Political Economy and Welfare Implications of the U.S.-Mexican Tomato Agreement

A Thesis
Presented in Partial Fulfillment of the Requirements for the
Degree of Master of Science
with a
Major in Applied Economics
in the
College of Graduate Studies
University of Idaho
by
Elijah J. Kosse

Major Professor: Stephen Devadoss, Ph.D.
Committee Members: Jeffrey Luckstead, Ph.D.; John Foltz, Ph.D.
Department Administrator: Cathy Roheim, Ph.D.

December 2015

Authorization to Submit Thesis

This thesis of Elijah Kosse, submitted for the degree of Master of Science with a Major in Applied Economics and titled "Political Economy and Welfare Implications of the U.S.-Mexican Tomato Agreement," has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

Major Professor: ______________________________ Date: ____________
Stephen Devadoss, Ph.D.

Committee Members: ______________________________ Date: ____________
Jeff Luckstead, Ph.D.

______________________________ Date: ____________
John Foltz, Ph.D.

Department Administrator: ______________________________ Date: ____________
Cathy Roheim, Ph.D.

Abstract

The goals of this thesis are to a) illustrate the effects of the tomato agreement for the United States, Mexico, and Canada, b) examine the political economy elements of this dispute, and c) empirically estimate the welfare implications of the agreement.

Chapter two provides extensive details of the agreement along with a graphical analysis where each nation is considered a large country and has the ability to affect the regional price.

Chapter three enhances the "Trade Talk" model of Grossman and Helpman (1995) to develop a theoretical model which treats the minimum price for imported tomatoes from Mexico as a negotiated settlement between the United States and Mexico and includes lobbying contributions.

Chapter four conducts a welfare analysis of the 2013 Suspension Agreement in comparison to free trade and calculates the change in producer and consumer surplus. The model allows for substitution among tomato categories in response to price changes.

Elijah J. Kosse

Department of Agricultural Economics
University of Idaho
Work: (208) 885-6264, Home: (208) 627-8239;
barr2482@vandals.uidaho.edu

EDUCATION

M.S. in Applied Economics	University of Idaho, Moscow, ID 83844
December, 2015	*Thesis*: Political Economy and Welfare Implications of the U.S.-Mexican Tomato Agreement
Master's Committee	Stephen Devadoss (adviser)
B.A. *magna cum laude*	University of Idaho, Moscow, ID 83844
2013	Major in Economics

PUBLICATIONS

1. Kosse, E., Devadoss, S., & Luckstead, J. (2014). US-Mexico tomato dispute. *Journal of International Trade Law and Policy*, 13(2), 167-184.
2. Kosse, E. and Devadoss, S., Welfare analysis of the U.S.-Mexican tomato Suspension Agreement, *Journal of Agricultural and Resource Economics* (Revised and Resubmitted).
3. Devadoss, S. and Kosse, E., Political Economy of the U.S.-Mexican Tomato Suspension Agreement, *Journal of Agricultural Economics* (In Review).

TEACHING EXPERIENCE

University of Idaho, Department of Agricultural Economics

Instructor	*Managerial Economics*
Spring, 2015; Spring, 2016	Taught a 300-level course on the theory and application of microeconomic concepts to optimizing managerial decisions. Aided students by providing optional remedial math and economics lessons.
Teaching Assistant	*Agricultural Markets in a Global Economy*

Fall, 2014; Fall, 2015	Assisted with teaching activities for an upper-division course in international trade. Graded assignments and quizzes in a timely matter and tutored students struggling with the course material.
Teaching Assistant	*International Trade and Policy*
Fall, 2014; Spring, 2016	Assisted with teaching activities for a Master's level course on trade by grading assignments and being available to help students.

RESEARCH EXPERIENCE

University of Idaho, Department of Agricultural Economics

Research Assistant	Performed research under Dr. Stephen Devadoss on the profitability of various woody biomass-based biofuels in the Inland Northwest. Funding provided by grant #2012-00948 of the Agriculture and Food Research Initiative.
Summer, 2013-present	Additional research conducted in the U.S. tomato dispute with Mexico, culminating in three journal articles. Also assisted Dr. Devadoss with various other research in international trade, with responsibilities including data collection and editing.

PRESENTATIONS and COMPETITIONS

April 2014. *U.S.-Mexico Tomato Dispute*. University of Idaho Innovation Showcase, Moscow, ID.

June 2015. *Climate Control: The new face of sustainable agriculture*. Student Case Study Competition. International Food and Agribusiness Management (IFAMA) annual meeting, Minneapolis-St. Paul, MN.

July 2015. *Bale Breaker Brewery and Loftus Ranches: What is the right "hop" into the future?* Semi-Finalist in AEM/Graduate Student Section Case Study Competition. AAEA/WAEA annual meeting, San Francisco, CA.

Acknowledgements

I am profoundly grateful for my chair and major professor **Dr. Stephen Devadoss**, who spent countless hours of his time helping me develop the models used in this thesis and assisting me academically. His work ethic and selfless spirit were inspiring to me. His teaching ability is extraordinary and I hope to have just a small portion of that talent in my future endeavors. I truly could not have finished this thesis without him.

I am also grateful to my thesis committee member Dr. Jeff Luckstead for assisting me with computer issues as well as his help reviewing my thesis as well as articles for submission. In addition, I am grateful for his help with various technological glitches. I am thankful to Dr. John Foltz for serving on my committee and reviewing the thesis.

Finally, I am thankful to have been a part of the Agriculture and Food Research Initiative: Socioeconomic Impacts of Wood-Based Biofuels Development Strategies on Northern Rocky Mountain Communities in the Northwest, Grant #2012-00948. While my thesis does not cover the same topic as the grant, this project enabled me to complete graduate school by providing the necessary funding.

Table of Contents

List of Tables

List of Figures

CHAPTER 1: Introduction to the U.S.-Mexican Agreement

1.1 Tomato Production, Trade, and the Suspension Agreement

The U.S.-Mexican "Great Tomato War" originally began as a trade dispute between tomato growers in a few states of Mexico (predominantly Sinaloa and Nayarit) and in Florida. Growers in these states supply tomatoes for the U.S. winter market. For many decades, Florida growers have claimed that Mexico is dumping its tomatoes in the U.S. market and called for antidumping investigations against Mexico as far back as 1978 (Baylis and Perloff, 2010). Furthermore, the North American Free Trade Agreement (NAFTA), which reduced tariff rates, exacerbated the Florida grower's claims of Mexican dumping. As a result, Florida asked the U.S. government to initiate an antidumping investigation. However, the U.S. and Mexican governments signed an agreement in 1996 with the purpose of suspending the antidumping investigation in return for instituting a higher import price. Thus, this agreement was termed the Suspension Agreement, which sets a minimum price for U.S. tomato imports from Mexico. Even though this dispute pits growers in Florida against growers in Mexico, the effects of the agreement are felt throughout North America. While the Suspension Agreement originally included only tomatoes grown in the winter season, in 1998 it was expanded to include summer tomatoes,[1] which are largely grown in California (Baylis and Perloff, 2010).

In 2012, after heavy lobbying from Florida growers who argued that Mexico continued to dump tomatoes on the U.S. market, the U.S. government decided to end the Suspension Agreement, which had been in effect in various forms for 16 years. In response, Mexico threatened to institute $1.9 billion worth of retaliatory tariffs. However, instead of escalating this trade war, both countries ultimately signed a new agreement which increased the minimum price for imported tomatoes (Wingfield and Cattan, 2012). The new agreement raised the minimum price by nearly ten cents per pound for winter field tomatoes and instituted new price minimums for speciality tomatoes (i.e., cherry & grape tomatoes) and tomatoes grown in greenhouses, the preferred method of production for Mexican farmers (ERS, 2015).

[1] According to the USDA (2014), the winter growing season is from October through May, and the summer growing season is from June to September.

Tomatoes are an important commodity for each of the NAFTA countries (the United States, Mexico, and Canada) and over 98.5% of all North American fresh tomato trade occurs within the region (ERS, 2015). U.S. tomato production ranks second in the world, trailing only China, while Mexico ranks tenth. In 2008, the United States and Mexico produced 32.65 billion and 5.91 billion pounds, respectively (FAOstat, 2015). Tomatoes produced are sold for two distinct end uses: fresh consumption and processing tomatoes. Two states – Florida and California – produce between 66% and 75% of the U.S. fresh-market tomatoes. Florida, with its subtropical and tropical weather, specializes in winter tomatoes while California grows summer tomatoes. In the winter months, Florida supplies about 90% of domestically grown fresh market tomatoes (ERSa, 2012). In 2010, the average price for Florida's fresh-tomatoes was $72.50 per cubic weight while California's average price was only $33.10. Since winter is the off-peak period, Floridian farmers receive higher prices for their tomatoes. Meanwhile, Canada produces a smaller quantity (1.6 billion pounds) and specializes in greenhouse tomatoes (Statistics-Canada, 2015). Canada is a net exporter in the summer season but a net importer in the winter season.

Of the roughly 32 billion pounds of tomatoes produced in the United States, about 80% are tomatoes grown for the processing sector, where the United States is a net exporter of tomato paste, sauce, and ketchup (ERS, 2015). Approximately 96% of U.S. processing tomatoes are grown in California (ERSa, 2012). While processed tomatoes dominate in total weight, fresh-market tomatoes earn higher returns due to higher prices (Boriss and Brunke, 2005), which accounts for the large price difference between California and Florida tomatoes. The Baja California state in Mexico also grows summer tomatoes, which compete with California-grown tomatoes in the U.S. market (USDA, 2013a). The main competition for Florida tomatoes comes from Mexican tomatoes, mostly from the Sinaloa state. Since Mexican tomato exports peak in winter, they reduce the prices Floridian producers would receive without competition (Asci et al., 2013).

For Mexico, tomatoes are the second highest valued agricultural export, behind beer

(Baylis, 2003), reaching $1.8 billion annually and supporting around 350,000 jobs in Mexico (Strom and Malkin, 2013). Mexico exports approximately 46% of its tomatoes, with over 90% going to the United States (Cook and Calvin, 2005). In 2000, imports from Mexico made up 95% of all tomato imports to the United States. Between 2011 and 2014, this percentage declined to 89.6% due to increased tomato exports from Canada, which now comprise 10% of total U.S. imports and 16% of greenhouse tomato imports. (ERS, 2015). Unlike the United States, Mexico does not differentiate between fresh and processing tomatoes. About 10% of tomatoes that cannot be sold on the fresh tomato market are processed into tomato paste, juice, sauce, etc. (Baylis and Perloff, 2010).

Mexico produces both greenhouse and field-grown tomatoes. In 2013, greenhouse tomato production was 47% and field tomato production was 53%, with the majority of greenhouse tomatoes being exported to the United States (ERS, 2015). Unlike Canada, Mexico's greenhouse tomatoes are primarily grown during the winter season. Though the production costs for greenhouse tomatoes are higher, greenhouse technology is 3-20 times more productive than field technology (Asci et al., 2013). The combination of large numbers of greenhouses, better soil conditions for Mexican field-grown tomatoes, and a more conducive climate causes Mexico to have a comparative advantage in the production of tomatoes for the winter market. Increased imports from Mexico have changed many elements of the tomato market, which now account for about 33% to 50% of all fresh-market tomatoes consumed in the United States, up from 20% in the 1990s. Since the signing of NAFTA, Florida has seen its value of tomato sales drop by 50%, from $500 million to $250 million, though there is substantial debate regarding NAFTA's role in this decline (Strom and Malkin, 2013).

Canada has capitalized on U.S. trade restrictions of tomato imports from Mexico and the resulting higher U.S. price by specializing in greenhouse tomatoes. Canada is the largest producer of greenhouse tomatoes in North America during the summer season. In 2003, Canada switched from being a net importer of tomatoes to a net exporter. The United States is still Canada's primary trading partner and imports approximately 10% of its tomatoes from

Canada (ERS, 2015). For a short period of time in 2001-2002, Canadian greenhouse tomatoes were subject to antidumping duties. The antidumping duties ceased after the U.S. government determined that there was no substantial injury to U.S. producers (USITC, 2013).

Because increased Mexican exports impact Florida the most, their producers lead the fight to restrict Mexican imports. Nonetheless, producers in California also lobby so that they can secure a higher price for their tomatoes. While producers from Florida would like to see imports decline, consumer groups prefer the lower prices arising from increased competition. In addition, over 370 businesses, including Wal-Mart and many tomato processors, sided with Mexico in 2012 when the U.S. Department of Commerce (USDOC) contemplated withdrawal from the Suspension Agreement (Strom, 2013). However, Florida's growers have a strong lobby and the state is a swing-state in U.S. elections, which makes government officials sensitive to their demands for import restrictions (Robins, 2013). Despite the new Suspension Agreement raising the minimum price by nearly ten cents, many producers in Florida are still not satisfied and continue to lobby for more restrictions (Sullivan, 2013).

Despite numerous threats by both countries to withdraw from this minimum import price policy, with the United States claiming the minimum price is too low and Mexico asserting the price is too high, the agreement has remained in effect in various forms for over 18 years. While Mexican producers would prefer free trade and Florida producers would prefer antidumping duties be levied against Mexico, the Suspension Agreement is still in effect due to the threat of retaliation by both countries. Since the Suspension Agreement is equivalent to a Voluntary Export Restraint, even though Mexican producers lose from the agreement, their loss is partially mitigated by quota revenues they receive. If antidumping duties were instituted, Mexican producers would lose those revenues. From the U.S. growers' perspective (and, by extension, the United States government), even though they would prefer that Mexico face antidumping duties, they could potentially "lose" the antidumping investigation, which would lead to free trade, the worst possible outcome for U.S. growers. The Suspension Agreement can thus be seen as an imperfect compromise between the United

States and Mexico.

1.2 Overview of Thesis

The Suspension Agreement for tomatoes has important trade implications for price, production, consumption, and welfare, which provides a fertile ground for economic study. Many different elements are involved in the Suspension Agreement: political economy and special interest group lobbying, reduced trade between Mexico and the United States, diversionary effects since Canada is not subject to the minimum price, and welfare redistribution among consumers and producers in all three countries. This thesis examines three different yet related aspects of the Suspension Agreement, including a graphical analysis of the Suspension Agreement and its effects on the United States, Mexico, and Canada, an investigation of the role of conflicting lobby groups and related aspects of the political economy, and a theoretical and empirical analysis of the welfare effects on the United States and Canada. The rest of the thesis is organized as follows.

Chapter two provides extensive details of the Suspension Agreement. The goal of this chapter is to graphically illustrate the effects of this agreement on prices, quantities, trade flows, and producer and consumer welfare using a three-country trade model of the United States, Mexico, and Canada. Each nation is considered a large country and has the ability to effect the regional price. For field tomatoes, Canada is a net importer due to their short growing season, and it is a net exporter of greenhouse and cherry & grape tomatoes. Consequently, graphical analysis involves two cases: first, Canada as an importer (field tomatoes) and second, Canada as an exporter (greenhouse and cherry & grape tomatoes). In both cases, Mexico is an exporter and the United States is an importer. When Canada imports, only the U.S. price rises while Mexican and Canadian prices fall. When Canada exports, both the U.S. and Canadian prices rise while the Mexican price falls. In both cases, the United States experiences a rise in producer surplus while consumer surplus falls. Meanwhile, since the Mexican price falls, producers surplus falls and consumer surplus increases. In addition, Mexican producers receive quota revenues for tomatoes sold in the United States thus the total effect on Mexican producers is ambiguous. When Canada is an importer (exporter), producers lose (gain) and consumers benefit (lose).

Chapter three builds upon the "Trade Talk" model of Grossman and Helpman (1995) to develop a theoretical model which treats the minimum price as a negotiated settlement between the United States and Mexico. This approach maximizes the joint welfare of each government's objection function. The objective function includes both contributions from special-interest lobbying as well as consumer welfare. The goals are to ascertain the economic factors and special-interest lobbying effects in determining the minimum import price for Mexican tomatoes. This is accomplished by adding multiple elements to the trade talk model, namely 1) including processed tomatoes which use fresh tomatoes as an intermediate input, 2) solving for the optimal price minimum rather than the optimal tariff, 3) utilizing large country assumptions, 4) including quota revenues that accrue to Mexican producers, and 5) incorporating the role of Canadian imports/exports.

One interesting element included in the model is the role of competing interests in lobbying by different industries, particularly the conflict between tomato growers and processors that use tomatoes as an intermediate input. Previous literature primarily discusses the role Florida producers played in the development and continued use of the Suspension Agreement. However, other groups –California growers and U.S. tomato processors– also lobby. In addition, imports/exports from Canada are also important in the development of trade policy. The effects of these factors are included in the model, thus creating a rich model that includes important elements of the dispute between the United States and Mexico.

The fourth chapter conducts a welfare analysis of the 2013 Suspension Agreement and calculates the change in producer surplus and consumer surplus compared to free trade. While the Suspension Agreement only applies for imported tomatoes from Mexico to the United States, the higher price in the United States due to the minimum price influences Canada's supply and exports/imports of tomatoes. Three categories of tomatoes are analyzed– field, greenhouse, and cherry & grape tomatoes. These categories closely correspond to the new tomato price categories established in the 2013 Suspension Agreement. The model allows for substitution among tomato categories in response to price changes. The goal of chapter four is to analyze the effects of the Suspension Agreement in comparison to free trade on prices, production, consumption, trade flows, and welfare in all three countries due to the price minimum on imports from Mexico.

The concluding chapter presents the key findings of this thesis and the implications. This thesis covers all important aspects of the Suspension Agreement, from historical and legal elements to the role of lobbying and its effects on producers and consumers throughout the region. As a result, we develop a rich understanding of the causes and effects of the Suspension Agreement. We show not only the effects on fresh tomatoes, the target industry, but also on processed tomatoes and Canada, which is not a signatory of the Suspension Agreement. This broad view captures both the unseen factors influencing the price minimum as well as the unintended consequences of the Suspension Agreement.

CHAPTER 2: History and Economic Analysis of the Suspension Agreement

2.1 Introduction and Overview

The United States rarely suspends antidumping investigations and the tomato Suspension Agreement is both the longest-lasting and most well-known of this unusual trade policy. Currently, only a few antidumping Suspension Agreements exist, including steel plates from Russia and the Ukraine, lemon juice from Mexico and Argentina, and uranium from the Ukraine. In each case, the United States either sets import limits or institutes a price minimum (International Trade Administration (ITAc, 2013)). Despite their rarity, Suspension Agreements have important welfare implications, not only for the countries involved but also for their trade partners. This chapter develops a conceptual analysis illustrating the welfare effects of the Suspension Agreement for both producers and consumers in the United States, Mexico, and Canada.

Tomatoes are of particular interest because they are a key agricultural export for Mexico[2], thus the Suspension Agreement has a substantial effect on Mexican producers. For the United States, the agreement was originally designed primarily to protect Floridian producers by setting a price floor. Therefore, the Suspension Agreement raises important questions regarding the role of political economy in trade negotiations, which will be covered in detail in chapter 3.

The objectives of this chapter are to (1) discuss the history of and economic debate around the tomato dispute, (2) investigate the role of political considerations in the Suspension Agreement by analyzing relevant trade laws, (3) cover changes in the tomato trade over recent decades and the role of NAFTA, and (4) develop a conceptual model to illustrate the welfare effects of the minimum price on Mexican tomato imports. While the United States primarily considers domestic producer welfare when ruling on trade disputes, trade policies affect both producers and consumers in each country. Unlike many trade policies, the Suspension Agreement does not generate government revenues. However, it does create (export quota)

[2] The leading Mexican agricultural export is beer, followed by tomatoes.

rents for producers in the exporting nation (Mexico) which are paid by the importing country (the United States). Since Canada is also an important trading partner, this paper examines these effects for all three affected countries.

The rest of this chapter is organized as follows: The next section discusses the relevant history of the dispute. Section 2 covers different laws regarding trade protection in the United States and their relevance to the tomato dispute. Section 3 explores the ongoing debate regarding the degree of and existence of dumping by Mexico, including the role of NAFTA and the peso devaluation. Section 4 presents an investigation into the role of the Suspension Agreement on trade and welfare. Section 5 develops the theoretical model to capture the welfare effects of the minimum price for both Mexico and the United States. Finally, section 6 presents implications of the agreement as well as concluding remarks.

2.2 Recent History of the Tomato Dispute

While the “Great Tomato War” is generally regarded as a result of NAFTA, it has roots much earlier. The first tomato dispute in the United States occurred in the late 1800s when the U.S. government imposed a 10% tariff on imported vegetables (including tomatoes) but not fruit. Three domestic importers sued the U.S. government, claiming that tomatoes should not have tariffs imposed because they are classified as a fruit in botany. In 1893, the Supreme Court ruled against the importers and treated tomatoes as a vegetable (ARS, 2015).

Before 1960, Florida’s main competition for winter tomatoes came from Cuba. After the embargo, Mexico began to produce more tomatoes to export to the United States. The first sign of the U.S.-Mexican tomato dispute occurred in 1968-69, when Florida producers pushed legislation through Congress to set larger size requirements for vine-ripened tomatoes, similar to those of mature green tomatoes grown in Florida. This legislation primarily affected Mexican tomatoes and reduced the supply of imported tomatoes, which aided the Floridian producers. However, the legislation was overturned in 1975. Afterwards, Florida producers lobbied for mandatory country-of-origin labeling. These attempts failed at the Federal level but the state of Florida did pass a law requiring country-of-origin labeling for fresh produce.

While Florida growers' lobbying efforts generally failed, Mexico did agree to a voluntary export quota (Johnecheck et al., 2010). Nevertheless, in 1978, Florida initiated an antidumping complaint with the USDOC against Mexico, claiming Mexico was selling at prices below fair market value during the winter months. The U.S. International Trade Commission (USITC) failed to find evidence of dumping and the case was dropped, but tension between Floridian and Mexican producers continued (Baylis, 2003).

