups. This distribution in Figure 9 skews slightly rightward, indicating that between 2004 and 2005, there was a positive change in the quality and price of groups where China had previously faced restrictions: this indicates quality-upgrading.
5.4.4  Mexico

Mexico’s graphs (Figure 10) display a distribution for previously-restricted groups that is centered slightly above zero, indicating a small quality and price upgrade as a result of the end of the MFA. Mexico’s change for unrestricted groups also is not quite as strongly concentrated at zero, indicating an export industry with greater overall change in the quality of goods between years.

Figure 10
5.4.5 **Italy**

The distributions of price and quality change for Italy’s industries in Figure 11 show the far larger impact that the removal of quotas had on price than on quality. The distribution of price changes skews positive, reflecting the increase in price for Italy’s goods after the end of the MFA. However, the quality change distribution follows a far more normal distribution centered at zero. This confirms the fact that the MFA had little impact on the relative quality of Italy’s exports to the US.

![Figure 11](image)

5.4.6 **El Salvador**

As shown in Figure 12, El Salvador’s quality distribution skews positive, reflecting the relatively large change in quality seen in El Salvadoran exports. The price change, however, follows a more normal distribution, centered at zero. However, the density graph also shows a second distribution of price changes, centered at around 25 percent. This indicates that quota groups experienced either minimal change or a far greater change as a result of the end of the MFA.
5.4.7 Honduras

The Honduras density graphs in Figure 13 show less of a shift in price and quality changes as a result of the end of the MFA. In fact, the price change for Honduran exports has a smaller variance for restricted textile groups than for unrestricted groups. This is further indicative of the weak relationship between restrictions on Chinese goods and the production decisions of firms in Honduras exporting to US markets.

Figure 13
6 Conclusion

Having evaluated the concept of quality upgrading from a theoretical and statistical perspective, I now return to the container ships, heavy with textile goods, which steamed towards US markets in January of 2005. As we now know, these goods were of a lower quality than those produced in China only months before. As these cheap goods flooded US markets, US interest groups began lobbying the government to impose safeguard quotas on a limited number of textile goods, which occurred in June of that same year. Almost immediately, China filled its quotas for these goods, and its export levels contracted in these restricted groups. And, as manufacturers began producing goods for export in 2006 in restricted groups, they immediately began producing goods of a far higher quality than during their unrestrained period of 2005.

Furthermore, I can now paint a picture of factories in Canada, El Salvador, Mexico, and other countries around the world that continued production of goods in 2005, only to find the prices of low-quality goods falling and high-quality goods rising. The statistical evidence shows that these factories responded accordingly, reallocating resources to the production of higher-quality goods to take advantage of the rising prices.

This thesis differentiates between developed and developing nations in the theory that it advances, but the results do not necessarily show a difference between lower and higher-income nations in terms of change in price and quality. Further analysis at a firm level might allow for greater understanding of whether this differentiation is valid. Verhoogen already indicated that firms in Mexico that export to the US act more like developed-nation firms in the quality of their exports, their productivity levels, and the training of their workers. This theory might apply to other developing nations as well.
The difficulty of this study, and of all studies that evaluate adjustments on a macro level, is that they are only as good as its highly aggregated data. This thesis makes use of US import data by country and year, which can reveal general trends. However, these trends cannot answer fundamental questions raised by the results of this thesis. For example, this thesis reveals that while El Salvador saw a large increase in quality of goods exported after the end of the MFA, its regional neighbor, Honduras, did not. Only a more thorough analysis of the investment decisions and firm structure of the textile industry in these two countries will explain why that is the case.

Thus, this thesis has enhanced our understanding of quality and quotas in international trade. It has identified a fundamental trend created by asymmetric quotas that leads to distortions in the market, and it attempts to measure the level of distortion by country. Though the Multi-Fibre Agreement has ended, the restriction of textile imports has not; and to understand the consequences of these restrictions, which could remain for some time, we must continue to examine their secondary and tertiary effects.

7 References