In the 1980s, the Mexican government showed increased willingness to unilaterally open its economy. In 1983, they eliminated import license requirements, official import prices, and quantitative restrictions. Mexico then signed the General Agreements on Trade and Tariffs (GATT) in 1986. The following year, the United States, Mexico, and Canada started negotiations to liberalize trade between the three countries, which culminated in 1994 with the signing of NAFTA. Under that agreement, summer tomato tariffs were to be phased out over a 4 year period ending in 1998 while tariffs on winter and spring tomatoes were to be phased out over a 9 year period ending in 2003. However, tomatoes were treated as a sensitive product in NAFTA negotiations, which allowed the U.S. government to institute a seasonal tariff-rate quota for winter and spring tomatoes as a safeguard measure to prevent surges in tomato imports. The quota was relaxed by 3% each year and finally eliminated in 2003. Any tomatoes sold in excess of the quota amount were charged a higher tariff rate (Zahniser et al., 2000). Between 1994 and 2003, imports exceeded the quota by more than 40% in all but one year. Since 1999, only tomatoes imported from Mexico in excess of the quota had a tariff levied on them, a rate that was only 2.29% in 1999 (Padilla-Bernal et al., 2000). Thus, there was no tariff imposed on in-quota imports from Mexico after 1998.

At the very beginning of NAFTA, in 1994, imports from Mexico actually declined 6.4% in volume but the year after, imports increased substantially by 57.32% in volume from the previous year. The Mexican peso was also devalued in December of 1994, going from 3.5 to 5.54 pesos per dollar in just two days. This devaluation made imports more attractive to U.S. consumers. There are still questions regarding the degree to which NAFTA or the devaluation of the peso had in augmenting tomato imports. In addition to NAFTA and the peso devaluation, Mexican exports also expanded rapidly in the mid-1990s due to new technology which extended the shelf life of vine-ripened tomatoes, increased demand for off-season produce, and reduced shipping costs (Padilla-Bernal et al., 2000). All of these factors led to an increase in exports from Mexico by 138% between 1993 and 2000 (Boriss and Brunke, 2005).

In response to the rapid surge in imports, Florida and a few other southern states filed another antidumping petition in late March of 1996. The petition was "to request initiation of an antidumping duty investigation of fresh tomatoes imported from Mexico which are being, or are likely to be, sold in the United States at less than fair value" (Gunter and Ames, 2001). Tomato imports from Mexico increased 93% from 1992 to 1996 while U.S. production declined by 21% over the same period. This supply increase led to a price decline from $0.36 per lb. to $0.29 per lb. by 1996 (Baylis, 2003).

In addition to the antidumping investigation, U.S. producers, primarily from Florida, made several trade protection requests to the U.S. Congress and Administration, including new regulations for labeling Mexican tomatoes, weekly administration of the tomato quota, an increase in sanitary inspections, a safeguard investigation, and a change in the definition of a "national industry" (Almonte-Alvarez et al., 2003). Florida growers sent two separate claims to the USITC which rejected both of their claims (Sanger, 2013).

After failing to get both the USITC and Congress to act, the Florida growers sent a complaint to the USDOC, which determined that Mexico was selling below fair market value. This was the first step in implementing antidumping duties against Mexico. USDOC then sent their report to the USITC, as required by law, which also investigated. The USITC voted 4-1 against the claim, determining that Mexican tomatoes were not causing material harm to U.S. producers on the whole, only Floridian producers (VanSickle et al., 2003).

On December 1, 1996, before the final USITC report came out, the USDOC and the Mexican government reached an agreement and instituted a minimum price of $5.17 per 25 lb. carton (20.68 cents per lb.) for imported Mexican tomatoes. In return, the United States agreed to suspend its antidumping investigation. The deal originally encompassed all Mexican tomatoes, regardless of the season. However, in 1998, two separate price floors were instituted. The price of winter tomatoes could not fall below $5.27 per 25 lb. carton (21.08 cents per lb.), up ten cents per 25 lb. from the previous agreement. Summer tomatoes could not fall below $4.30 per 25 lb. carton (17.2 cents per lb.). Since the reference price did not take into account transportation costs, the difference between Florida's price and the Cost, Insurance and Freight (CIF) import price was miniscule (Baylis and Perloff, 2010).

In 2002, the agreement was repealed when several Mexican tomato shippers refused to resign the agreement. The antidumping investigation was set to begin again (Baylis, 2003). However, a new agreement was signed in December, 2002. Under this agreement, the price floor was raised to 21.69 cents per lb. for winter tomatoes and remained unchanged for summer tomatoes. A similar process occurred in 2008, with Mexico ultimately signing the new agreement (Baylis and Perloff, 2010). The price minimum remained unchanged in the 2008 agreement (ITA, 2011).

In 2012, growers in Florida asked the U.S. government to dissolve the Suspension Agreement and reinstate the antidumping investigation. Mexico offered to increase the minimum price by 18-25%, depending on the type of tomato, and force all growers to abide by the new minimum price. In the past, only 85% of the growers had to sign onto the agreement, a feature common to Suspension Agreements (Strom and Malkin, 2013). A trade war between the U.S. and Mexico seemed very likely, but a new agreement was reached in March of 2013 which raised the minimum price by nearly ten cents per pound for winter field tomatoes and instituted new price minimums for greenhouse tomatoes and specialty tomatoes (i.e., cherry & grape). Instead of one category for all fresh tomatoes, there are now four (field-grown, greenhouse-grown, loose specialty, and packed specialty tomatoes). Since greenhouse and cherry & grape tomatoes have a higher value, the previous Suspension Agreement was non-binding for those categories. See Table 1 for the new reference prices, with the speciality tomato categories combined.

Mexico assured the United States that it will increase the enforcement of the agreement. All domestically produced tomatoes sold in Mexico will be labeled “Not for Export to the U.S.” in order to prevent tomatoes from being smuggled into the United States and sold at a price less than the mandatory minimum (ITAa, 2013). As in previous agreements, only fresh tomatoes are covered, not tomatoes designated for processing. On May 1, 2013, the Florida Tomato Exchange filed suit against the USITC, challenging the new Suspension Agreement (Ohlemeier, 2013). Despite the new Suspension Agreement raising the minimum price by around ten cents per pound for winter field tomatoes, many producers in Florida are still not satisfied and continue to lobby for more restrictions (Sullivan, 2013).

2.3 U.S. Trade Laws and Politics

Two U.S. agencies, the USDOC and the USITC, both investigate allegations of dumping. The president appoints the Secretary of Commerce, subject to approval by the Senate, while the cherry & grape is considered an independent, quasi-judicial agency. Their primary roles come from Title VII of the Tariff Act of 1930 (amended in 1979). Under this law, U.S. industries may petition the USDOC and USITC for relief from imports that are sold in the United States either at less than fair value (commonly referred to as dumping), or that receive high subsidies by foreign governments. Dumping and subsidies are considered unfair trade practices by both agencies (USITC, 2013). Section 734(c) of the Tariff Act of 1934 calls for the “complete elimination of the injurious effects of exports to the United States” (ITAa, 2013).

The USITC and the USDOC each have roles in investigating dumping petitions, but they cover different aspects of the claims. The USDOC first determines whether the alleged dumping and subsidies by foreign nations are actually occurring and, second, the margins of the dumping. In contrast, the USITC determines whether the U.S. industry is “materially injured or threatened with material injury” by reason of the imports under investigation. If the agencies decide that dumping exists and that it is harming a U.S. industry, then USDOC will issue an antidumping duty order to offset the dumping or a countervailing duty order to offset the subsidy (USITC, 2013). The USITC does not have to find unfair trade practices, only injury or likely injury to the U.S. industry.

The USITC's responsibilities also stem from section 201 of the Trade Act of 1974, which states that if the USITC determines that an item is being imported into the United States in large enough quantities to be a "substantial cause of serious injury or threat of serious injury to a domestic industry producing a like or directly competitive product," it recommends that the president institute a relief measure, generally in the form of antidumping or countervailing duties (CVD). In 1988, loss of market share was added as sufficient evidence of substantial injury (Gunter and Ames, 2001). Relief through duties is for the short term, the purpose of which is to allow the affected industry time to adjust to the increased competition. The United States has several options available, including imposing CVD, tariffs, tariff-rate quotas, quotas, or negotiation of agreements with foreign countries.

Alternatively, the United States can enter into a Suspension Agreement, like in the tomato case. If this occurs, investigations into dumping are suspended and different means of protection can be enacted. The Suspension Agreement must eliminate at least 85% of the alleged dumping (ITAc, 2013). These agreements are quite rare, with the tomato agreement being the longest-lasting, as previously discussed.

Historically, to prove dumping, the industry requesting relief had to show the foreign country engaged in predatory pricing, or deliberately priced below production costs in order to capture the market. Antidumping laws were merely an extension of antitrust laws. Now, dumping includes selling at a lower price in the United States than in other countries or pricing below average total costs, even though it is legal for U.S. companies to price below average total costs in the domestic and export markets (Gould and Gruben, 1994). In the Suspension Agreement signed between Mexico and the United States, the governments were permitted to make arrangements to set a minimum price. However, if U.S. and Mexican firms in the tomato supply chain tried to set a price floor, it would be considered collusion and the firms would be acting contrary to U.S. antitrust laws (Almonte-Alvarez et al., 2003).

In addition to laws, politics also enters the conversation with regards to trade in tomatoes. During the 1996 dispute, the U.S. Secretary of Commerce Mickey Kantor stated: “The agreement will provide strong relief to the tomato growers in Florida and other states and help preserve jobs in the industry. Mexican growers will have continued access to the U.S. market, but only on fair terms.” However, an official in the Clinton Administration offered a different perspective: “The math was pretty simple, Florida has 25 electoral votes, and Mexico doesn’t.” The agreement was signed during the presidential campaign between Bob Dole and Bill Clinton. Mexico’s Commerce and Interior Secretary expressed concerns about the U.S. handling of the tomato dispute, saying that, “Mexico has said that the investigation is incompatible with the disciplines established in the World Trade Organization and the North American Free Trade Agreement. As a result, Mexico reserves its right to continue using legal instruments available in these agreements to defend the interests of its exporters” (Sanger, 2013).

2.4 Ongoing Dispute: Level of Dumping

During the investigation in 1996, USDOC estimated that dumping margins ranged from 4.16% to 188.45%. However, Mexico has consistently denied any dumping of tomatoes onto the U.S. market. According to Lance Jungmeyer, head of the Fresh Produce Association of the Americas which represents the Mexican tomato industry, "It would be impossible to sustain hundreds perhaps thousands of Mexican tomato companies for years on end selling below their cost. They wouldn’t be able to do that" (Robins, 2013).

Highly perishable agricultural commodities pose unique difficulties not present in non-perishable commodities when determining if dumping exists. Schmitz et al. (1981) researched those and uncovered flaws in the USDOC and USITC processes. By considering any sales below costs of production as evidence of dumping, a country (like Mexico) can be found to be dumping even when the U.S. growers do not change their production practices regardless of imports entering the U.S. market and even though U.S. growers are allowed to sell below their own costs of production. Due to the perishable nature of produce, growers frequently have to sell below the cost of production or risk even higher losses. Schmitz cited the case of California lettuce, which has only miniscule competition from imports, where growers sell below costs of production for all or a portion of sales during certain periods to avoid greater losses. He also found that from 1968-1978, some or all Floridian tomatoes were sold below costs of production 50.8% of the time. In conclusion, Schmidt recommended that highly perishable agricultural exports either be exempt from antidumping suits or that economists develop new models for perishable agricultural imports which incorporate normal business practices rather than only looking at cost of production.

Another potential problem in antidumping investigations, including the tomato investigation, is that only current exchange rates are utilized to determine fair or normal prices, instead of lagging the effects of changes in the exchange rate, which would provide enough time for producers to properly account for sustained exchange rate trends. Raafat and Salehizadeh (2002) concluded that foreign producers have to raise their prices when the dollar increases in value. This results in conditions opposite to dumping because products are imported to the U.S. above local prices. As a result, Raafat and Salehizadeh believed that the increase in antidumping petitions serve as protectionist tools.

The degree to which NAFTA affected the U.S. tomato industry is still hotly contested. Nzaku and Houston (2009) analyzed consumer demand for vegetables and found that NAFTA had no effect on consumer expenditures. This is likely a result of minimal competition from non-NAFTA countries in fresh vegetables. Nearly all vegetables sold in the United States are either grown domestically or produced in either Mexico or Canada. They found that imported tomatoes have an own price elasticity of -0.5317, compared to -0.4505 for domestically produced tomatoes and concluded that domestic and foreign tomatoes are substitutes. The authors recommended that tomato imports should be discouraged through price incentives and tariffs. The peso devaluation occurred very close to the signing of NAFTA, leading many Florida growers to blame NAFTA for the surge in imports. However, an estimated 87% of the increase in tomato imports in 1996 was caused by the 1994-1995 peso devaluation while only 6% came from the reduction in tariffs (Málaga et al., 2001).

Specifically related to the tomato dispute, Jordan and VanSickle (1995) modeled Mexican and Floridian tomato production as an oligopoly, where each country's prices depended on the other. The authors found that in the short run, Mexico responds to changes in Florida's prices but Florida does not respond to changes in Mexican prices, thus making Florida the price leader. Florida's prices depend more on its own prior prices. The increased Mexican imports caused prices to decline, but only the first lagged period was statistically significant.

Besides the Suspension Agreement, legislators in the United States also use country-of-origin-labeling (COOL) to protect producers. In the early 2000s, many U.S. growers, including tomato producers, pushed for a bill requiring COOL, hoping that Americans would prefer domestically-produced goods. The 2002 and 2008 Farm Bills required labeling for many agricultural products, including all perishable agricultural commodities such as tomatoes. Johnecheck et al. (2010) analyzed the welfare effects of this bill in the tomato trade. They simulated multiple scenarios, a high preference for domestic tomatoes (60% preference value, obtained from a hypothetical willingness-to-pay study), a medium preference (30%), a low preference (10%), and no preference. The authors studied each preference level for varying costs of the labeling under inelastic versus elastic demand. COOL led to a net welfare increase for most cases with medium and high preferences and a net decline for the remaining scenarios. In all scenarios, Mexican imports declined. The study assumed that Mexican and Floridian tomatoes were identical products, despite Florida growing primarily mature green tomatoes while Mexico specializes in vine-ripened tomatoes.

Regardless of whether or not Mexico engages in dumping, the Suspension Agreement has substantial effects on welfare of producers and consumers in the United States, Mexico, and Canada.

2.5 Effects of the Suspension Agreement on Trade and Welfare

In recent decades, Mexico has increased production (Figure 1) from 1265.27 million lbs to 6945.33 million lbs in 2007. Between 1990 and 2007, Mexico expanded exports from a low of 422.34 million lbs in 1992 to a high of 2364.78 million lbs in 2007, corresponding with an increased value of exports from $202.09 million to $1219.88 million (Figure 2). Meanwhile, Florida's production and value of production began to decline (Figure 3) after peaking in 1992 at 2085.80 million lbs. Since then, total production has trended downward while total value has been more volatile. Value of production for the 2005 season ($804.97 million) approached the record 1992 season ($821.81 million); however, by 2007, total value had dramatically declined ($424.94 million), nearing the low 1999 season ($409.74 million).

While the USITC and USDOC primarily investigate the effects of trade on domestic producers, many economists have researched unanticipated aspects of the increased trade with Mexico due to both NAFTA and the Suspension Agreement. The major area of research is the diversionary effects of the Suspension Agreement. Baylis and Perloff (2010) analyzed the diversionary effects of the Suspension Agreement. Due to the U.S. restrictions, Mexico exported more to Canada while Canada increased its exports to the United States. When looking at only the periods when the price floor is binding, they concluded 33% of the drop in the winter and 34% of the drop during the summer in Mexican exports to the United States is offset by shipments from elsewhere, primarily Canada. The agreement also has an indirect effect on trade in processed tomatoes. Mexico sends its surplus tomatoes to the processing sector to produce tomato paste and puree, some of which is then exported to the United States. Mexico increased its exports of tomato paste by 34% since the signing of the first Suspension Agreement. In conclusion, they found that 85% of the price floor's direct effect is offset by increased imports of fresh tomatoes from Canada and increased tomato paste imports from Mexico. The new, higher minimum prices agreed to in the Suspension Agreement of 2013 are likely to have even more distortionary effects on trade.

Fresh tomatoes and processed tomatoes are related products but processed tomato flows are substantially different from fresh tomato trade flows. While the U.S. is a net importer of fresh tomatoes, it is a net exporter of processed tomatoes. Since processed tomatoes are not perishable, additional markets are available for producers, making trade more global, rather than regional. In North America, only 3.6 metric tons/month of fresh tomatoes come from outside the continent, compared to 55,000 tons/month of trade within the continent (Baylis, 2003). Processed tomatoes take many different forms that can be combined into four broad categories: tomato juice, ketchup and sauces, canned whole or pieces, and paste and puree.[3] Trade in processed tomatoes extends beyond North America as summarized in Table 2.

Despite a vast amount of literature studying the tomato war between the United States and Mexico, welfare analysis has received scant attention. Guajardo and Elizondo (2003) utilized a spatial equilibrium model to find welfare in nine different regions, Mexico, the rest of Latin America, the United States, Canada, the European Union, the rest of Europe, Asia, Africa, and Oceania. The study analyzed the effects on quantities demanded and supplied and world welfare for six different scenarios. The first scenario examined world trade assuming no transportation costs or tariffs. In the second scenario they incorporated transportation costs. The third scenario added tariffs to the analysis and the fourth scenario included the 1994 tariffs for NAFTA members and 2000 tariffs for the rest of the world. The fifth scenario eliminated NAFTA tariffs, and the final scenario evaluated a 20% increase in transportation costs with 2000 world tariffs. The authors determined that transportation costs have a more significant effect on surplus loss than tariffs. In addition, through the second and third scenarios, they found that Canadian tariffs did restrict imports from all regions except for the United States, which had an existing trade agreement prior to NAFTA. They also concluded that the NAFTA agreement led to Mexico becoming an exporter of tomatoes to the United States.

Overall, world welfare declined when tariffs between NAFTA countries were abolished because of the imports diverted from low cost producers to higher cost Mexico. The minimum export price was not modeled into the equation and the main objective was to look at world welfare, not just the change of welfare between the U.S. and Mexico. Jung (2004) studied welfare impact and found the effect of the minimum price on consumer welfare is most

[3] Baylis and Perloff (2010) considered only the effects on tomato paste, rather than looking at the effect on all processed tomato products.

likely negative. She also found that U.S. producer surplus could decline if U.S. consumers substitute away from domestic tomatoes and toward Mexican tomatoes as a result of the increased prices caused by the price floor. The minimum price is an important trade policy but its effects on welfare have rarely been studied, either analytically or empirically.

2.6 Methodology and Welfare Results

This section presents the conceptual model of the voluntary export restriction agreed to by the United States and Mexico on all three relevant countries. The model illustrated in Figure 4 shows the effect of the minimum price policy on U.S., Mexican, and Canadian prices, supply, demand, trade, and welfare for greenhouse and cherry & grape tomatoes. In this model, consistent with the trade flow data on greenhouse and cherry & grape tomatoes, the United States (U) is a large importer and Mexico (M) and Canada (C) are large exporters. The U.S. supply $\left(S^U\right)$ and demand $\left(D^U\right)$ curves are illustrated in panel A in the upper left diagram. The U.S. excess demand curve $\left(ED^U\right)$ is the difference between U.S. demand and supply and is shown in panel B. Mexico's supply curve $\left(S^M\right)$ and demand curve $\left(D^M\right)$ are illustrated in panel E. The Mexican excess supply curve $\left(ES^M\right)$ is the difference between Mexican supply and demand and is illustrated in panels F and translated to panel C. Canada's supply curve $\left(S^C\right)$ and demand curve $\left(D^C\right)$ are in diagram H. The Canadian excess supply curve $\left(ES^C\right)$, which is the difference between supply and demand, is illustrated in panel G and translated upward to panel D. Summing the Mexican and Canadian excess supply curves yields the total excess supply curve $\left(ES^{M+C}\right)$, located in panel B. The intersection of the U.S. excess demand $\left(ED^U\right)$and the total excess supply curve $\left(ES^{M+C}\right)$ gives the free market equilibrium price $\left(P^{FT}\right)$ and quantities. For the United States, supply is $P^{FT}c$, demand is $P^{FT}d$, and imports are cd. For Mexico, supply is $P^{FT}l$, demand is $P^{FT}k$, and exports are kl. For Canada, supply is $P^{FT}q$, demand is $P^{FT}p$, and exports are pq. Under free trade, U.S. imports (cd) are equal to Mexican exports (kl) plus Canadian exports (pq), which are equal to rm in the regional market diagram.

The minimum price set by the Suspension Agreement fixes the U.S. price $\left(P^{MIN}\right)$

above the free trade price, which leads to an import of $\bar{Q}$. We assume that the minimum price is binding and the price faced by the U.S. consumers is P^{MIN}. The U.S. price minimum applies only in the United States. The U.S. supply increases from $P^{FT}c$ to $P^{MIN}a$, demand declines from $P^{FT}d$ to $P^{MIN}b$, and imports decline from cd to ab. Due to the large country assumption, Mexican price declines. The new Mexican price is found by drawing a straight line under P^{MIN} until it intersects with ES^{M+C}, resulting in Mexican price P^{M}. To ascertain the supply and demand in Mexico, this price is extended to ES^{M} and eventually to the Mexican market. Mexican quantity supplied decreases from $P^{FT}l$ to $P^{M}h$, quantity demanded increases from $P^{FT}k$ to $P^{M}g$, and exports decline from kl to gh. Since the prevailing price $\left(P^{MIN}\right)$ in the United States is also faced by Canada, Canadian price $\left(P^{C}\right)$ increases relative to free trade price. To determine the supply and demand in Canada, this price is extended to ES^{C} and then to the Canadian market. Canadian supply increases from $P^{FT}q$ to $P^{C}o$, demand declines from $P^{FT}p$ to $P^{C}n$, and exports increase from qp to on.

Welfare analysis shows the change in welfare due to price and quantity changes caused by the Suspension Agreement. In the United States, price and production increase leads to a producer surplus gain of $P^{MIN}acP^{FT}$. Price increases and consumption decline result in a consumer surplus loss of $P^{MIN}bdP^{FT}$. Consequently, the United States endures a net loss of $abdc$ (equal to $stmr$ in diagram B). In Mexico, price and production decrease causes a producer surplus loss of $P^{FT}lhP^{M}$. However, as a result of the voluntary export restraint nature of the Suspension Agreement, Mexican producers also gain a quota rent of $efhg$. The total effect for Mexican producers is then $efhg - P^{FT}lhP^{M}$, which is equal to $efji - P^{FT}kgP^{M} - kig - jlh$. Price decline and consumption increase leads to Mexican consumer surplus gain of $P^{FT}kgP^{M}$. The net change in Mexican welfare (sum of producer welfare and consumer surplus) is $efji - kig - jlh$, which is ambiguous. The Mexican welfare will be positive if part of the quota rent $(efji)$ is more than the part of the producer surplus loss (kig and jlh). This is the reason that the Mexican producers are willing to abide by the Suspension Agreement. The price increase in Canada causes a producer surplus gain of

$P^{C}oqP^{FT}$ and a consumer surplus gain of $P^{C}npP^{FT}$. Overall, when Canada exports, there is a net gain of $noqp$.

Figure 5 illustrates the case where Canada imports (i.e., field tomatoes) and demonstrates the effect of the minimum price on U.S., Mexican, and Canadian prices, supply, demand, trade, and welfare. The United States (U) and Canada (C) are large importers and Mexico (M) is a large exporter. The U.S. supply $\left(S^{U}\right)$ and demand $\left(D^{U}\right)$ curves are illustrated in diagram A in the lower left panel. The U.S. excess demand curve $\left(ED^{U}\right)$ is the difference between U.S. demand and supply and is shown in diagram G in upper panel and translated into diagram B in the lower panel. The Mexican supply curve $\left(S^{M}\right)$ and demand curve $\left(D^{M}\right)$ are depicted in diagram E in the upper left panel. The Mexican excess supply curve $\left(ES^{M}\right)$ is the difference between supply and demand and is drawn in the regional market diagram F in the upper panel. Canadian supply $\left(S^{C}\right)$ and demand $\left(D^{C}\right)$ curves are illustrated in diagram D in the lower right panel. Canadian excess demand curve $\left(ED^{C}\right)$ is derived as the difference between demand and supply and is presented in diagram C in the lower panel and translated to diagram H in the upper panel. Summing the U.S. and Canadian excess demand curves yields the total excess demand curve $\left(ED^{U+C}\right)$ which is depicted in the regional market diagram F in the upper panel. The intersection of the Mexican excess supply curve $\left(ES^{M}\right)$ and the total excess demand curve $\left(ED^{U+C}\right)$ represents the free market equilibrium price $\left(P^{FT}\right)$ and quantity. This free trade price is traced to each country to obtain the supply and demand. For the United States, supply is $P^{FT}c$, demand is $P^{FT}d$, and imports are cd. For Mexico, supply is $P^{FT}l$, demand is $P^{FT}k$, and exports are kl. For Canada, supply is $P^{FT}n$, demand is $P^{FT}o$, and imports are no. Under free trade, U.S. plus Canadian imports $(cd + no)$ are equal to Mexican exports (kl), which are rm in the regional market diagram.

The minimum price set by the Suspension Agreement fixes the U.S. price (P^{MIN}) above the free trade price. For this figure, we illustrate this by shifting ED^{U} downward $\left(ED^{U'}\right)$ which results in total excess demand of $ED^{U+C'}$. The U.S. price P^{MIN} is found at the intersection of $ED^{U+C'}$ and ES^{M} and adding the price wedge $\left(tu, \text{ or } P^{MIN} - P^{M}\right)$. This price is extended to ED^U and then to the U.S. market. The U.S. supply increases to from $P^{FT}c$ to $P^{MIN}a$, demand declines from $P^{FT}d$ to $P^{MIN}b$, and imports fall from cd to ab. Due to the large country assumption, Mexican price declines. The new Mexican price is at the intersection of $ED^{U+C'}$ and ES^M. At this new price $\left(P^M\right)$, Mexican quantity supplied decreases from $P^{FT}l$ to $P^M h$, quantity demanded increases from $P^{FT}k$ to $P^M g$, and exports decline from kl to gh. As with Mexico, Canada's price $\left(P^C\right)$ declines relative to free trade and is found by extending a line from the intersection of $ED^{U+C'}$ to ED^C and down to the Canadian market diagram. Canadian supply declines from $P^{FT}n$ to $P^C q$, demand increases from $P^{FT}o$ to $P^C p$, and imports rise from no to qp.

In the welfare analysis, the U.S. increase in price and production leads to a producer surplus gain of $P^{MIN}acP^{FT}$. The decline in consumption due to higher prices results in a consumer surplus loss of $P^{MIN}bdP^{FT}$. The United States has a net loss of $abdc$ because of the Suspension Agreement. In Mexico, price and production decrease causes a producer surplus loss of $P^{FT}lhP^M$. However, as a result of the voluntary export restraint nature of the Suspension Agreement, Mexican producers also gain a quota rent of $efhg$ in diagram E. The total effect for Mexican producers is $efhg - P^{FT}lhP^M$, which is equal to $efji - P^{FT}kgP^M - kig - jlh$. Price decline and consumption increase lead to Mexican consumer surplus gain of $P^{FT}kgP^M$. The net change in Mexican welfare (sum of producer welfare and consumer surplus changes) of $efji - kig - jlh$ is ambiguous. The price decline in Canada causes a producer surplus loss of $P^{FT}nqP^C$ and a consumer surplus gain of $P^{FT}opP^C$, resulting in a net gain of $nopq$.

2.7 Implications and Conclusions

As the theoretical model indicates, the Suspension Agreement's minimum price does help Florida tomato farmers but, if the quota rents are large enough, may also aid Mexican producers. If Mexican producers do gain, some of the U.S. consumer surplus loss is shifted to Mexican producers in the form of quota rent. U.S. consumers are hurt, as well as tomato processing plants since they purchase fresh tomatoes for use as inputs. Canada gains from the

Suspension Agreement whether it exports or imports. When Canada exports (imports), it gains because producer (consumer) surplus gain is higher than consumer (producer) surplus loss. The higher price minimum after the 2013 agreement will likely intensify the welfare effects, and the addition of different categories with distinct prices is likely to have additional consequences for both welfare and trade distortions which are dealt in detail in chapter 4.

While Floridian producers are substantially affected by Mexican tomato imports, those same imports increased the welfare of American consumers through lower prices. As with all issues in trade, any policy pursued will require trade offs and some groups will be hurt while others will benefit. Because of the strong lobbying by producers, politicians often do not consider the broader implications of their policies. The Suspension Agreement with Mexico is a prime example of that problem.

Previous research shows the agreement has far-reaching affects, including the increased production of Mexican tomato paste as well as increased trade with Canada. However, little work has been conducted into the direct welfare effects of the agreement. The theoretical model developed in this paper helps to demonstrate those direct effects. While all trade barriers distort free trade, each type of barrier impacts welfare differently. Though several studies have examined the effects of tariffs or antidumping duties, only a very few studies analyzed the effects of a minimum price in detail. Furthermore, a minimum price affects welfare differently from antidumping duties. If the United States instituted antidumping duties, the U.S. government would receive revenues and there would be no quota rent for Mexican producers.

The tomato war between Mexican and Floridian producers has lasted decades, with no end in sight. The new agreement is already being challenged in court. While many anticipated that NAFTA would enable a new age of free trade, the U.S. government’s policies toward tomatoes still err on the side of protection to Florida producers. In looking at international trade, the United States is primarily concerned with only one aspect, the effects on its domestic producers. This is because losses to individual consumers from trade restrictions are small so they are unlikely to lobby the government to oppose trade restrictions. Though politicians do not tend to formulate trade policies based on welfare maximization, it is important to consider the implications of different policies on all parties. In the case of tomatoes, perhaps the only solution would be an unbiased observer who investigates the alleged Mexican dumping, but with Florida's political importance as a swing state, intense lobbying by the tomato growers, and current U.S. law, this is unlikely to occur.

The Suspension Agreement between Mexico and the United States provides a fertile ground for research in many different areas. The next chapter analyzes the political economy of lobbying by tomato growers and processors in the determination of the price minimum.

CHAPTER 3: Political Economy and the Suspension Agreement

3.1 Introduction and Overview

Since the 1960s Mexico began to produce more tomatoes for export to the United States. In response, tomato growers from Florida began lobbying for trade barriers at both the state and federal level in the 1960s and 1970s. At the state level, Florida passed mandatory country-of-origin labeling for vegetables in 1979; while at the federal level, Florida growers successfully lobbied for minimum size requirements for tomato imports in 1968 (Bredahl et al., 1987). However, this size requirement was eliminated after one year (Padilla-Bernal et al., 2000). Despite this lobbying, Mexican exports continued to expand, particularly in the mid 1990s due to the implementation of NAFTA (Krueger, 1999), the Mexican peso devaluation of 1994 (VanSickle, 1996), greenhouse production (Guajardo and Elizondo, 2003), and technological advancement in extending the shelf life of vine-ripened tomatoes (Ruggles et al., 1996). Mexican tomato exports to the United States surged by 93% between 1994 and 1996, while U.S. production declined by 21%, which led to an increase in the total supply (imports plus domestic production) and caused a U.S. producer price decline of 20% (Baylis, 2003). As a result of the import surge and price decline, tomato growers from the southeastern states petitioned the U.S. government, requesting "an antidumping duty investigation of fresh tomatoes imported from Mexico which are being, or are likely to be, sold in the United States at less than fair value" (Gunter and Ames, 2001).

In 1996, as a compromise between conducting a thorough investigation into the dumping allegations and free trade, the U.S. government and the Mexican producers signed an agreement to suspend the antidumping investigation, which is commonly known as the Suspension Agreement since it suspended the antidumping investigation and instituted a minimum price or floor price for tomato imports from Mexico to the United States. This minimum import price is higher than the free trade price; otherwise, it is nonbinding. In setting the minimum import price, this agreement equalizes, after accounting for transportation costs, the prices of Mexican and U.S. tomatoes (Baylis and Perloff, 2010).

The Suspension Agreement has been modified and renewed several times since it was first signed in 1996. Originally, the agreement only covered winter tomatoes to appease producers in the southern states and established a reference price of $0.2068/lb. However, tomato production for the fresh market is also substantial in California, Ohio, New York, and Arizona. Hence, in 1998 a reference price of $0.172/lb. was established for tomatoes grown in the summer season. This litigation continued and, in 2002, the minimum import price was increased to $0.2169/lb to further restrict imports, though the summer price remained at $0.172/lb. The minimum prices remained unchanged from 2002-2012.

In 2012, the United States threatened to pull out of the Suspension Agreement and re-initiate the antidumping investigation. Mexico responded that it would institute $1.9 billion worth of retaliatory tariffs if the United States imposed antidumping duties. To avoid long litigation, the United States and Mexican producers signed a new agreement in 2013. This agreement a) substantially increased the minimum price, b) covered various categories of tomatoes: winter and summer field tomatoes, greenhouse tomatoes, and cherry & grape tomatoes, c) instituted separate minimum prices for these categories of tomatoes, and d) subjected all Mexican growers to the minimum price rather than only 85% of the growers as in the previous agreements.

Functionally, the Suspension Agreement acts as a voluntary export restraint (VER) because the imposition of a minimum price creates the same distortionary effects as a voluntary export quota. As in VER, Mexican producers export a limited volume and sell at a higher price in the United States. This quota rent—the difference between price in the United States and Mexican domestic price times exports—accrues to the Mexican producers. In Mexico, producers receive a lower domestic price plus quota revenues and consumers benefit. The quota revenues ameliorate some of the losses arising from the reduced volume of exports. In the United States, the higher minimum price favors producers but harms consumers, causing a net welfare loss which is further exacerbated since the U.S. government does not receive any tariff revenues. The question becomes why the United States and Mexico would agree to a distortionary policy that causes a welfare loss for the United States and possibly for Mexico also. This paper answers this question by employing a theoretical analysis based on a political economy argument where special-interest groups influence the government to impose trade restrictions.

Traditional welfare analysis does not incorporate the role of lobbying and other political considerations in the formulation of trade policy. In this tomato trade dispute, lobbying by a special interest group—U.S. tomato growers—plays a critical role in the development of the Suspension Agreement. While this agreement directly affects the fresh tomato industry, the minimum price hurts the U.S. processed tomato industry by increasing the price of their primary input. Unlike U.S. tomato growers, U.S. tomato processors would prefer the lower tomato price under free trade, and hence they lobby against the Suspension Agreement. Thus, the alliance between Mexican tomato producers and U.S. processors favors free trade.

To secure a favorable policy from the government, various tomato groups spend money on political lobbying and contributions. The Florida Tomato Exchange, the Western Grower's Association, California Tomato Growers lobby the U.S. government for higher minimum import price, whereas tomato processors– primarily Wal-Mart–lobby against import restrictions. Table 3 presents the payments on lobbying by these tomato groups.

Tomato producers and processors, in addition to lobbying, also directly finance political campaigns. The amount spent on campaigns tends to be much larger than the amount spent on lobbying. Table 4 presents these campaign contributions by growers and processors.

While lobbying efforts and direct cash contributions occur from many different groups, other political concerns may also play a role in the development of the Suspension Agreement. The status of Florida as a swing-state may cause elected officials to strongly consider Florida interests despite the relatively small amount spent on lobbying and contributions by Florida growers. According to one official in the Clinton Administration after the first Suspension Agreement was signed, "The math was pretty simple, Florida has 25 electoral votes, and Mexico doesn't" (Sanger, 2013). More formal research has also been conducted into the degree of protection afforded to industries primarily located in swing-states. For instance, Muuls and Petropoulou (2008) found that the degree of concentration of a particular industry in a state that is both a swing state and decisive for an election, as in the case of Florida, leads to higher levels of protection for that industry.

Though Canada was not directly involved in the negotiations for the Suspension Agreement, the interlinkage of the tomato market has substantial impacts on production, consumption, and trade in Canada. Additionally, imports of field tomatoes to Canada and exports of greenhouse and cherry & grape tomatoes from Canada impacts markets in the United States and Mexico. Canada produces by far the fewest tomatoes of the three countries, yet they are the most valuable fresh vegetable export for Canada, particularly due to the greenhouse tomato industry, which increased 13-fold in value between 1995 and 2005 (Statistics-Canada, 2013).

This chapter advances the framework of Grossman and Helpman (1995) to model the long-running tomato trade war between the United States and Mexico by capturing various intricacies and characteristics of this trade litigation. Specifically, we 1) include three categories of tomatoes (fresh large, cherry & grape tomatoes, and processed tomatoes), each with different levels of minimum import prices, 2) incorporate conflicting goals of fresh-tomato growers and processed tomato producers who use fresh tomatoes as an intermediate input, 3) solve for the optimal price minimum for imports,[4] 4) consider the large-country case which endogenizes the price as opposed to the small-country case which treats price as exogenous, 5) analyze the VER nature of this policy with quota revenues accruing to Mexican producers, and 6) develop a three-country model by including the Canadian tomato market. All these distinctive characteristics not only make the model more complex but also enrich the analysis and the results by specifically applying it to the case of the U.S.-Mexican tomato dispute.

[4] Studies in this area of political economy of trade generally seek to find optimal tariffs (Grossman and Helpman, 1994; Gawande et al., 2006).

The rest of the chapter is organized as follows. Section 2 discusses the previous literature of political economy models. Section 3 develops the theoretical model. Section 4 presents the analysis and results of the model. Finally, Section 5 contains the implications and conclusions.

3.2 Overview of Political Economy Models

Tullock (1967) noted that though trade barriers reduce welfare, governments routinely enact such barriers because of special-interest group lobbying for protection. Several political economic models seek to explain the seemingly irrational behavior of countries that enact trade barriers at the expense of national interest. The median-voter theorem by Downs (1957) models two political parties competing for voters. In order to gain the largest number of votes, the politicians appeal to the median voter rather than conservatives or liberals. As a result, both parties push for similar tariff schedules which are between free trade and high levels of protection.

One potential concern with the median-voter theorem is that complexities of the modern political process are not considered, where most do not live in a direct democracy but rather a republic, with elected representatives formulating policies that may not serve the majority of their constituents. In addition, these elected representatives often receive campaign contributions from special-interest groups and are lobbied by these rent-seeking pressure groups. To account for these political realities, many models incorporate the role of lobbying in setting trade barriers and assume there is a trade-off between economic efficiency (i.e., free trade) and political efficiency (i.e., being re-elected or their party coming to power). This lobbying imposes additional costs on a nation. Findlay and Wellisz (1982) extended Tullock's analysis through the creation of a tariff formation function which summarizes the relationship between two lobbies, one advocating for free trade and the other for protection, and the policies that emerge from the political process. Taking the policy function as given, Findlay and Wellisz analyze Nash equilibrium contributions by the lobby groups. They find the costs of special-interest lobbying can reduce a nation's welfare. In extreme cases, a low tariff resulting from an immense and costly struggle in the political arena could be worse for overall welfare than a higher tariff that is not strongly opposed by lobbies.

Brock and Magee (1978) were among the first to endogenize the tariff formulation by modeling tariffs as the outcome of a redistributive battle among the special-interest group lobbyists. This model still relies heavily upon voters by assuming a probabilistic voting model. One political party advocates for protection and the other for export promotion. The two political parties act as Stackelberg leaders and anticipate the amount of lobby money they will receive for all levels of protection or export promotion, and then select the policy that balances between the most lobbying money and the most votes. Another approach to incorporate lobbying is broadly known as political competition models (Magee et al., 1989), where competing parties announce their intended trade policies prior to election. Lobby groups determine which candidate will work the most for their cause and use their resources to help sway voters. This model again places emphasis on the election.

Later models minimized the role of elections and allowed more flexibility by not requiring either of the two competing political parties in favor of free trade or trade restrictions. The seminal work of "Protection for Sale" by Grossman and Helpman (1994), proposed a model in which politicians maximize campaign contributions and the welfare of the citizens. As the title indicates, lobbies in essence purchase preferable trade policies through campaign contributions. Grossman and Helpman (GH) combined several elements of a model advanced by Stigler (1971) who posited that members of an interest group determine how much to spend on lobbying and campaign contributions in order to maximize their total income net of spending on political persuasion, while the legislators supply protection or regulation to maximize votes. In contrast, in GH analysis the politicians maximize their own welfare by considering lobby contributions and the general welfare. In GH model, elections are only implicitly considered because politicians are concerned that their decisions have consequences for their re-election. Lobbyists in turn are not only working to influence the election but also to curry favor from the elected officials.

GH determines the optimal vector of trade policies–import and export taxes–to maximize the weighted sum of special-interest's welfare and national welfare. The equilibrium is found for a two-stage noncooperative game where lobbies select their campaign contributions simultaneously in the first stage and the government in each country independently determines trade policy in the second stage. Another important contribution of this model relates to the local truthfulness condition, where each lobby sets its contribution amount so that elected officials will legislate policies that will bring benefits to befittingly match the contribution paid by the lobbyists. This local truthfulness underscores the *quid pro quo* relationship, where lobbies donate and politicians respond with favorable trade policies.

Grossman and Helpman (1995) extended their Protection for Sale model to analyze cases of noncooperative trade disputes and cooperative trade agreements between two countries. Both the trade-war (noncooperative) and trade-talk (cooperative) models relaxed the small country assumption, which treats world price as given and consider a large country case where the world price is determined endogenously. The trade-war model follows the noncooperative game theoretic tariff analysis by Johnson (1953). However, unlike Johnson's work, GH does not assume the government is purely benevolent, acting in the best interest of the nation, but allows lobbying contributions to influence trade policy. Each country maximizes its objective function over its trade policies, which results in Nash equilibrium and associated welfare inefficiency.

In the trade-talk model, two countries engage in negotiations to determine trade policy. Each country maximizes a common objective function, which is a weighted average of both countries' welfare functions, over its trade instruments. Since the Suspension Agreement is negotiated through bargaining between the U.S. government and Mexican producers, it is modeled in this study using the trade talk approach.

Since the Protection for Sale and Trade Wars and Trade Talks of GH (Grossman and Helpman, 1994, 1995), various theoretical enhancements have been made, such as endogenizing the formation of lobbies themselves (see Mitra, 1999) and the incorporation of foreign lobbying (see Stoyanov, 2009; Gawande et al., 2006). Mitra found conditions that make lobbies more persuasive, particularly industries with high capital requirements, more inelastic demand, fewer competitors, and a centralized geographic distribution. Several of these conditions characterize the tomato lobby, particularly Florida tomato growers. Another key enhancement of the general Protection for Sale model was to incorporate intermediate and final goods in empirical studies (see Gawande and Bandyopadhyay, 2000; McCalman, 2000). This chapter extends the literature by developing a political economy model which includes the intermediate input–fresh tomatoes–and final good–processed tomatoes–with conflicting interests in the Suspension Agreement.

3.3 Theoretical Model

We model the U.S.-Mexican trade agreement by incorporating lobby contributions and societal welfare. We consider three categories of tomatoes: fresh large (i.e., field and greenhouse), cherry & grape, and processed. Field and greenhouse tomatoes were aggregated as fresh-large tomatoes because growers in both groups petition for a larger minimum price and produce the tomatoes which are used as the intermediate input in the production of processed tomatoes in addition to fresh consumption.

The consumer problem is to maximize utility

$$u = c_0 + u_1(c_1) + u_2(c_2) + u_3(c_3) + \sum_{i=4}^{n} u_i(c_i), \tag{1}$$

subject to the budget contraint $I = c_0 + p_1c_1 + p_2c_2 + p_3c_3 + \sum_{i=1}^{n} p_ic_i$, where c_0 is the composite numeraire good, c_1 is large tomatoes, which can be used for consumption or processing, c_2 is cherry & grape tomatoes used for consumption only, c_3 is processed tomatoes, c_i $(i = 4, .., n)$ are other goods in the economy, I is income, and p_i is the price of good i. The sub-utility function $u_i\ (c_i)$ is differentiable, increasing, and strictly concave. There are N consumers in the country.

The utility maximization problem yields the demand functions $c_i = d_i\ (p_i)$, where $d_i\ (p_i)$

is the inverse of $u_i^{'}(c_i)$. Plugging the demand function $d_i(p_i)$ into the budget constraint we obtain the demand for the numeraire good $c_0 = I - p_1 d_1(p_1) - p_2 d_2(p_2) - p_3 d_3(p_3) - \sum_{i=4}^{n} p_i d_i(p_i)$. Substituting the demand functions into the utility functions yields the indirect utility function

$$V(I, p_1, p_2, p_3) = I + \sum_{i=1}^{n} u_i(d_i(p_i)) - \sum_{i=1}^{n} p_i d_i(p_i) = I + \sum_{i=1}^{n} CS(p_i), \qquad (2)$$

where $\sum_{i=1}^{n} CS(p_i)$ is the consumer surplus equal to $\sum_{i=1}^{n} u_i(d_i(p_i)) - \sum_{i=1}^{n} p_i d_i(p_i)$. Applying Roy's Identity,

$$-\frac{\frac{\partial V}{\partial p_i}}{\frac{\partial V}{\partial I}} = -\frac{\frac{\partial V}{\partial p_i}}{1} = -\frac{\partial V}{\partial p_i} = -\frac{\partial CS}{\partial p_i} = c_i(p_i). \text{ Thus, } \frac{\partial V}{\partial p_i} = \frac{\partial CS}{\partial p_i} = -c_i(p_i).$$

The composite good c_0 is produced using only labor under constant returns to scale with input-output coefficient of 1. Since the price of c_0 is 1, the wage rate is 1. The production of large tomatoes (y_1) and cherry & grape tomatoes (y_2) requires labor and specific factor (K), while production of processed tomatoes (y_3) needs labor, specific factor, and large tomatoes (y_1). With wage rate fixed at 1, total payments to the specific factor in the production of tomatoes $i = 1, 2$ depend only on the price of fresh tomatoes. These total payments are the profits to the producers and owners of the specific factor: $\pi_i(p_i) = \max_{L_i} \left[p_i f_i(L_i, K_i) - L_i \right], i = 1, 2, 4, ..., n$. From maximized profit, the output supply is $\frac{\partial \pi_i(p_i)}{\partial p_i} = \pi_i^{'}(p_i) = y_i(p_i)$.

The profits in the processed tomatoes also accrue to the specific factor: $\pi_3(p_3, p_1) = \max_{L_3, y_1} \left[p_3 f_3(L_3, K_3, y_1) - L_3 - p_1 y_1 \right]$. The processed tomato supply is $\frac{\partial \pi_3(p_3, p_1)}{\partial p_3} = y_3(p_3, p_1)$. The demand for large tomatoes used as intermediate inputs in processed-tomato production is $\frac{\partial \pi_3(p_3, p_1)}{\partial p_1} = -y_{3,1}^{d}(p_3, p_1)$.

The above demand and supply analyses apply to all three countries the United States (U), Mexico (M), and Canada (C). The Suspension Agreement implements a price floor $(\bar{p}_i)$

which applies only to large and cherry & grape tomatoes. However, processed tomatoes operate under free trade. Since this trade policy works as a voluntary export restraint, the quota revenues accrue to Mexican producers. These quota revenues are $\left(\bar{p}_i - p_i^M\right) * m_i$, $i = 1, 2$, where p_i^M is the price in Mexico and m_i is U.S. imports of Mexican tomatoes.

With labor income normalized to one, the total population equals the labor income in each nation L^j, $j = U, M$. Organized industries $\left(i \in L^j, j = U, M\right)$ in the United States (Mexico), represented by $L^U_{i \in L^U}$ $\left(L^M_{i \in L^M}\right)$, earn a fraction of the labor income depending on their size relative to the nation's total population.

The U.S. government objective function is

$$G^U = \sum_{i \in L^U} C^U + a^U \left[W^U\right], \tag{3}$$

where $\sum\limits_{i \in L^U} C^U$ is the amount of lobbying contributions received by the U.S. government, the parameter $a^U \geq 0$ signifies U.S. elected officials concern for national welfare W^U. This welfare is composed of labor income, producer surplus, and consumer surplus (i.e.,$W^U = L^U + \sum\limits_{i=1}^{n} \Pi_i^U \left(p_i^U\right) + \sum\limits_{i=1}^{n} CS^U \left(p_i^U\right)$). Similarly, the Mexican government's objective function is

$$G^M = \sum_{i \in L^M} C^M + a^M \left[W^M\right], \tag{4}$$

where $\sum_{i \in L^M} C^M$ is the amount of lobbying contributions received by the Mexican government, $a^M \geq 0$ denotes the weight Mexican elected officials place on national welfare W^M. This welfare is composed of labor income, producer surplus, quota revenues, and consumer surplus (i.e., $W^M = L^M + \sum\limits_{i=1}^{n} \Pi_i^M \left(p_i^M\right) + \sum\limits_{i=1}^{n} CS^M \left(p_i^M\right)$). Since both countries negotiate to reach an agreement, the problem entails joint maximization of weighted U.S. and Mexican governments' objective functions (3 and 4)

$$a^M G^U + a^U G^M = a^M C^U_{i \in L^U} + a^U C^M_{i \in L^M} + a^M a^U \left[W^U + W^M\right]. \tag{5}$$

Thus, the governments seek to maximize joint welfare such that welfare of one country cannot be raised without lowering welfare of the other country.

Lobbying enters the model through the campaign contribution schedule $C_i = \max\{0, W_i - B_i\}$, where W_i is the ith industry's welfare and B_i is the maximum net welfare lobby group i can obtain. This is the truthful contribution schedule because it presents the true welfare W_i the lobby group will obtain for various policy levels. Using this truthful contribution schedule, we can ascertain the welfare of each lobby net of the contributions: $W_i - C_i = \min\{W_i, B_i\}$. Substituting the campaign contributions of both countries into (5), we obtain

$$a^M \sum_{i \in L^U} \left[W_i^U - B_i^U\right] + a^U \sum_{i \in L^M} \left[W_i^M - B_i^M\right] + a^M a^U \left[W^U\right] + a^M a^U \left[W^M\right], \tag{6}$$

Welfare for the ith industry in country j is

$$W_i^U = L_i^U + \Pi_i^U + \alpha_i^U CS_i^U \tag{7}$$

$$W_i^M = L_i^M + \Pi_i^M + QR_i^M + \alpha_i^M CS_i^M, \tag{8}$$

where L_i^j is labor income, Π_i^j is profits, QR_i^M is Mexican quota revenues, and $\alpha_i^j CS_i^j$ is consumer surplus for the fraction of the population that owns the specific factor industry i. For U.S. and Mexican industries, the welfare is expressed such that the fraction of the population belonging to particular lobby groups is represented by α_i^U $\left(\alpha_i^M\right)$ for the United States (Mexico). For the remainder of the chapter, we let $\alpha^U, \alpha^M = 0$, signifying that the members of each individual lobby group compose a negligible share of the total population.

All three groups of producers lobby the government. Fresh large and cherry & grape tomato growers lobby for a higher minimum price for imports. In contrast, U.S. tomato processors and Mexican growers lobby for free trade, i.e., not for a high, fixed price and restrictions on imported tomatoes. Since Canada is not a signatory to the Suspension Agreement, their welfare is not directly considered. However, Canadian imports and exports influence the tomato markets in all three countries. The regional market clearing conditions for all three categories of tomatoes are

$$m_1^U - x_1^M + m_1^C = \left[c_1^U\left(\bar{p}_1\right) + y_{3,1}^{d,U}\left(p_3^U, \bar{p}_1\right) - y_1\left(\bar{p}_1\right)\right]$$
$$- \left[y_1^M\left(p_1^M\right) - c_1^M\left(p_1^M\right) - y_{3,1}^{d,M}\left(p_3^M, p_1^M\right)\right] + \left[c_1^C\left(p_1^C\right) - y_1^C\left(p_1^C\right)\right] = 0$$
$$m_2^U - x_2^M - x_2^C =$$
$$\left[c_2^U\left(\bar{p}_2\right) - y_2^U\left(\bar{p}_2\right)\right] - \left[y_2^M\left(p_2^M\right) - c_2^M\left(p_2^M\right)\right] - \left[y_2^C\left(p_2^C\right) - c_2^C\left(p_2^C\right)\right] = 0$$
$$x_3^U - m_3^M = \left[y_3^U\left(p_3^U, \bar{p}_1\right) - c_3^U\left(p_3^U\right)\right] - \left[c_3^M\left(p_3^M\right) - y_{3,1}^M\left(p_3^M, p_1^M\right)\right] = 0.$$

The first equation states that U.S. imports minus Mexican exports plus Canadian imports of fresh tomatoes sum to zero. The second equation entails similar market clearing for cherry & grape tomatoes, except that Canada is an exporter. Furthermore, these tomatoes are not used for processed tomato production. The last equation indicates that U.S. exports of processed tomatoes is equal to Mexican imports of processed tomatoes.[5]

3.4 Analysis and Results

Using the political economy model developed in the previous section, we can investigate the influence of special-interest politics on optimal price minimum. First, we analyze minimum import price determination for large tomatoes, which involves processed tomato market also because large tomatoes are used as the primary input in the production of processed tomatoes. Then, we examine the minimum import price policy for cherry & grape tomatoes, which does not involve the processed-tomato market.

Fresh-Large Tomatoes

After substituting W_i^j and W^j from equations (7) and (8) into (6), the U.S. FOC with respect to $\bar{p}_1$ and the Mexican FOC with respect to p_1^M, after considerable simplifications, are

[5] The Canadian processing sector is a very small component of the NAFTA market and consequently not considered in the analysis. However, inclusion of the Canadian processed-tomato market will not alter the solution in any significant way.

respectively[6]

$$
\begin{aligned}
& a^M\left[y_1^U - y_3^{U,d}\right] + a^M a^U\left[y_1^U - y_{3,1}^{U,d} - c_1^U\right] \\
& +a^U\left[y_1^M\frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right]\left(1 - \frac{\partial p_1^M}{\partial \bar{p}_1}\right)\right] \\
& +a^U\left[\left(\bar{p}_1 - p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]\frac{\partial p_1^M}{\partial \bar{p}_1} - y_{3,1}^{M,d}\frac{\partial p_1^M}{\partial \bar{p}_1}\right] \\
& +a^M a^U\left[y_1^M\frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right]\left(1 - \frac{\partial p_1^M}{\partial \bar{p}_1}\right)\right] \\
& +a^M a^U\left[\left(\bar{p}_1 - p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]\frac{\partial p_1^M}{\partial \bar{p}_1} - y_{3,1}^{M,d}\frac{\partial p_1^M}{\partial \bar{p}_1} - c_1^M\frac{\partial p_1^M}{\partial \bar{p}_1}\right] \\
= \; & 0
\end{aligned} \tag{9}
$$

$$
\begin{aligned}
& a^U\left[y_1^M - \left(y_1^M - c_1^M - y_{3,1}^{d,M}\right) + \left(\bar{p}_1 - p_1^M\right)\left(\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right) - y_{3,1}^{d,M}\right] \\
& +a^U a^M\left[y_1^M - c_1^M - y_{3,1}^{d,M} - \left(y_1^M - c_1^M - y_{3,1}^{d,M}\right) + \left(\bar{p}_1 - p_1^M\right)\left(\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right)\right] \\
= \; & 0.
\end{aligned} \tag{10}
$$

These two FOCs cannot be solved separately because they are linearly dependent. Consequently, they are set equal to each other and solved for the optimal price wedge $\left(\bar{p}_1 - p_1^M\right)$. However, before solving for the price wedge, we need to obtain $\frac{\partial p_1^M}{\partial \bar{p}_1} = p_1^{M'}$, i.e., the effect of U.S. minimum import price on Mexican tomato price because the U.S. FOC contains this term. Utilizing the market-clearing conditions $m_1^U - x_1^M + m_1^C = 0$ and

[6] Detailed derivations of this section is presented in Appendix 3.1.

$x_3^U - m_3^M = 0$, we solve for $\frac{\partial p_1^M}{\partial \bar{p}_1}$ and $\frac{\partial p_3^M}{\partial \bar{p}_1}$.

$$p_1^{M'} = \frac{\left(-m_1^{U'}\right)\left(x_3^{U'} - m_3^{M'}\right) + \left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}}{\left(-x_1^{M'} + m_1^{C'}\right)\left(x_3^{U'} - m_3^{M'}\right) - \frac{\partial y_3^M}{\partial p_1^M}\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \tag{11}$$

$$\frac{dp_3^M}{d\bar{p}_1} = \frac{\left(x_1^{M'} - m_1^{C'}\right)\frac{\partial y_3^U}{\partial \bar{p}_1} + m_1^{U'}\frac{\partial y_3^M}{\partial p_1^M}}{\left(-x_1^{M'} + m_1^{C'}\right)\left(x_3^{U'} - m_3^{M'}\right) - \frac{\partial y_3^M}{\partial p_1^M}\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \tag{12}$$

Equations (11) and (12) endogenously determine the effects of the Suspension Agreement on p_1^M and p_3^M, and thus capturing the large-country effects. We substitute (11) into (9) and after considerable simplification, we solve for $\left(\bar{p}_1 - p_1^M\right)$.

$$
\begin{aligned}
\left(\bar{p}_1 - p_1^M\right) \quad = \quad & \frac{a^M y_1^U \left[\overbrace{-\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} + m_1^{C'}\right)\left(x_3^{U'} - m_3^{M'}\right)}^{(+)} + \overbrace{\frac{\partial y_3^M}{\partial p_1^M}\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}^{(-)} \right]}{a^U \left(1 + a^M\right) B} \\
& + \frac{a^M y_{3,1}^{U,d} \left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} + m_1^{C'}\right)\left(x_3^{U'} - m_3^{M'}\right)}^{(-)} \overbrace{-\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(+)} \right]}{a^U \left(1 + a^M\right) B} \\
& + \overbrace{\frac{-y_1^M \left(1 + x_1^{M'}\right)}{\left(1 + a^M\right)\left(1 + x_1^{M'}\right) x_1^{M'}}}^{(-)} + \overbrace{\frac{y_{3,1}^{M,d} \left(1 + x_1^{M'}\right)}{\left(1 + a^M\right)\left(1 + x_1^{M'}\right) x_1^{M'}}}^{(+)} + \overbrace{\frac{x_1^M \left(1 + x_1^{M'}\right)}{\left(1 + a^M\right)\left(1 + x_1^{M'}\right) x_1^{M'}}}^{(+)} \\
& + \frac{x_1^M \left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} + m_1^{C'}\right)\left(m_3^{M'} - x_3^{U'}\right)}^{(+)} + \overbrace{\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)} \right]}{\left(1 + a^M\right) B} \\
& + \frac{a^M m_1^C \left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} + m_1^{C'}\right)\left(m_3^{M'} - x_3^{U'}\right)}^{(+)} + \overbrace{\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)} \right]}{\left(1 + a^M\right) B}
\end{aligned}
$$

where $B = \underbrace{\left(x_1^{M'}\left(1 + x_1^{M'}\right)\left[-m_1^{U'}\left(\acute{x}_3^{U'} - m_3^{M'}\right) + \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}\right]\right)}_{(+)}.$

This equation contains seven terms on the right-hand side. The first term has two components, which capture the influence of the fresh market tomato on the price wedge. The first component shows the impacts of U.S. large tomato fresh consumption in determining the price wedge, while the second component shows the impacts of intermediate input use of large tomatoes for processing. The fresh tomato consumption exerts a positive impact upon the price wedge and highlights the importance of the magnitude of output in determining the price wedge, i.e., the larger the output, the larger the price wedge because tomato growers with large output can contribute more for lobbying. This component also reflects the Ramsey pricing rule in that the more inelastic is excess demand $\left(m_1^{U'} \text{ in } B \text{ in the denominator}\right)$, the smaller the deadweight loss arising from the distortion, implying that the government would prefer a higher price wedge. However, the second component exerts a negative impact upon the price wedge because due to the Suspension Agreement policy, fresh tomato price in Mexico will decline which will increase the supply of processed tomatoes, leading to a lower price for processed tomatoes which reduces the processors' demand for fresh tomatoes. Consequently, fresh tomato producers do not want to face a lower demand for their tomatoes from the processing industry. Thus, this second effect acts to reduce the price wedge. The first component is a direct effect and the second component is an indirect effect, and we expect that direct effect of the fresh market tomatoes to outweigh the indirect effect of the processed market tomatoes, leading to a net positive effect on the price wedge. The degree to which the price wedge increases depends upon the weight $\left(a^U\right)$ the U.S. government places upon national welfare. The more the government is concerned about national welfare (larger a^U), the less influence producers have in securing a higher minimum price.

The second term demonstrates the impacts of the U.S. processing sector on the minimum price. This term also contains two competing forces influencing the price wedge. The first component shows the direct impact of the processors' demand for the fresh market tomatoes on the optimal price wedge. The Suspension Agreement increases the price of fresh tomatoes and processors find it more expensive and reduce their demand for fresh tomatoes–the primary input in the processing sector. This direct effect is not beneficial to the processors because they prefer lower prices for fresh tomatoes. The larger the output of processed tomatoes, the more influence the processors can exert in reducing the price wedge.

This result underscores the importance of processors wanting free trade in fresh tomatoes, implying no price wedge. In contrast, the second component exerts the indirect effect of the Suspension Agreement lowering the fresh tomato price in Mexico, which will increase the supply of processed tomatoes, leading to a lower price for U.S. processed tomatoes. This lower price harms the processing industry and hence reduces the demand for fresh tomatoes for processed-tomato production. Since this indirect effect works against the interest of processors, it induces an upward influence on the price wedge. However, the direct effect likely dominates the indirect effect, indicating the overall effect of the U.S. processed tomato industry is to lower the price wedge. As with the first term, the more weight the U.S. government places on national welfare, the smaller the price wedge. Thus, the direct effect coming from processors and government's weight on national welfare reinforce each other in reducing the minimum price.

Summing the first and second terms, i.e., the total effect of U.S. tomatoes, both large and processed, yields

$$\frac{a^M\left[\overbrace{\left(y_1^U - y_{3,1}^{U,d}\right)\left(\frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^M}{\partial p_1^M} + m_1^{C'}\right)\left(m_3^{M'} - x_3^{U'}\right)}^{(+)} + \overbrace{\left(y_1^U - y_{3,1}^{U,d}\right)\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)}\right]}{a^U\left(1+a^M\right)B}.$$

The sign of the first component in the above term is positive because $\left(y_1^U - y_{3,1}^{U,d}\right) > 0$, which highlights the dominance of the fresh market sector over the processing sector in determining the higher minimum price. The second component of the above equation shows that the negative indirect effect on the minimum price of the fresh market is larger than that of the processing market. However, the direct effect of the first term will overshadow the indirect effect of the second term, resulting in a higher minimum price.

The third term is the terms of trade effect, seen from the U.S. perspective. While the Suspension Agreement helps to raise the fresh tomato import price, it depresses the price in

Mexico, which is beneficial to the United States as an importing country. This price-depressing effect is larger if Mexican excess supply is more inelastic, and thus the terms of trade effect.

The fourth term, a direct effect, incorporates the role of Mexican large tomato supply on the price minimum. Due to the large country assumption, the price of tomatoes in Mexico declines as a result of the minimum price, which harms Mexican producers, who would prefer free trade. The higher the magnitude of Mexican output, the more lobbying occurs and hence the more influence this term has on the price wedge. When the excess supply $\left(x_1^{M'}\right)$ is more inelastic, the Suspension Agreement can lower the Mexican fresh tomato price more, causing more harm to Mexican producers. Consequently, Mexican producers would like to see a smaller price wedge if excess supply is inelastic. Both Mexican fresh tomato output and inelastic excess supply reinforce each other for a lower price wedge.

The fifth term, an indirect effect, establishes the effects of Mexican processor demand for fresh tomatoes. Lower Mexican fresh tomato price benefits the processors as the cost of production for their primary input, i.e., fresh tomatoes, falls. Thus, this indirect effect emanates from Mexican processors who prefer a higher price wedge, though at the expense of Mexican large-tomato growers. By summing the Mexican tomato market direct and indirect effects, we obtain the overall effect of Mexican growers and processors:

$$\frac{-\left(y_1^M - y_{3,1}^{M,d}\right)}{\left(1+a^M\right)\left(1+x_1^{M'}\right)x_1^{M'}}.$$

Since $\left(y_1^M - y_{3,1}^{M,d}\right) > 0$, the harm to Mexican producers eclipses the gains to Mexican processors, which serves to reduce the price wedge. The higher the weight the Mexican government places on overall welfare, i.e., larger the a^M, the lower the price wedge. That is, the Mexican government would prefer free trade from the national welfare point of view. It is important to note that the Suspension Agreement results in producer surplus loss exceeding consumer surplus gain since Mexico is a large tomato exporter. When the Mexican government places a higher weight, it is safeguarding the interest of large-tomato producers by prefering free trade.

The sixth term highlights the direct and indirect effects of quota revenues accruing to Mexican producers. This term is viewed from the Mexican large-tomato producers' perspective with two competing forces. The first shows the positive impacts of quota revenues. Because of the Suspension Agreement, the price wedge between the United States and Mexico increases, which augments quota revenues and thus is beneficial to Mexican producers. The second component demonstrates the indirect effect through the processing sector. As a result of the Suspension Agreement, more fresh tomatoes are available in Mexico, lowering fresh tomato price which expands processed tomato supply. This increase in processed tomato supply lowers processed tomato price, reducing the demand for fresh tomatoes for processing and further lowering the Mexican large tomato price and working against the interest of large-tomato growers. The direct effects are expected to dominate the indirect effects. Therefore, the net result of the quota revenue effect is to increase the price wedge.

The seventh and final term shows the impacts of Canadian imports on the optimal price wedge. Because of the Suspension Agreement, Mexican fresh market tomato prices are lower, augmenting the Canadian imports of tomatoes from Mexico. Since Canada is an importer of large tomatoes, the Suspension Agreement policy works in its favor and this direct effect positively influences the price wedge. The second component reflects the indirect effect. As lower Mexican fresh market tomato price augments the supply of processed tomatoes, reducing the price of the processed tomatoes. This leads to lower demand for fresh market tomatoes in the processing sector and consequently fewer fresh tomatoes will be available for export to Canada. Thus this indirect effect is not beneficial to Canada and puts a downward pressure on the price wedge.

Cherry & Grape Tomatoes

We now analyze the political process in determining the optimal price wedge for the cherry & grape tomatoes. This analysis differs from the previous case in two primary ways; 1) the processing sector is not part of the analysis because cherry & grape tomatoes are not used for processing and 2) Canada is now an exporter because of large scale greenhouse production of cherry & grape tomatoes. Taking the derivative of 6 with respect to the cherry & grape tomato minimum price, we obtain the U.S. FOC:[7]

$$\begin{aligned} & a^M y_2^U + a^U \left[y_2^M p_2^{M'} + \left(y_2^M - c_2^M\right) \left(1 - p_2^{M'}\right) + \left(\bar{p}_2 - p_2^M\right) \left(y_2^{M'} - c_2^{M'}\right) p_2^{M'} \right] \\ & + a^M a^U \left[y_2^U - c_2^U \right] \\ & + a^M a^U \left[y_2^M p_2^{M'} + \left(y_2^M - c_2^M\right) \left(1 - p_2^{M'}\right) + \left(\bar{p}_2 - p_2^M\right) \left(y_2^{M'} - c_2^{M'}\right) p_2^{M'} - c_2^M p_2^{M'} \right] \\ = \; & 0 \end{aligned} \tag{13}$$

Similarly, the Mexican FOC is obtained by taking the derivative with respect to the Mexican cherry & grape price.

$$\begin{aligned} & a^U \left[y_2^M - \left[y_2^M - c_2^M\right] + \left(\bar{p}_2 - p_2^M\right) \left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) \right] \\ & + a^M a^U \left[y_2^M - \left[y_2^M - c_2^M\right] + \left(\bar{p}_2 - p_2^M\right) \left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) - c_2^M \right] \\ = \; & 0 \end{aligned} \tag{14}$$

The FOCs differ from large tomatoes since the processing sector is absent; consequently, the process for finding the optimal price wedge for cherry & grape tomatoes is simpler. Using the market clearing condition $m_2^U - x_2^M - x_2^C = 0$, we solve for $\frac{\partial p_2^M}{\partial \bar{p}_2}$ $\left(\text{rewritten as } p_2^{M'} \right)$:

$$p_2^{M'} = \frac{m_2^{U'} - x_2^{C'}}{x_2^{M'}}. \tag{15}$$

Due to linear dependence, we set 13 and 14 equal to each other and solve for the price wedge $\left(\bar{p}_2 - p_2^M\right)$.

[7] Detailed derivations of cherry & grape tomato analysis are presented in Appendix 1.

$$\left(\bar{p}_2 - p_2^M\right) = \overbrace{\frac{a^M y_2^U}{a^U\left(1+a^M\right)\left(x_2^{M'} + x_2^{C'} - m_2^{U'}\right)}}^{(+)} + \overbrace{\frac{x_2^M}{\left(1+a^M\right)x_2^{M'}}}^{(+)} + \overbrace{\frac{-y_2^M}{\left(1+a^M\right)x_2^{M'}}}^{(-)} + \overbrace{\frac{x_2^M}{\left(1+a^M\right)\left(x_2^{M'} + x_2^{C'} - m_2^{U'}\right)}}^{(+)} + \overbrace{\frac{-a^M x_2^C}{\left(1+a^M\right)\left(x_2^{M'} + x_2^{C'} - m_2^{U'}\right)}}^{(-)} \quad (16)$$

The optimal price wedge for cherry & grape tomatoes depends on five terms which highlight the importance of U.S. supply, terms of trade, Mexican supply, quota revenues, and exports from Canada. The first term on the right-hand side demonstrates the influence of U.S. cherry & grape growers in securing the higher price minimum. U.S. suppliers benefit from the Suspension Agreement as limited imports from Mexico keep the U.S. producer price high. Consequently, cherry & grape supply exerts a positive impact upon the price wedge. The larger the output, the larger the price wedge because tomato growers with large output can contribute more for lobbying to curry favor. This term also includes the Ramsey pricing rule in that more inelastic is the excess demand $\left(m_2^{U'}\right)$, the smaller the deadweight loss arising from the distortion, implying that the government would prefer a higher price wedge. In addition, the more inelastic is Canadian excess supply $\left(x_2^{C'}\right)$, the higher the price wedge. The rationale for this result is that the United States will import more from Canada when Canadian excess supply is inelastic and to avoid the lower price from increased Canadian exports to the United States, the United States prefers higher minimum price for Mexican imports and further restrict imports from Mexico. The level of influence U.S. producers have on the price wedge depends on the degree of concern elected officials have for the national welfare $\left(a^U\right)$. A higher weight mitigates the impact of the first term on the price wedge.

The second term depicts the terms of trade effect. The Suspension Agreement raises the cherry & grape import price and, due to the large country assumption, depresses the price in Mexico, which is beneficial to the United States as an importing country. If Mexican excess supply is more inelastic, this price depressing effect is larger, hence the terms of trade effect which pushes the price wedge higher.

The third term involves Mexican cherry & grape tomato supply. Since a higher price wedge reduces prices in Mexico, growers are negatively affected and would prefer free trade. Hence, Mexican growers desire a lower minimum price. The higher the output, the more influence Mexican growers have on their government and the lower the price wedge. For Mexico, when the excess supply $\left(x_1^{M'}\right)$ is more inelastic, the Suspension Agreement reduces the Mexican cherry & grape tomato prices more and further harming Mexican producers. Therefore, with an inelastic supply, Mexican producers prefer a smaller price wedge in order to minimize their losses. This term is also effected by the weight the Mexican government places on national welfare $\left(a^M\right)$, i.e., a higher concern for welfare further reduces the price wedge, bringing it closer to free trade.

The fourth term incorporates the role of export quota revenues from the Mexican producers' perspective. Quota revenues accruing to Mexican producers from the price wedge is beneficial. The higher the price wedge between the United States and Mexico, the higher the export quota revenues. Consequently, the quota revenue effect serves to increase the optimal price wedge. It is worth noting that the third term captures Mexican producers' loss due to reduced production, but the fourth term reflects the quota revenue gain due to the VER nature of the Suspension Agreement policy. These two terms counteract each other; it is generally expected that producers' loss is more harmful than quota revenue gain.

The final term includes the effects of Canadian exports. As the price wedge stemming from the Suspension Agreement increases, Canada, which is not bound by the export limitations of the Suspension Agreement, has an incentive to increase production and exports to the United States. These exports limit the effectiveness of the Suspension Agreement on aiding U.S. producers. As a result, Canadian exports work against U.S. desire to have a higher minimum price.

Implications and Conclusions

The model expounded upon in this chapter highlights the importance of political lobbying in the formation of the tomato trade policy. Utilizing the foundations of Grossman and Helpman's trade-talk model, we incorporated numerous intricacies covering the Suspension Agreement of the U.S.-Mexican tomato war in order to capture the political forces behind the minimum price policy. These complexities include the addition of final and intermediate tomatoes, opposing lobbying by the producers of fresh and processed tomatoes, a large country assumption which endogenizes the prices, a three-country framework which incorporates Canadian imports/exports, a solution for the optimal price minimum rather than the optimal tariff, and inclusion of quota revenues accruing to Mexican producers.

Our model solves for the optimal minimum price policy given the cooperative bargaining between the United States and Mexico. The price wedge depends on the goal of the elected officials' motives. While most previous models assumed governments were strictly benevolent, in this model the price wedge varies depending on the relative importance elected officials place on national welfare versus campaign contributions. For the United States and Mexico, a higher weight on national welfare narrows the price wedge. In the equilibrium solution, neither lobby groups nor government in each country has an incentive to change its behavior, i.e., no lobby can increase its contributions to induce a more favorable policy without lowering the welfare the opposing lobbies, nor can a government increase political gains by changing policy without adversely impacting the other government.

In the final solution for both large and cherry & grape tomatoes, the optimal price wedge depends upon the elasticity of import demand and export supply. Inelastic U.S. import demand reduces the deadweight loss, hence allowing for a higher price wedge. However, inelastic export supply increases the price wedge and harms Mexican producers. From Mexico's perspective, the effect of inelastic export supply is to reduce the price wedge, bringing it closer to free trade and contributing to the terms of trade effect. The magnitude of output substantially impacts the price wedge. For the United States, higher fresh tomato or cherry & grape tomato supply implies a larger lobby and hence higher contributions to the U.S. politicians, which intensifies the degree of protection awarded to U.S. growers. From the Mexican perspective, higher Mexican output induces a larger push towards free trade due to the minimum import price's depressing effect on Mexican prices.

In the large tomato market, competing forces from the fresh and processed sectors' lobbying influences the optimal price wedge in opposite directions. While previous literature primarily discusses the role Florida producers played in the development and continued use of the Suspension Agreement, our model also includes the role of U.S. tomato processors. In doing so, our analysis provides an explanation for why their lobbying efforts seem unsuccessful compared to lobbying by growers since the direct effect from fresh tomatoes outweighs the indirect effect from the processing sector. Yet, the processing sector's indirect effects work to contain the direct effects and hence mitigate the impacts on the optimal wedge. Whereas in the cherry & grape tomato market, since the processing sector is not present, only direct effect is in play, which generates unambiguous impacts.

In addition, imports/exports from Canada also play an important role indirectly in determining the minimum price of the Suspension Agreement. When Canada is an importer, these imports serve to push the price wedge higher because Canada can import lower-priced tomatoes from Mexico. However, when Canada is an exporter, exports from Canada will lower the U.S. price and thus acts against the effectiveness of the U.S. Suspension Agreement to keep the minimum import price higher.

CHAPTER 4: Welfare Analysis of the U.S.-Mexican Tomato Suspension Agreement

4.1 Introduction and Overview

As seen throughout the previous chapters, the "Great Tomato War" (Bredahl et al., 1987) has important implications on all three NAFTA countries (United States, Mexico, and Canada), despite its origins as a conflict between only the United States and Mexico. As explained in detail in chapter 2, Floridian growers have claimed since the late 1960s that Mexico dumps (i.e., sells at a price below the cost of production) tomatoes on the U.S. winter market, causing domestic prices to fall (Johnecheck et al., 2010). However, Mexico continues to deny that it engages in dumping.

Tomato trade in all three countries are interlinked. Tomatoes are an important export commodity for Mexico because they are the second most valuable agricultural export for Mexico (Baylis, 2003).[8] Tomatoes are also a vital commodity for the United States, which is the second largest producer of tomatoes worldwide (processing and fresh markets combined), with Florida and California producing between two-thirds and three-quarters of tomatoes for the fresh market. Florida supplies tomatoes during the winter months (October-May) and California in the summer months (June-September). Outside of winter months, Canada is also a large producer of tomatoes, primarily those grown in greenhouses, though it is a net importer of field tomatoes due to their short growing season. Between 2011-2014, 16% of greenhouse tomatoes imported to the United States came from Canada (ERS, 2015). During the winter months, Mexico and Florida supply about 97% of all tomatoes in the United States (Calvin and Barrios, 1999).

NAFTA was supposed to bring a new age of free trade between the United States and Mexico. However, this trade war escalated when the United States initiated an antidumping investigation against Mexico shortly after the signing of NAFTA in 1994. But in 1996, the two countries signed an agreement to suspend the antidumping investigation (hence the name Suspension Agreement) and set a price floor or minimum price at which Mexican fresh

[8] The leading Mexican export is beer.

tomatoes are to be imported into the United States. The minimum price is generally set above the Mexican price plus transportation costs from Mexico to the United States. In other words, the minimum price is designed to equalize the Mexican producer price for exports sold in the United States and the U.S. producer price. If the United States pursued the investigation and were to find that Mexico had dumped, heavy tariffs could have been imposed on Mexican tomatoes. Though this trade war originally dealt with winter tomatoes, which predominantly included Florida and a few Mexican states because they harvest the majority of their tomatoes during these months, summer tomatoes were also brought into this cross-border trade conflict (Zahniser et al., 2000; Baylis and Perloff, 2010). Thus, it is important to consider all tomatoes, not just Florida winter tomatoes, in studying this dispute.

While the trade dispute arose due to Mexican tomatoes, in recent decades Canada has begun to grow significant quantities of greenhouse tomatoes. Even though their climate does not allow for large amounts of conventionally-grown field tomatoes, the use of greenhouses allows for large-scale production in all seasons except winter. Between 2010 and 2014, Canadian greenhouse tomato exports to the United States accounted for between 15 and 24% of all U.S. imports (ERS, 2015). Because of the Suspension Agreement, diversionary effects from Mexico to Canada have occurred (Baylis and Perloff, 2010). Since about 98.5% of all fresh tomato imports originate from Mexico and Canada, a three-country trade framework is suitable for this study. Thus, our analysis includes Mexico and Canada as exporters and the United States as an importer.

In 2012, after heavy lobbying from Florida growers who claimed that Mexico continues to dump tomatoes on the U.S. market, the U.S. government decided to terminate the Suspension Agreement, which had been in effect in various forms for 16 years.[9] In response, Mexico threatened to institute $1.9 billion worth of retaliatory tariffs. Instead of escalating this trade war, both countries ultimately signed a new agreement, which was implemented in

[9]After 1996, Suspension Agreements were renewed in 2002 and 2008, along with several amendments in other years. In 1996, the price minimum was $0.2068 per pound for all tomato imports (Zahniser et al., 2000). In 2008, the minimum prices were $0.2169 and $0.172 per pound for winter and summer tomato imports, respectively (USDA, 2013).

2013 and raised the minimum price for imported tomatoes (Wingfield and Cattan, 2012). This new agreement increased the minimum price by nearly ten cents per pound and instituted new price minimums for all categories of tomatoes (USDA, 2014). These categories include greenhouse, field, small tomatoes (loose), and small tomatoes (packaged). In this chapter, we investigate the effects of the new Suspension Agreement for three broad categories of tomatoes: greenhouse, field, and small (cherry & grape) tomatoes.[10] As each category has different minimum import prices, we look at the effects of the minimum import price policy on prices, supply, demand, trade, and welfare for each category of tomatoes in all three countries.

This minimum price policy can be understood as a voluntary export restraint (VER)[11] in that a) the volume of Mexican exports at this set minimum price is fixed, similar to an export quota under VER, and b) in both policies, the quota revenues accrue to exporters. Consequently, the welfare results are identical to a voluntary export quota. While Canada is exempt from the minimum price, when it exports, Canadian prices do increase as the United States imports less from Mexico but more from Canada.

While many commodity groups lobby for trade barriers, commodities facing greater competition from imports are often awarded the most protection. This may be a result of a government's support for loss-avoidance of a particular producer group (Freund and Ozden, 2008). For instance, NAFTA increased overall U.S. welfare; however, increased tomato imports from Mexico lowered prices and production (Guajardo and Elizondo, 2003). This can explain why tomato producers lobbied for and received new trade barriers against imports from Mexico soon after the signing of NAFTA. However, other studies indicate that the Mexican peso devaluation of 1995 was the primary contributing factor for the increase in Mexican exports, rather than NAFTA or dumping (Padilla-Bernal et al., 2000).

Regardless of the reasons for the increased tomato imports, the Suspension Agreement has significant effects on welfare. Despite this, very little research has been conducted into examining the benefits and losses of this agreement for producers and

[10] Loose and packaged small tomatoes are combined into small (cherry & grape) tomatoes.
[11] This comparison holds only under perfect competition and no uncertainty.

consumers. Jung (2009) estimated an inverse almost ideal demand system (IAIDS) to quantify the effects of the Suspension Agreement on consumers. However, she did not estimate changes in producer welfare but hypothesized that producer surplus could decline if U.S. consumers substitute away from domestic tomatoes and toward Mexican tomatoes as a result of the increased prices caused by the price floor. In contrast, our study analyzes the effects of the Suspension Agreement on both producer surplus for the United States and Canada and producer welfare (surplus plus quota revenues) for Mexico, in addition to computing consumer surplus in each country.

The rest of the paper is organized as follows. Section 2 develops a three-country theoretical model of trade and incorporates the minimum import price policy. Section 3 describes the data and calibrates the parameters used in the empirical analysis. Section 4 presents the empirical results. Section 5 summarizes the paper and discusses important implications of the results.

4.2 Theoretical Analysis

The three types of tomatoes–greenhouse, field, and small (cherry & grape) tomatoes–are denoted by index $i = 1, 2, 3$, respectively. The three countries included in the model are Mexico (M), Canada (C), and the United States (U). This section formulates a theoretical trade model with demand and supply components for each category of tomato and country and presents the welfare analysis of the Suspension Agreement.

Supply and Demand

Since this study analyzes the short-run effects of the new Suspension Agreement, we assume that producers cannot immediately substitute one category of tomatoes for the other in the production process. This is particularly true for field and greenhouse tomatoes, which have different land requirements, capital, and farming practices. For supply, we consider linear functions:

$$S_i^j = -c_i^j + d_i^j \, p_i^{p,j}, \quad i = 1, 2, 3, \;\; j = U, M, C, \tag{17}$$

where $p_i^{p,j}$ is the producer price for the ith tomato category in country j.

To allow for substitutions among the three categories of tomatoes, we consider a constant elasticity of substitution (CES) demand function for tomato category i in country j. To derive the CES demand function, consider the consumer's problem with utility function

$$U = A\frac{\sigma}{\sigma-1}\left(\delta_1 x_1^{\left(\frac{\sigma-1}{\sigma}\right)} + \delta_2 x_2^{\left(\frac{\sigma-1}{\sigma}\right)} + \delta_3 x_3^{\left(\frac{\sigma-1}{\sigma}\right)}\right) + x_0,$$

where δ_i indicates the share parameter of the three tomato varieties and $\delta_3 = 1 - \delta_1 - \delta_2$, x_i is demand of tomato category i, x_0 is consumption of all other goods, and σ is the elasticity of substitution between varieties of tomatoes. Index 1, 2, 3 refer to greenhouse, field, and cherry & grape tomatoes, respectively.

The consumer maximizes the utility function subject to the budget constraint $Y = p_1x_1 + p_2x_2 + p_3x_3 + x_0$. The Lagrangian for this maximization is

$$\$ = A\frac{\sigma}{\sigma-1}\left(\delta_1 x_1^{\left(\frac{\sigma-1}{\sigma}\right)} + \delta_2 x_2^{\left(\frac{\sigma-1}{\sigma}\right)} + \delta_3 x_3^{\left(\frac{\sigma-1}{\sigma}\right)}\right) + x_0 + \lambda\left(Y - p_1x_1 - p_2x_2 - p_3x_3 - x_0\right).$$

Solving the FOCs and introducing superscript $j = U, M, C$ and c to denote consumer yields the following demand functions for all three categories of tomatoes in all three countries

$$D_i^j = \left(\frac{p_i^{c,j}}{A_i^j \delta_i^j}\right)^{-\sigma_i}, \; i = 1, 2, 3, \; j = U, M, C, \tag{18}$$

where D_i^j is the quantity of tomato category i consumed in country j, and $p_i^{c,j}$ is the consumer price of tomato category i in country j.

Under the Suspension Agreement, the United States sets the minimum import price at $\bar{p}_i^{p,U}$, for imports of ith tomato category from Mexico.[12] The producer price linkage between Mexico and the United States is

[12] This minimum import price is generally binding; otherwise, there is no need for this policy.

$$\bar{p}_i^{p,U} = p_i^{p,M} * T_i + t_i^{M,U}, \tag{19}$$

where T_i is the price wedge caused by the minimum price and $t_i^{M,U}$ is the transportation cost from Mexico to the U.S. border. As discussed in the introduction, this price wedge is the difference in producer prices for tomatoes sold domestically in Mexico and tomatoes sold for export in the United States. Ultimately, the goal of the minimum price is to equalize U.S. producer prices and Mexican producer prices for exports sold in the United States. The producer price linkages for Canadian exports of greenhouse and cherry & grape tomatoes to the United States and for Canadian imports of field tomatoes from Mexico are

$$\bar{p}_i^{p,U} = p_i^{p,C} + t_i^{C,U} \text{ or } p_i^{p,C} = \bar{p}_i^{p,U} - t_i^{C,U},\ i = 1, 3 \tag{20}$$

$$p_i^{p,C} = p_i^{p,M} * T_i + t_i^{M,U} - t_i^{C,U},\ i = 1, 3 \tag{21}$$

$$p_i^{p,C} = p_i^{p,M} + t_i^{M,C},\ i = 2. \tag{22}$$

The price linkage between the producer and consumer price $\left(p_i^{c,j}\right)$ at the retail market in each country is

$$p_i^{c,j} = p_i^{p,j} + m_i^j, \quad i = 1, 2, 3;\ j = U, M, C, \tag{23}$$

where m_i^j denotes the transport cost within the country and the market margin.

The U.S. excess demand $\left(Q_{i,ED}^U\right)$ for the ith category of tomato is the difference between its demand $\left(D_i^U\right)$ and supply $\left(S_i^U\right)$:

$$Q_{i,ED}^U = \left(\frac{p_i^{c,U}}{A_i^U \delta_i^U}\right)^{-\sigma_i} - \left(-c_i^U + d_i^U p_i^{p,U}\right),\ i = 1, 2, 3. \tag{24}$$

Mexican excess supply $\left(Q_{i,ES}^M\right)$ for the ith category of tomato is the difference between its supply $\left(S_i^M\right)$ and demand $\left(D_i^M\right)$:

$$Q_{i,ES}^M = -c_i^M + d_i^M p_i^{p,M} - \left(\frac{p_i^{c,M}}{A_i^M \delta_i^M}\right)^{-\sigma_i},\ i = 1, 2, 3. \tag{25}$$

Similarly, Canadian excess supply of tomato categories $i = 1, 3$ $\left(Q_{i,ES}^C\right)$ is the difference between its supply $\left(S_i^C\right)$ and demand $\left(D_i^C\right)$ while excess demand $\left(Q_{2,ED}^C\right)$ of the field tomato category ($i = 2$) is the difference between its demand $\left(D_2^C\right)$ and supply $\left(S_2^C\right)$:

$$\begin{aligned} Q_{i,ES}^C &= -c_i^C + d_i^C p_i^{p,C} - \left(\frac{p_i^{c,C}}{A_i^C \delta_i^C}\right)^{-\sigma_i},\ i = 1, 3, \\ Q_{2,ED}^C &= \left(\frac{p_2^{c,C}}{A_2^C \delta_2^C}\right)^{-\sigma_2} - \left(-c_2^C + d_2^C p_2^{p,C}\right). \end{aligned} \tag{26}$$

The regional market-clearing conditions are

$$Q_{i,ED}^U = Q_{i,ES}^M + Q_{i,ES}^C,\ i = 1, 3 \tag{27}$$

$$Q_{2,ED}^U + Q_{2,ED}^C = Q_{2,ES}^M. \tag{28}$$

Once all the price linkage equations (19) and (20)-(22) are substituted in the above market-clearing condition, we can solve the simultaneous equations in (27) and (28) for Mexican producer price $\left(p_i^{p,M}\right)$ for the ith category of tomatoes.

Welfare Effects

To analyze the welfare effects of the minimum-support price policy, we obtain producer surplus, quota revenues, and EV measures. The producer surplus is the area left of the supply curve between the free trade price $\left(p_i^{p*}\right)$ and new producer price $\left(p_i^{p,j}\right)$ under the

2013 Suspension Agreement. U.S. producer surplus is

$$\int_{p_i^{p,U*}}^{\bar{p}_i^{p,U}} \left(-c_i^U + d_i^U p_i^{p,U}\right) dp_i^{p,U}, \quad i = 1, 2, 3. \tag{29}$$

In the United States, because of this Suspension Agreement, producers receive the higher minimum price $\left(\bar{p}_P^{p,U}\right)$ and increase their production. Consequently, the producer surplus is positive.

With the Suspension Agreement, Mexican producers face lower prices. However, they receive quota revenues for their exports to the United States. Mexican producer surplus and quota revenues are

$$\int_{p_i^{p,M}}^{p_i^{p,M*}} \left(-c_i^M + d_i^M p_i^{p,M}\right) dp_i^{p,M} + QR_i^M, \quad i = 1, 2, 3, \tag{30}$$

where $QR_i^M = \left(\bar{p}_i^{p,U} - p_i^{p,M}\right)\left(S_i^M - D_i^M\right)$, i.e., the price difference between the United States and Mexico times the quantity of Mexican exports to the United States. The Suspension Agreement policy lowers the Mexican producer price from the free trade price $p_i^{p,M*}$ to $p_i^{p,M}$. As $p_i^{p,M}$ decreases, Mexican producers supply less, and consequently producer surplus declines. However, they receive export quota revenues which are positive. The sum of producer surplus loss and export quota revenues could be a gain or loss, which is an empirical question covered below in the empirical analysis. Bredahl et al. (1987) have shown that if two countries could cooperate and agree to a Voluntary Export Restraint, rents for producers in both countries could rise. That is, the minimum price under this Suspension Agreement could be set such that both U.S. and Mexican producers could gain. However, in reality the minimum price is not selected to maximize the gain of both producers. As a result, the welfare gain of U.S. producers is positive, but gains to Mexican producers could be positive or negative.

Because of this Suspension Agreement, for greenhouse and cherry & grape tomatoes, the United States imports less from Mexico, which causes Canada to export more to the United States. As a result, the price in Canada increases which augments Canadian producer surplus:

$$\int_{p_i^{p*}}^{p_i^{p,C}} \left(-c_i^C + d_i^C p_i^{p,C}\right) dp_i^{p,C}, \;\; i = 1, 3. \tag{31}$$

For field tomatoes, Canada imports more from Mexico because Mexico diverts its sales from the United States to Canada due to the U.S. minimum import price policy. Consequently, the field tomato price in Canada declines and the producer surplus is

$$\int_{p_i^{p,C}}^{p_i^{p*}} \left(-c_i^C + d_i^C p_i^{p,C}\right) dp_i^{p,C}, \; i = 2. \tag{32}$$

The consumer surplus is the area left of the demand curve between the new consumer price $\left(p_i^{c,j}\right)$ and the free trade price $\left(p_i^{c*}\right)$ under the 2013 Suspension Agreement. U.S. consumer surplus is

$$\int_{\bar{p}_i}^{p_i^{c*}} \left(\frac{p_i^{c,U}}{A_i^U \delta_i^U}\right)^{-\sigma_i} dp_i, \; i = 1, 2, 3. \tag{33}$$

Since the minimum price increases the price relative to free trade, U.S. consumer surplus is positive.

For Mexico, consumer surplus for each category of tomatoes is

$$\int_{p_i^M}^{p_i^{c*}} \left(\frac{p_i^{c,U}}{A_i^U \delta_i^U}\right)^{-\sigma_i} dp_i, \; i = 1, 2, 3. \tag{34}$$

Contrary to the United States, Mexican consumer surplus is positive since the Mexican price declines under the Suspension Agreement.

Finally, Canada's consumer surplus is

$$\int_{p_i^{c,C}}^{p_i^{c*}} \left(\frac{p_i^{c,U}}{A_i^U \delta_i^U} \right)^{-\sigma_i} dp_i, \ i = 1, 2, 3, \tag{35}$$

which is negative for greenhouse and cherry & grape tomatoes since the new price in Canada resulting from the Suspension Agreement is higher than the free trade price. However, for field tomatoes the consumer surplus is positive since, when Canada is an importer, the increased imports from Mexico resulting from the U.S. minimum price reduces the Canadian consumer price in comparison to free trade.

4.3 Data and Calibration

To calibrate the model, we collected data from a variety of sources and cross-checked the data from different sources to ensure the data was accurate. The model was calibrated using 2012 data, which was selected based on availability of all required data and because it was the most representative year with no large supply shocks. For instance, Mexican supply in 2011 was 51% of 2012's supply due to adverse weather conditions (Servicio de Informacion Agroalimentaria y Pesquera (SIAP), 2015). Below we explain in detail the data sources for all variables in the following order: production, imports/exports, consumption, prices, and additional parameters for the United States, Mexico, and Canada.

NASS (2012) combines the production data for U.S. greenhouse and field tomatoes and reports it as a single category. We used the shipping and movement data from AMS (2015a) to obtain the percentages of greenhouse and field tomato production and applied these percentages to the total production data in NASS (2012) to disaggregate production data for greenhouse and field tomatoes. The production data for cherry & grape tomatoes are not directly available from any sources. Consequently, we used shipping and movement information from AMS (2015a) to construct the production data for cherry & grape tomatoes.[13,14]

Mexico provides a detailed set of data for various types and varieties of tomatoes (SIAP, 2015). We used this data to construct the production data for the three categories of tomatoes. Canada does not report data for greenhouse and field tomatoes separately. However, for 2011 it does report the greenhouse tomato production (Statistics-Canada, 2013). We used this 2011 data for greenhouse tomato production and the total tomato production in 2012 to construct the greenhouse and field tomato production in 2012 (Statistics-Canada, 2015). Furthermore, Canada groups cherry & grape tomatoes along with greenhouse tomatoes. To separate the cherry & grape tomato production from greenhouse tomato production, we used Canada's imports and exports of cherry & grape tomatoes.

For U.S. imports and exports, we used information from ERS (2015) which separates data by greenhouse, roma, round, cherry, and grape tomatoes. To obtain estimates for field tomatoes, we combined roma and round tomatoes. For Canada, we again used Statistics-Canada (2015, 2013) to determine import and export data, and for consistency we compared that data with U.S. imports from Canada. Since Mexico does not report trade data, we used the data for U.S. and Canadian tomato trade with Mexico. Finally, consumption was determined as domestic production plus imports minus exports.

We collected producer and retail price data for each tomato category in all three countries. Greenhouse tomato prices were higher than field tomato prices. Examination of price data from USITC (2013) indicated that the minimum price was the same for all categories until 2013 and generally non-binding for Mexican greenhouse exports to the United States. ERS (2015) does not report price data for greenhouse tomatoes. Since the minimum price was designed to equalize prices for Mexican exports and U.S. producers, we used the new 2014 greenhouse minimum price plus transportation costs to determine the U.S. producer

[13]We acknowledge Suzanne Thornsbury for helping us to obtain this data and also with the process of constructing the production data for cherry & grape tomatoes.

[14]Since the total shipment of greenhouse and field tomatoes collected from AMS (2015a) is similar to the total production data for these two categories of tomatoes reported in NASS (2012), we felt it was appropriate to use the cherry and grape shipping data in AMS (2015a) to construct the production data for this category of tomatoes.

price. For U.S. field tomatoes, we utilized the average producer price from ERS (2015). Cherry & grape tomato prices were derived in a similar fashion to greenhouse tomatoes as the 2008 Suspension Agreement's price minimum was not binding.

For Mexican producers, we had to determine both domestic and export prices. Mexican producer prices for greenhouse tomatoes were determined in a similar process to the United States by realizing that the previous Suspension Agreement was not binding, implying that producers received identical prices in the domestic and export markets, excluding transport costs. Mexican producer prices for field tomatoes in the domestic market were obtained from SIAP (2015). Mexican prices reported in SIAP were listed in terms of pesos but were converted to U.S. dollars using the peso-dollar exchange rate. Mexican export prices for field tomatoes were collected from USITC (2013). In 2012, producers received $0.17/lb for field tomatoes sold domestically and $0.22/lb (the weighted average minimum price for both summer and winter under the previous Suspension Agreement) for field tomatoes sold in the United States.

Canadian prices are similar to those in the United States for greenhouse tomatoes. Statistics-Canada (2015) reports a price of $0.52/lb for greenhouse producers, though this price also includes higher-priced cherry tomatoes. After disaggregating cherry & grape tomatoes from all greenhouse tomatoes, we estimated a producer price of $0.50/lb. Prices for field and cherry & grape tomatoes were not readily available. As a result, we utilized equations (21) and (22) to estimate the field and cherry & grape tomato prices.

Consumer prices were readily available for the United States through AMS (2015b). However, these prices are reported by tomato type (i.e., vine-ripened, cherry, grape, plum, etc.) and these types do not correspond perfectly with the minimum price categories. Since greenhouse tomatoes are largely vine-ripened tomatoes, we used this price as a proxy for all greenhouse tomatoes. We used a weighted average of plum, roma, and large tomato prices for field tomato prices. Finally, we used a weighted average of cherry & grape tomato prices.

For Mexico, we assumed a similar magnitude price difference between greenhouse and field tomatoes as in the United States since direct price information was only available for field tomatoes. Consumer prices for field tomatoes were obtained from Numbeo (2014) which lists average prices from grocery stores for tomatoes. Cherry & grape tomato prices were also difficult to ascertain; consequently, prices found in Wal-Mart in Mexico were used as a proxy (Walmart, 2015). For Canada, we utilized Numbeo (2014), which lists the average price per pound for tomatoes. We used this price for field tomatoes and assumed an equal magnitude difference in price for greenhouse and cherry & grape tomatoes as in the United States. With these consumer and producer prices, the in-country transport costs and retail margins were found by subtracting consumer price $\left(p_i^{c,j}\right)$ from producer price $\left(p_i^{p,j}\right)$.

The remaining parameters to estimate include the expenditure share parameters for tomato categories $\left(\delta_i^j\right)$, price wedges (T_i), supply parameters $\left(c_i^j \text{ and } d_i^j\right)$, and the elasticity of substitution parameter (σ). Expenses in each country was determined by multiplying retail price times consumption for each category of tomatoes and summing these expenses. Similarly, the share parameter was found by dividing the spending on a particular commodity by the total expenditure on tomatoes in each country (i.e., summing the retail price times consumption for each category of tomatoes). Table 5 presents this data.

For the free trade scenario, the price wedges (T_i) were set to one, implying no price difference for Mexican tomatoes sold within the country and those sold for export, excluding transport cost. For the 2013 minimum price policy, we computed the price wedges: $T_1 = 1.10$, $T_2 = 1.37$, and $T_3 = 1.06$. These price wedges were estimated by collecting the producer price in Mexico and the export price in the United States for each category of tomatoes. Field tomatoes have the highest price wedge because this category already faced a binding minimum price before the new, higher minimum price. The average transport cost from interior Mexico to the U.S. border $\left(t_i^{C,U}\right)$ was estimated at $0.06/lb in 2007 by Bayard et al. (2007). We considered a slightly higher value of $0.08/lb for greenhouse and field tomatoes in 2012 due to higher gas prices. In addition, we estimated transportation costs of $0.10/lb for cherry & grape tomatoes due to packaging requirements. We used similar estimates for transportation costs from Canada to the U.S. border $\left(t_i^{C,U}\right)$.

While numerous studies have estimated the elasticity of demand for aggregate tomatoes (see Huang, 1985; Málaga et al., 2001), only one estimated the elasticity of supply for aggregate tomatoes (Jung, 2004). We used the elasticity estimates from this study as a basis to construct the supply elasticity of $\varepsilon = 0.98$. The 2012 production quantities $\left(S_i^j\right)$ and producer prices $\left(p_i^{p,j}\right)$ are used to calibrate the coefficients of the supply functions (see equation (17)). Table 6 reports the calibrated supply parameters for each country j and tomato category i.

Finally, we consider an Armington elasticity of substitution, σ, equal to 1.10, which is reported by Jung (2004).

4.4 Analysis and Results

This section presents the impacts of the 2013 Suspension Agreement's higher minimum prices on endogenous variables (prices, supply, demand, and trade) for all three categories of tomatoes and also welfare measures (producer welfare and consumer surplus). Towards this goal, we run two simulation scenarios: baseline and alternate. The baseline scenario is free trade, with price wedges set to one. The alternate scenario is the 2013 Suspension Agreement, where the price wedges are $T_1 = 1.10$, $T_2 = 1.37$, and $T_3 = 1.06$. Mexican producer price for each tomato category i is endogenously determined using the market clearing condition (27) and (28), which we use to find the remaining consumer and producer prices in each country j through the price linkage equations (19-23). With these prices, we compute the supply, demand, and trade for each category of tomatoes under the two scenarios and also the percentage changes between the two scenarios to quantify the impacts of the Suspension Agreement policy. Table 7 presents these results.

Under the 2013 Suspension Agreement, the minimum import prices for all three categories of tomatoes is higher in the United States compared to those under free trade because these prices are binding. For greenhouse tomatoes, U.S. producers see their price rise by about 5.10% compared to that under free trade, which leads to an increase in supply of 5.28%. In response to this policy, consumer price rises by 1.42% and demand for greenhouse tomatoes falls by 1.54%. Since we allow substitution between tomato types in consumption, the magnitude of price and quantity changes for consumers is less than that of producers. With higher producer price for greenhouse tomatoes, imports decline by 3.99%.

Since the minimum import price reduces U.S. import demand for Mexican greenhouse tomatoes, prices in Mexico fall. Mexican producer prices decline by 3.44%. In response to the fall in producer price, Mexican greenhouse tomato supply declines by 3.49%. Because of the decline in exports of 13.75%, Mexican consumer prices decline by 1.34% and the quantity of greenhouse tomatoes sold domestically increases by 1.50%.

The Suspension Agreement induces a trade diversionary effect, i.e., Mexican exports are diverted from the United States to Canada. Consequently, with a higher U.S. price, Canada increases its exports to the United States by 8.20%. As a result of the Canadian increased exports, the greenhouse tomato producer price in Canada rises by 6.22% and the consumer price by 1.47%. In response to higher prices, supply increases by 6.25% while demand declines by 1.59%. It is worth pointing out that, although the percentage changes are generally largest in Canada, since Canada’s quantities are much smaller, changes in the volume are smaller compared to those of the United States and Mexico, indicating Canada is a relatively small player in all three tomato markets.

Field tomatoes, which already had a binding minimum price even before the new 2013 Agreement, experience the largest magnitude changes of all three tomato categories. The higher the wedge between the free trade and the minimum import price, the more distortionary the effects. Since the minimum import price is substantially higher than the free trade price, U.S. imports from Mexico are significantly reduced, causing a greater increase in domestic price. As a result of the policy, U.S. field tomato imports falls by 43.80%, which leads to an increase in U.S. producer price by 18.87%. This price increase boosts U.S. supply by 18.91%. With this reduction in imports, the consumer price increases by 4.25% and demand declines by 4.48%. Once again, the impacts on producers outweigh the effects on consumers as a result of substitution between tomato categories in consumption.

The impacts of the Suspension Agreement's higher minimum price on the Mexican field tomato market are substantial. This policy significantly restricts Mexican exports of field tomatoes to the United States by 25.43%. Consequently, Mexico sells more in the domestic market which reduces the producer and consumer price by 8.63% and 2.49%, respectively. The lower price leads to a 8.65% decrease in supply and a 2.82% increase in demand.

Canada is an importer of field tomatoes. Since Mexico exports less to the United States under the minimum import price policy, it diverts its exports to Canada. Mexican field tomato exports to Canada rise by 19.24%. As a result of more imports coming into Canada, field tomato prices in Canada decline by 5.18% for producers, leading to a supply decline of 5.22%. Because of substitution among the three types of tomatoes, consumer prices for field tomatoes fall by only 1.66%, resulting in a demand increase of 1.85% .

The final category is cherry & grape tomatoes. With the smallest price wedge between the free trade and minimum price, the impacts on trade are smaller than those of the greenhouse and field tomatoes. Mexican and Canadian cherry & grape tomato exports to the United States decline by 3.62%. Similarly, the changes in prices and quantities are also minimal. For example, the producer price in the United States increases by only 1.65%, a much smaller increase than those of greenhouse or field tomatoes. Consumer prices rise by only 0.27%. Supply (demand) increases (decreases) by 1.72% (0.30%).

Since the minimum price is closer to the free trade price, the domestic price in Mexico for producers (consumers) only declines by 3.55% (0.58%). These small impacts lead to correspondingly minor changes in supply (demand) of −3.59% (0.64%). Canada, as a net exporter of cherry & grape tomatoes, also experiences only minor changes. Canada is a very minor player in the trade of cherry & grape tomatoes and the 4.99% increase in exports of cherry & grape tomatoes corresponds to an increase of only about 1.5 million pounds. Since Canada augments its exports to the United States, Canadian producer and consumer prices increase by 2.24% and 0.30%, respectively. This increase in prices leads to a supply increase of 2.28% and a demand decrease of 0.33%.

In summary, the higher minimum prices benefit U.S. producers and hurts U.S. consumers. In contrast, Mexican producers incur producer surplus losses from the price minimum policy compared to free trade, while consumers gain. We quantify these welfare changes using producer surplus (PS) and consumer surplus (CS). Producer surplus for the United States and Canada were determined through equations (29) and (31). For Mexican producers, we compute producer surplus loss plus quota revenues (see (30)). CS for each country is computed using equations (33-35). Table 8 reports the results of these welfare measures.

For the United States, producer surplus is positive for each category because producers gain from higher prices under the minimum import prices. While greenhouse tomato producers experience a moderate \$12.06 million increase in producer surplus, field tomato producers gain the most, by \$122.25 million. Cherry & grape tomatoes, which saw the smallest price increase and also represent the smallest tomato category, have the smallest increase in producer surplus of \$2.48 million. Overall, U.S. tomato producer surplus increases by \$136.75 million for all three categories. While producers benefit from price increases in all three categories of tomatoes, consumer surplus falls. Greenhouse tomato consumer surplus falls by \$44.16 million and field tomato consumer surplus has the most substantial loss of \$174.06 million. Cherry & grape consumer surplus has a modest decline of just \$3.94 million. Summing consumer surplus across all categories, the total decline is \$222.16 million.

For Mexico, producer welfare includes both producer surplus loss and quota revenues. The greenhouse tomato category has a net loss of \$5.85 million for Mexico producers, with a quota revenues of \$24.37 million and a producer surplus loss of \$30.22 million. Field tomato producers experience the greatest welfare loss of $-$\$25.60 million (quota revenues of \$50.12 million and producer surplus loss of \$75.72) since the magnitude of the price decline is the highest. For cherry & grape tomatoes, producer welfare declines by just \$0.19 million, which is comprised of \$2.74 million in quota revenues and producer surplus loss of \$2.92 million. Summing the producer welfare of all three categories of tomatoes yields a net loss of $31.64 million. Without quota revenues accruing to Mexican producers, the reduction in producer surplus would be $108.86 million. Consumers gain in every category of tomato consumption. Consumer surplus gains in greenhouse, field, and cherry & grape are, respectively, $20.86, $47.67, and $1.19 million. The overall consumer surplus gain is $69.72.

Canada experiences price increases in greenhouse and cherry & grape tomatoes, which are exports, and a price decrease in field tomatoes, which is an import. Consequently, Canada sustains mixed producer and consumer surplus results. Greenhouse and cherry & grape tomato producers experience a gain of $18.75 and $0.74 million as Canadian prices for these tomatoes rise. In contrast, field tomato producers lose $22.40 million as increased imports from Mexico lead to price declines. Total Canadian producer surplus over all three categories was a loss of $2.91 million. For consumers, the gain in field tomato consumer surplus of $32.66 million dominated consumer surplus losses in greenhouse and cherry & grape tomatoes (−3.59 and − 0.37 million, respectively). As a result, Canadian consumers gain $28.70 million.

Summing producer welfare and consumer surplus yields the net welfare effects. For greenhouse tomatoes, the United States loses $32.10 million while Mexico and Canada gain $15.01 and $15.16 million, respectively. Overall, the region loses $1.93 million from the greenhouse price minimum compared to free trade. The region has a more substantial loss from the new field tomato reference price of $19.48 million since high net loss of $51.81 million in the United States overshadows the gains to Mexico ($22.07 million) and Canada ($10.26 million). The cherry & grape tomato minimum price has a small but negative impact upon the region of −$0.09 million. Once again, the United States loses as a result of this policy (−$1.46 million) while Mexico and Canada gain ($1.00 and $0.37 million, respectively). In total, the region experiences a loss of $21.50 million from the 2013 Suspension Agreement in comparison to free trade.

4.5 Implications and Conclusions

The tomato war between Mexican and U.S. producers has lasted several decades, with no end in sight. This war started in the 1960s when Mexico began exporting tomatoes to the United States. U.S. tomato producers are hurt by increased tomato imports from Mexico. However, those same imports increase the welfare of U.S. consumers through lower prices. Under the Suspension Agreement, as with any import restriction, producers gain and consumers lose. In instituting the minimum import price, the United States is primarily concerned about the interest of domestic producers. This preference for producers is likely because of heavy lobbying by the tomato producers to keep prices from falling due to greater imports from Mexico. Furthermore, the U.S. government is less concerned about losses to consumers because these losses are negligible to individual consumers, making them unlikely to lobby the government to oppose import restrictions. The Suspension Agreement with Mexico is a prime example of such preference by the U.S. government since U.S. producers experience a substantial gain, while individual U.S. consumer's losses are very small.

Despite widespread agreement by economists that free trade increases net welfare, nations tend to impose trade barriers because governments focus on loss to a particular group rather than the overall net gain from free trade. In this study, we find that producers in the United States as well as producers of greenhouse and cherry & grape tomatoes in Canada benefit from the Suspension Agreement. While Mexican producers lose in all three tomato categories, much of their loss is ameliorated due to quota revenues. Until this most recent agreement, the trade in both greenhouse and cherry & grape tomatoes were not binding since the minimum import price was too low to restrict trade. Now, however, the prices of these two categories are higher, leading to binding trade restrictions which causes the United States to divert its imports from Mexico to Canada. The category most impacted by the new minimum price is field tomatoes, whose price was already binding even before the 2013 agreement.

While most U.S. consumers are unaware of the Suspension Agreement, this policy does have aggregate adverse impacts on consumers. Since tomatoes are a commonly consumed product, the overall effect of the Suspension Agreement on consumer welfare is large, even though it only minimally affects each individual consumer. With the United States experiencing higher consumer prices, consumer surplus declines significantly, particularly for field tomatoes. In examining the welfare effects of the 2013 Suspension Agreement, this study quantifies the effects of this trade policy on both producers and consumers. Overall, while Mexico and Canada gain, the United States and the region as a whole experience a loss from these minimum import prices.

CHAPTER 5: Thesis Implications and Conclusions

5.1 Final Remarks

This thesis presents all important aspects of the Suspension Agreement, from historical and legal elements to the role of lobbying and its effects on producers and consumers throughout the United States, Mexico, and Canada. As a result, we develop a thorough understanding of the causes and effects of the Suspension Agreement. We show not only the impacts on fresh tomatoes, the primary industry involved in this dispute, but also on processed tomatoes, which are negatively affected by this dispute. In addition, the analysis not only covers the United States and Mexico, signatories of this agreement, but also Canada, which is not directly involved but impacted by this agreement due to the interrelationship of the tomato market in these three countries. These interlinkages of primary and final commodities and among three countries underscore both the underlying causes and unintended consequences of the Suspension Agreement.

Chapter 2 explains the history of the tomato dispute and possible factors influencing the development of the Suspension Agreement and graphically illustrates the impacts of the Suspension Agreement using a three-county trade analysis. The graphical analysis demonstrates that the Suspension Agreement lowered welfare in the region, largely due to the loss in the United States. Mexican net welfare depends on the size of export quota revenues because tomato growers experience a producer surplus loss and consumers benefit. Interestingly, Canada always experiences a gain in welfare from a minimum price, whether it is a net importer or exporter, since consumer (producer) welfare outweighs producer (consumer) loss when Canada imports (exports).

Chapter 3 explores the political factors that influence the formation of the Suspension Agreement as well as finding the optimal price minimum when the special-interest groups are lobbying for favorable trade policies. Using Grossman and Helpman’s political economy model as a starting point, we incorporate numerous elements that apply directly to the U.S.-Mexican tomato dispute, namely the role of competing lobby groups (i.e., fresh vs.

processing tomatoes), quota revenues accruing to Mexican producers, the Suspension Agreement's imposition of a minimum price rather than a tariff, and the role of Canadian tomatoes. In this analysis, we show the importance of the size of the lobby groups, the weight elected officials place on national welfare as opposed to lobby contributions, and the elasticity of exports and import demand in determining the optimal price wedge. Mexico is willing to abide by this agreement since it benefits their consumers. In addition, the quota revenues offset some of the producer losses, which favors the optimal price wedge.

The final chapter completes an empirical examination of the welfare effects of the Suspension Agreement for three categories of tomatoes corresponding to the 2013 agreement. Because the minimum price is higher than the free trade price, U.S. producers gain from this agreement. This chapter explicitly captures substitution between tomato categories. By allowing consumers to substitute one category for another, some of the consumer surplus loss experienced by the United States is mitigated, though consumers still suffer substantial losses. Even though U.S. producers gain in every category, consumer surplus loss dwarfs producer surplus gains. The empirical results show that Mexican quota revenues offset much of the producer surplus loss, though the minimum prices still result in lower producer surplus across all three tomato categories. Mexican consumers benefit from lower prices and, after summing producer welfare and consumer surplus, this trade policy leads to net gains for Mexico. As predicted in the conceptual analysis results of chapter 2, Canadian producers (consumers) lose (gain) when Canada is an importer (exporter) and gain (lose) when Canada is an exporter (importer) and Canadian net welfare is always positive. Despite both Mexico and Canada gaining from this agreement, the region as a whole loses due to the large consumer surplus loss of the United States. If future agreements substantially raise the reference prices, as advocated by Florida growers, the effects on welfare will be even greater.

Despite the multitude of issues arising from the Suspension Agreement as well as the dubious assertion that Mexico dumps, this agreement is repeatedly renegotiated. Hence, the Suspension Agreement is a recurrent agreement with no external enforcement institution such as the WTO overseeing the negotiation process. Utilizing the WTO dispute settlement body would establish rules and regulations for negotiations, provide transparency and credibility, and timelines for settlement which can avoid the continuous litigation and reoccurring agreements (Klimenko et al., 2008). With a neutral third-party, the United States and Mexico would not be able to manipulate the parameters of dispute resolution processes through threats of antidumping duties or retaliatory tariffs. Furthermore, consigning the tomato dispute to the WTO would likely expose the invalidity of the U.S. claims of Mexican dumping and the need for a minimum import price. In addition, continuation of this Suspension Agreement for nearly 20 years is well beyond the short-term remedy of industry adjustment to greater imports.

References

Almonte-Alvarez, J., D. M. Conley, et al. (2003). Us–Mexico food systems and the tomato trade dispute. *International Food and Agribusiness Management Review 5*(3).

AMS (2015a). Market News Portal, Movement. Agricultural Marketing Service, USDA, https://www.marketnews.usda.gov/mnp/fv-home.

AMS (2015b). Market News Portal, Retail Prices. Agricultural Marketing Service, USDA, https://www.marketnews.usda.gov/mnp/fv-home.

ARS (2015). Products and services: Tomato facts. Agricultural Research Service, USDA, http://www.ars.usda.gov/main/main.htm.

Asci, S., J. J. VanSickle, and D. Cantliffe (2013). The potential for greenhouse tomato production expansion in Florida. In *Southern Agricultural Economics Annual Meeting, available at: http://purl.umn.edu/143095*.

Bayard, B., L. Chen, and H. Thompson (2007). Free trade and a case of local tomato production. *Agricultural Economics Review 8*(2), 71.

Baylis, K. (2003). Dispatches from the tomato wars: The spillover effects of trade barriers. Paper presented at the American Agricultural Economics Association Annual Meeting, July 27-30.

Baylis, K. and J. M. Perloff (2010). Trade diversion from tomato suspension agreements. *Canadian Journal of Economics/Revue canadienne d'économique 43*(1), 127–151.

Boriss, H. and H. Brunke (2005). Commodity profile: Tomatoes, fresh market. Technical report, Agricultural Marketing Research Center.

Bredahl, M., A. Schmitz, and J. S. Hillman (1987). Rent seeking in international trade: The Great Tomato War. *American Journal of Agricultural Economics 69*(1), 1–10.

Brock, W. A. and S. P. Magee (1978). The economics of special interest politics: The case of the tariff. *The American Economic Review*, 246–250.

Calvin, L. and V. Barrios (1999). Marketing winter vegetables from Mexico. *Journal of Food Distribution Research 30*, 50–62.

Cook, R. and L. Calvin (2005). Greenhouse tomatoes change the dynamics of the north american fresh tomato industry. Technical report, Economic Reseach Service, U.S. Department of Agriculture.

Downs, A. (1957). An economic theory of political action in a democracy. *The journal of political economy*, 135–150.

ERS (2015). Vegetable and pulses data, tomatoes. Economic Research Service, USDA, http://www.ers.usda.gov/data-products/vegetables-and-pulses-data/data-by-commodity-imports-and-exports.aspx.

ERSa (2012). Fresh tomato industry. U.S. Department of Agriculture. Economic Research Service, USDA, http://www.ers.usda.gov/topics/crops/vegetables-pulses/tomatoes.aspx.

FAOstat (2015). Production quantity. Food and Agriculture Organization of the United Nations, http://faostat.fao.org.

Findlay, R. and S. Wellisz (1982). Endogenous tariffs, the political economy of trade restrictions, and welfare. In J. Bhagwati (Ed.), *Import Competition and Response*.

Freund, C. and C. Ozden (2008). Trade policy and loss aversion. *The American Economic Review*, 1675–1691.

Gawande, K. and U. Bandyopadhyay (2000). Is protection for sale Evidence on the Grossman-Helpman theory of endogenous protection. *Review of Economics and Statistics 82*(1), 139–152.

Gawande, K., P. Krishna, and M. J. Robbins (2006). Foreign lobbies and US trade policy. *The Review of Economics and Statistics 88*(3), 563–571.

Gould, D. M. and W. C. Gruben (1994). Gatt and the new protectionism. *Economic Review-Federal Reserve Bank of Dallas*, 29.

Grossman, G. M. and E. Helpman (1994). Protection for sale. *The American Economic Review 84*(4), 833–850.

Grossman, G. M. and E. Helpman (1995). Trade wars and trade talks. *Journal of Political Economy 103*(4), 675–708.

Guajardo, R. G. and H. A. Elizondo (2003). North American tomato market: a spatial equilibrium perspective. *Applied Economics 35*(3), 315–322.

Gunter, L. F. and G. C. Ames (2001). U.S.-Mexican tomato wars and the 1996 antidumping suspension agreement. *Farm and Business-The Journal of The Caribbean Agro-Economic Society 4*(2).

Huang, K. S. (1985). *US demand for food: A complete system of price and income effects*. Number 1714. US Dept. of Agriculture, Economic Research Service.

ITA (2011). Fresh tomatoes from Mexico: Suspension Agreement. International Trade Association, http://ia.ita.doc.gov/tomato/.

ITAa (2013). Suspension of antidumping investigation: Fresh tomatoes from Mexico. International Trade Association, http://ia.ita.doc.gov/tomato/2013-agreement/documents/Mexico-Tomatoes-Agreement-20130304.pdf.

ITAc (2013). Trade agreements. International Trade Association, http://ia.ita.doc.gov/agreements/index.html.

Johnecheck, W. A., P. E. Wilde, and J. A. Caswell (2010). Market and welfare impacts of COOL on the US-Mexican tomato trade. *Journal of Agricultural and Resource Economics*, 503–521.

Johnson, H. G. (1953). Optimum tariffs and retaliation. *The Review of Economic Studies*, 142–153.

Jordan, K. H. and J. J. VanSickle (1995). Integration and behavior in the us winter market for fresh tomatoes. *Journal of Agricultural and Applied Economics 27*(01), 127–137.

Jung, J. (2004). *Understanding the COMPAS model: Assumptions, structure, and elasticity of substitution*. Ph. D. thesis, University of Florida.

Jung, J. (2009). Effects of the Suspension agreement: US-Mexico fresh tomatoes antidumping case. Paper presented at the American Agricultural Economics Association Annual Meeting, July 26-28.

Klimenko, M., G. Ramey, and J. Watson (2008). Recurrent trade agreements and the value of external enforcement. *Journal of International Economics 74*(2), 475–499.

Krueger, A. O. (1999). Trade creation and trade diversion under nafta. Technical report, National Bureau of Economic Research.

Magee, S. P., W. A. Brock, and L. Young (1989). *Black Hole Tariffs and Endogenous Policy Theory*. Cambridge University Press.

Málaga, J. E., G. W. Williams, and S. W. Fuller (2001). US-Mexico fresh vegetable trade: the effects of trade liberalization and economic growth. *Agricultural Economics 26*(1), 45–55.

McCalman, P. (2000). Protection for sale and trade liberalization: an empirical investigation. *Available at SSRN 1288207*.

Mitra, D. (1999). Endogenous lobby formation and endogenous protection: a long-run model of trade policy determination. *American Economic Review*, 1116–1134.

Muuls, M. and D. Petropoulou (2008). A Swing State theory theory of trade protection in the Electoral College. Centre for Economic Performance Discussion Paper No. 849, London School of Economics.

NASS (2012). Vegetables 2012 summary. U.S. Department of Agriculture. http://usda.mannlib.cornell.edu.

Numbeo (2014). Cost of living. http://www.numbeo.com/cost-of-living/historical-data-country.

Nzaku, K. and J. E. Houston (2009). Dynamic estimation of us demand for fresh vegetable imports. In *2009 Annual Meeting, July 26-28, 2009, Milwaukee, Wisconsin*, Number 52209. Agricultural and Applied Economics Association.

Ohlemeier, D. (2013). *The Packer*, 03 May, 2013. http://www.thepacker.com/fruit-vegetable-news.html.

OpenSecrets (2015). Influence and lobbying. OpenSecrets, Center for Responsible Politics, www.opensecrets.org.

Padilla-Bernal, L., D. Thilmany, et al. (2000). Mexican-US fresh tomato trade: An analysis of volume, prices and transaction costs. http://ageconsearch.umn.edu/handle/36445.

Raafat, F. and M. Salehizadeh (2002). Exchange rates, import prices, and antidumping cases: an empirical analysis. *The International Trade Journal 16*(3), 269–293.

Robins, T. (2013). *WUSF News*, 24 January, 2013. http://wusfnews.wusf.usf.edu/post/florida-tomato-growers-say-mexico-trade-deal-rotten.

Ruggles, F., T. McCarty, C. DeFilippo, J. Stewart, S. Aranoff, and V. Libeau (1996). Fresh tomatoes from Mexico, publication 2967. Technical report, U.S. International Trade Commission.

Sanger, D. (2013). *The New York Times*, 12 October 1996. http://www.nytimes.com/1996/10/12/us/president-wins-tomato-accord-for-floridians.html.

Schmitz, A., R. S. Firch, and J. S. Hillman (1981). Agricultural export dumping: the case of mexican winter vegetables in the us market. *American Journal of Agricultural Economics 63*(4), 645–654.

SIAP (2015). Produccion agropecuaria y pesquera, Produccion anual. Servicio de Informacion Agroalimentaria y Pesquera, http://www.siap.gob.mx/.

Statistics-Canada (2013). Greenhouse, sod and nursery industries. http://www.statcan.gc.ca/pub/22-202-x/22-202-x2011000-eng.htm.

Statistics-Canada (2015). Supply and disposition of food in Canada. http://www76.statcan.gc.ca/stcsr/query.html.

Stigler, G. J. (1971). The theory of economic regulation. *The Bell journal of economics and management science*, 3–21.

Stoyanov, A. (2009). Trade policy of a free trade agreement in the presence of foreign lobbying. *Journal of International Economics 77*(1), 37–49.

Strom, S. (2013). *The New York Times*, 03 February, 2013. http://www.nytimes.com/2013/02/04/business/united-states-and-mexico-reach-deal-on-tomato-imports.html.

Strom, S. and E. Malkin (2013). *The New York Times*, 27 September, 2012. http://www.nytimes.com/2012/09/28/business.html.

Sullivan, E. (2013). Florida tomato growers not satisfied despite Mexico-U.S. agreement on prices. http://http://www.tampabay.com/news/business/agriculture/florida-tomato-growers-not-satisfied-despite-mexico-us-agreement-on-prices/2112886.

Tullock, G. (1967). The welfare costs of tariffs, monopolies, and theft. *Economic Inquiry 5*(3), 224–232.

USDA (2013). 2008 Suspension Agreement. United States Department of Agriculture, http://enforcement.trade.gov.

USDA (2014). 2013 Suspension Agreement. United States Department of Agriculture, http://enforcement.trade.gov.

USITC (2013). Import injury. United States International Trade Commission, http://www.usitc.gov/traderemedy.

VanSickle, J. J. (1996). A compromise in the fresh tomato trade dispute. *Fla. J. Int'l L. 11*, 399.

VanSickle, J. J., E. A. Evans, and R. D. Emerson (2003). US-Canadian tomato wars: An economist tries to make sense out of recent antidumping suits. *Journal of Agricultural and Applied Economics 35*(02), 283–296.

Walmart (2015). Frutas y verduras. http://www.walmart.com.mx.

Wingfield, B. and N. Cattan (2012). U.S. to end Mexican tomato pact, raising risk of trade war. http://www.bloomberg.com/news/2012-09-27/u-s-ends-mexican-tomato-price-accord-raising-risk-of-trade-war.html.

Zahniser, S., D. Skully, and A. Somwaru (2000). NAFTA commodity supplement, WRS-99-1A. Technical report, Economic Reseach Service, U.S. Department of Agriculture.

Table 1: 2013 Suspension Agreement Reference Prices

Category	Winter (Oct. 23-June 30) tomato minimum price, $ per lb.	Summer (July 1-Oct 22) tomato minimum price, $ per lb.
Field	0.31	0.2458
Greenhouse	0.41	0.3251
Cherry & Grape	0.555	0.44

Source: ITAa (2013)

Table 2: Top Three Trading Partners with the United States for Processed Tomatoes in 2014 (in 1,000 lbs)

Tomato Products	U.S. Imports	U.S. Exports
Juice	Ukraine 32 Turkey 23 Mexico 20	Mexico 1, 758 Dominican Rep. 181 Canada 36
Sauces	Italy 243, 991 Mexico 32, 745 Dominican Rep. 7, 825	Canada 365, 426 Mexico 37, 307 Japan 35, 346
Canned, whole or pieces	Canada 12, 129 Italy 10, 536 Turkey 6, 895	Canada 86, 231 Mexico 19, 055 Japan 8, 326
Paste	Italy 4, 094 China 2, 358 Turkey 1, 824	Italy 204, 978 Mexico 115, 857 Canada 87, 768
Ketchup	Canada 31, 716 Mexico 344 Italy 311	Canada 76, 373 Mexico 19, 459 U.A.E. 6, 220
Pulp and Puree	Italy 6, 787 Canada 1, 756 Mexico 1, 072	Canada 29, 355 Italy 13, 634 Japan 4, 488

Source: ERS (2015)

Table 3: Dollars Spent on Lobbying by Various Groups, 2008-2014

Year	Florida Tomato Growers Exchange[a]	Western Growers Association[b] (all lobbying)	California Tomato Growers	Wal-Mart[c] (all lobbying)
2008	$20, 000	$705, 000	$20, 000	$0
2009	$40, 000	$640, 000	$20, 000	$0
2010	$10, 000	$640, 000	$0	$0
2011	$0	$640, 000	$0	$0
2012	$90, 000	$670, 000	$0	$184, 000
2013	$50, 000	$700, 000	$0	$0
2014	$0	$175, 000	$0	$0

[a] Florida Tomato Growers Exchange is a coalition of Florida tomato producers.
[b] Western Growers Association is located in California and its members are many fruit and vegetable producers, including tomato growers. Thus, its expenditures on lobbying cover many issues related to different fruit and vegetable growers.
[c] Wal-Mart's spending includes lobbying for many causes, which also covers spending *against* the Suspension Agreement.
Source: OpenSecrets (2015)

Table 4: Dollars Spent on Campaign Contributions by Tomato Sectors, 2012

Sector	2012 Election Contributions, in $
Florida Tomato Growers	$115, 750
California Tomato Growers	$388, 247
Processors (not solely tomatoes)	$841, 433

Source: OpenSecrets (2015)

Table 5: Share Parameters for the United States, Mexico, and Canada

	δ_1^j	δ_2^j	δ_3^j
$j = U, M, C$	share of budget		
United States	0.46	0.44	0.10
Mexico	0.38	0.58	0.04
Canada	0.08	0.87	0.04

Table 6: Supply Parameters for the United States, Mexico, and Canada

$j = U, M, C$	c_1^j	d_1^j	c_2^j	d_2^j	c_3^j	d_3^j
United States	17.78	1200.32	3.10	5800.31	12.12	480.11
Mexico	35.23	6800.21	9.34	16, 000.78	2.20	480.52
Canada	4.02	2200.07	10.33	2807.24	1.50	190.43

Table 7: Impact of Suspension Agreement on Tomato Prices and Quantities

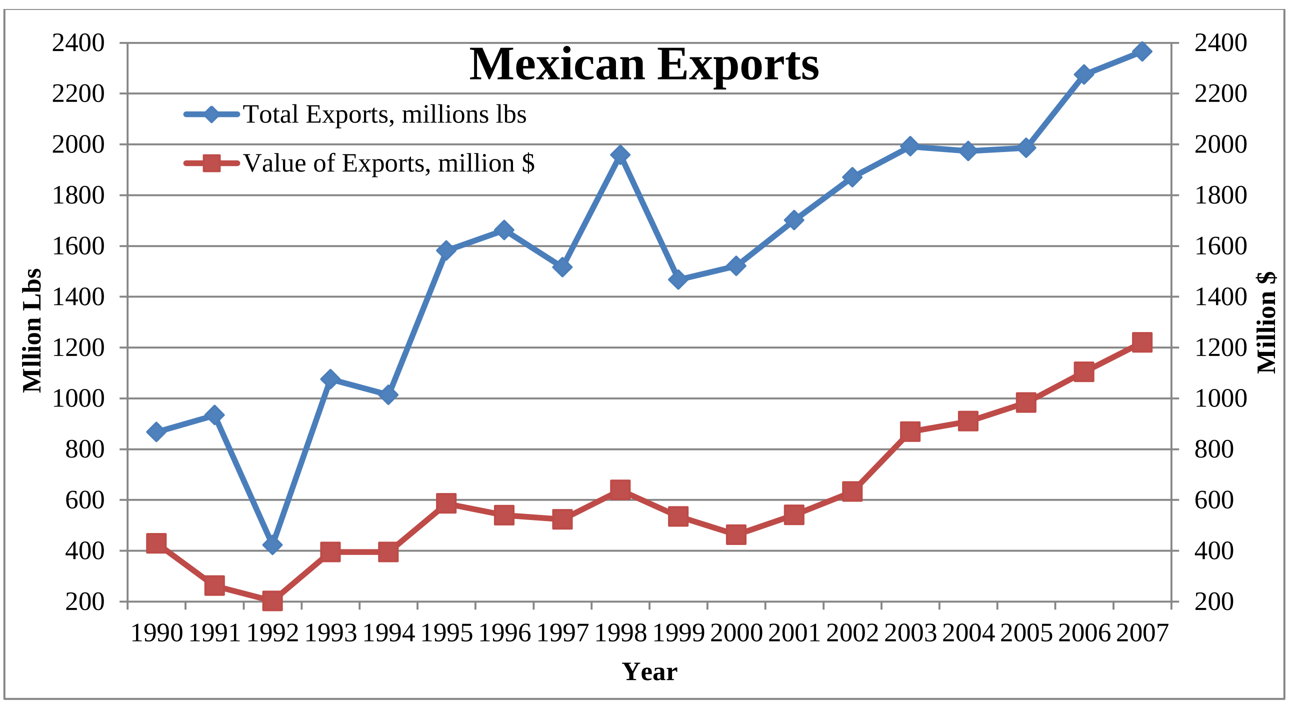
Variable	United States	Mexico	Canada
	%Δ	%Δ	%Δ
Greenhouse			
Producer Price	5.10	−3.44	6.22
Supply	5.28	−3.49	6.25
Consumer Price	1.42	−1.34	1.47
Demand	−1.54	1.50	−1.59
Imports/Exports	−3.99	−13.75	8.20
Field			
Producer Price	18.87	−8.63	−5.18
Supply	18.91	−8.65	−5.22
Consumer Price	4.25	−2.49	−1.66
Demand	−4.48	2.82	1.85
Imports/Exports	−43.08	−25.43	19.24
Cherry & Grape			
Producer Price	1.65	−3.55	2.24
Supply	1.72	−3.59	2.28
Consumer Price	0.27	−0.58	0.30
Demand	−0.30	0.64	−0.33
Imports/Exports	−3.62	−6.38	4.99

Table 8: Producer Welfare, Consumer Surplus, and Net Welfare in Millions of Dollars

	United States	Mexico	Canada
Greenhouse			
Producer Welfare	12.06	−5.85	18.75
Consumer Surplus	−44.16	20.86	−3.59
Net Welfare	−32.10	15.01	15.16
Field			
Producer Welfare	122.25	−25.60	−22.40 [15]
Consumer Surplus	−174.06	47.67	32.66
Net Welfare	−51.81	22.07	10.26
Cherry & Grape			
Producer Welfare	2.48	−0.18	0.74
Consumer Surplus	−3.94	1.19	−0.37
Net Welfare	−1.46	1.00	0.37

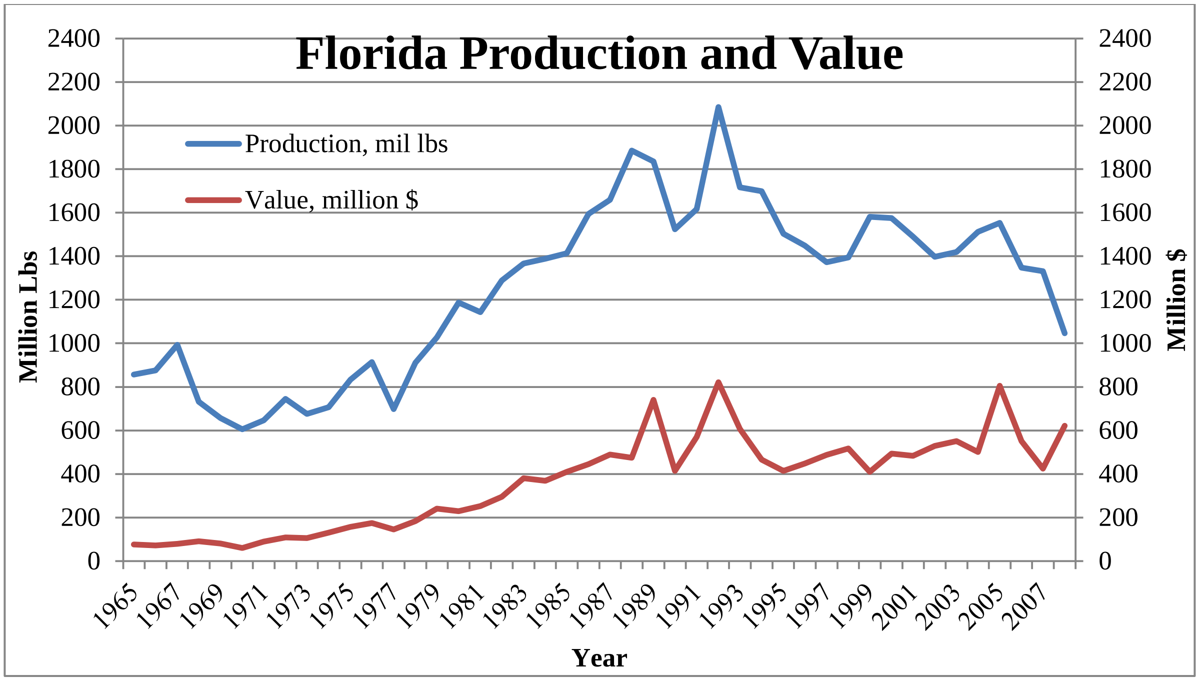
Source: ERS, 2015

Figure 1: Mexican Tomato Production, 1965-2008



Source: ERS, 2015

Figure 2: Mexican Tomato Exports and Value, 1990-2007



Source: ERS, 2015

Figure 3: Florida Tomato Production and Value, 1965-2008

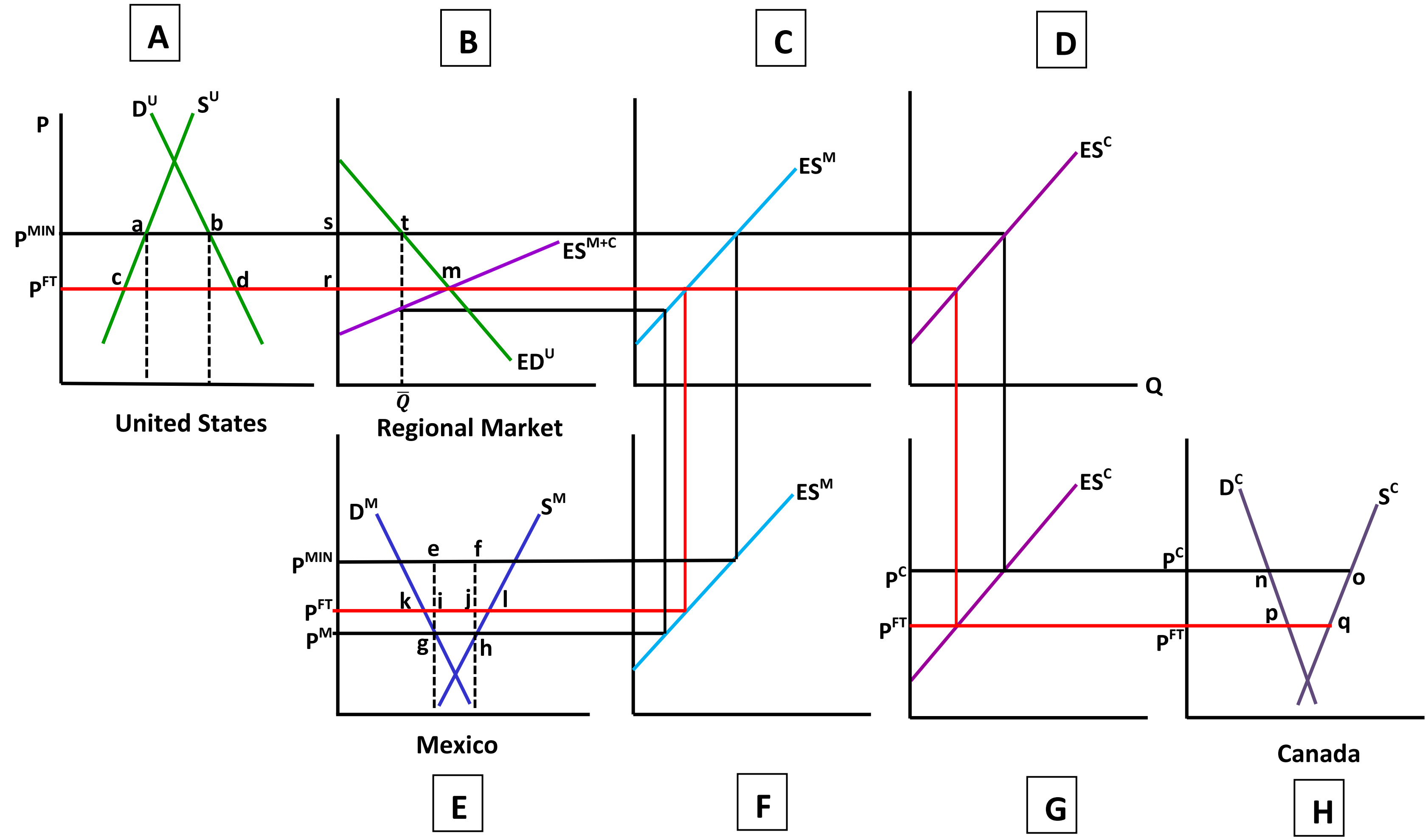


Figure 4: United States is an Importer and Mexico and Canada are Exporters

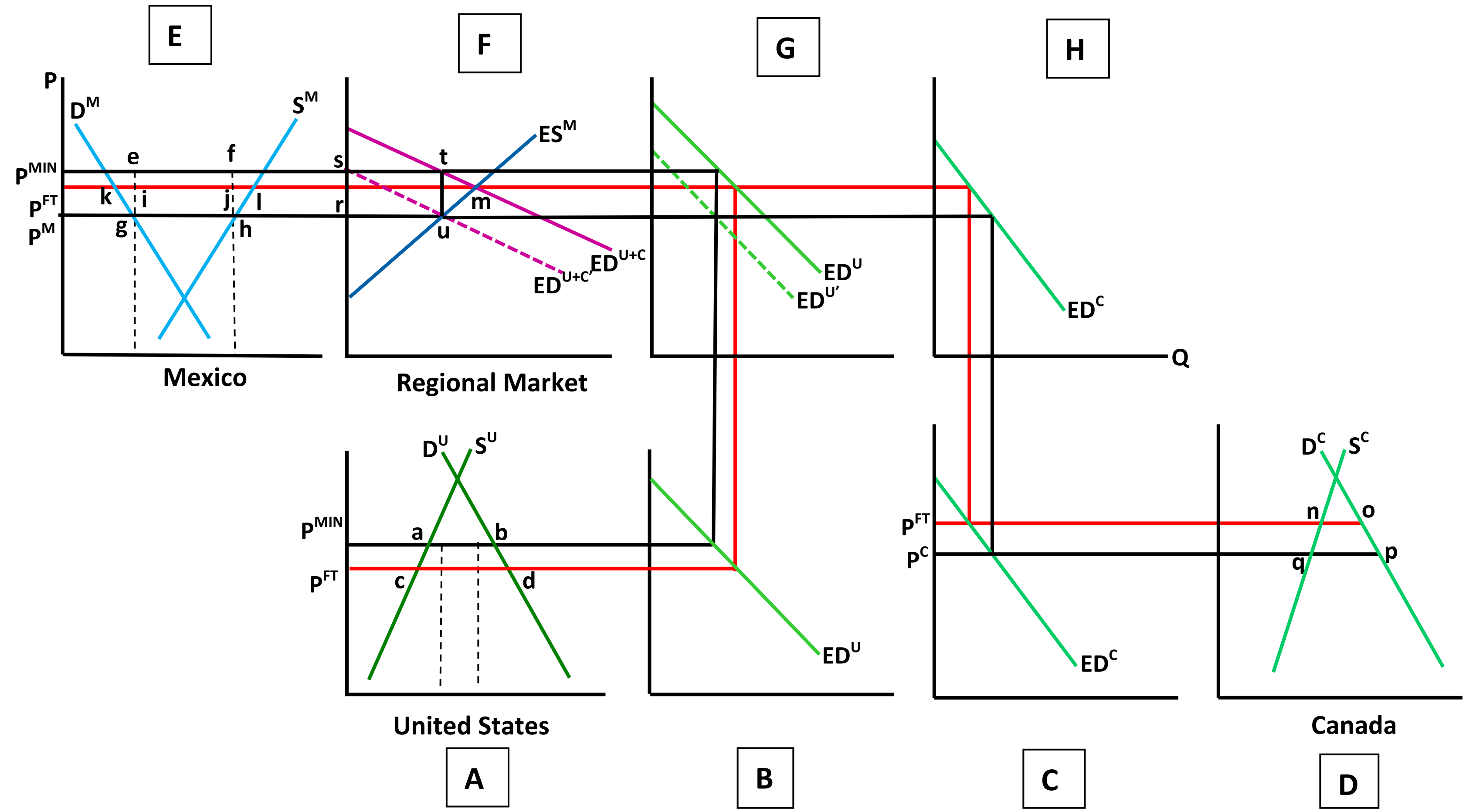


Figure 5: United States and Canada are Importers and Mexico is an Exporter

Appendix 3.1: Derivation of Optimal Price Wedge

Fresh Large Tomatoes

Utilizing the FOC of the maximization of (6) in chapter 3, section 3, the U.S. FOC with respect to $\bar{p}_1$ is

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial \bar{p}_1} + \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} \right] + a^U a^M \left[\sum_{i=1}^n \frac{\partial L^U}{\partial \bar{p}_1} + \sum_{i=1}^n \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial \bar{p}_1} + \sum_{i=1}^n \frac{\partial CS^U \left(p_i^U\right)}{\partial \bar{p}_1} \right] \quad (1)$$

$$a^U \sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial \bar{p}_1} + \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial \bar{p}_1} + \frac{\partial QR_i^M \left(p_i^M\right)}{\partial \bar{p}_1} - \frac{\partial B_i^M}{\partial \bar{p}_1} \right] + a^U a^M \left[\sum_{i=1}^n \frac{\partial L^M}{\partial \bar{p}_1} + \sum_{i=1}^n \frac{\partial \Pi_i^M \left(\bar{p}_i\right)}{\partial \bar{p}_1} + \sum_{i=1}^n \frac{\partial QR_i^M \left(p_i^M\right)}{\partial \bar{p}_1} + \sum_{i=1}^n \frac{\partial CS^M \left(p_i^M\right)}{\partial \bar{p}_1} \right],$$

while the Mexican FOC with respect to p_1^M is

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial p_1^M} + \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial p_1^M} - \frac{\partial B_i^U}{\partial p_1^M} \right] + a^U a^M \left[\sum_{i=1}^n \frac{\partial L^U}{\partial p_1^M} + \sum_{i=1}^n \frac{\partial \Pi_i^U \left(\bar{p}_i\right)}{\partial p_1^M} + \sum_{i=1}^n \frac{\partial CS^U \left(p_i^U\right)}{\partial p_1^M} \right] \quad (2)$$

$$a^U \sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial p_1^M} + \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial p_1^M} + \frac{\partial QR_i^M \left(p_i^M\right)}{\partial p_1^M} - \frac{\partial B_i^M}{\partial p_1^M} \right] + a^U a^M \left[\sum_{i=1}^n \frac{\partial L^M}{\partial p_1^M} + \sum_{i=1}^n \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial p_1^M} + \sum_{i=1}^n \frac{\partial QR_i^M \left(p_i^M\right)}{\partial p_1^M} + \sum_{i=1}^n \frac{\partial CS^M \left(p_i^M\right)}{\partial p_1^M} \right]$$

$$= \; 0.$$

For the U.S. FOC, we solve for each component below. The first term is the U.S. contribution schedule for lobby groups.

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial \bar{p}_1} + \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} \right]$$

$$\frac{\partial L_1^U}{\partial \bar{p}_1} + \frac{\partial \Pi_1^U \left(\bar{p}_1\right)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} = y_1^U$$

$$\frac{\partial L_2^U}{\partial \bar{p}_1} + \frac{\partial \Pi_2^U \left(\bar{p}_2\right)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} = 0$$

$$\frac{\partial L_3^U}{\partial \bar{p}_1} + \frac{\partial \Pi_3^U(\bar{p}_1, p_3)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} = -y_3^{U,d}$$

$$\frac{\partial L_j^U}{\partial \bar{p}_1} + \frac{\partial \Pi_j^U\left(p_j^U\right)}{\partial \bar{p}_1} - \frac{\partial B_i^U}{\partial \bar{p}_1} = 0 \;, j \neq 1-3.$$

$$a^M \left[y_1^U - y_3^{U,d}\right] \tag{3}$$

For U.S. total welfare,

$$a^M a^U \left[\sum_{i=1}^{n} \frac{\partial L^U}{\partial \bar{p}_1} + \sum_{i=1}^{n} \frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial \bar{p}_1} + \sum_{i=1}^{n} \frac{\partial CS^U\left(p_i^U\right)}{\partial \bar{p}_1}\right].$$

$$\frac{\partial L^U}{\partial \bar{p}_1} = 0$$

$$\frac{\partial \Pi_1^U(\bar{p}_1)}{\partial \bar{p}_1} = y_1^U$$

$$\frac{\partial \Pi_2^U(\bar{p}_2)}{\partial \bar{p}_1} = 0$$

$$\frac{\partial \Pi_3^U\left(p_3^U, \bar{p}_1\right)}{\partial \bar{p}_1} = -y_{3,1}^{U,d}$$

$$\frac{\partial \Pi_j^U\left(p_j^U\right)}{\partial \bar{p}_1} = 0,\; j \neq 1-3$$

$$\frac{\partial CS^U(\bar{p}_1)}{\partial \bar{p}_1} = -c_1^U$$

$$\frac{\partial CS^U\left(p_j^U\right)}{\partial \bar{p}_1} = 0,\; j \neq 1$$

$$a^M a^U \left[y_1^U - y_{3,1}^{U,d} - c_1^U\right] \tag{4}$$

Mexico's contribution to the U.S. FOC consists of lobby contributions and total welfare. For Mexican large fresh tomato growers, the contribution schedule contains labor income, profits, and quota revenues, where $QR_1^M = \left(\bar{p}_1 - p_1^M(\bar{p}_1)\right)\left[y_1^M\left(p_1^M(\bar{p}_1)\right) - c_1^M\left(p_1^M(\bar{p}_1)\right) - y_{3,1}^{M,d}\left(p_1^M(\bar{p}_1)\right)\right]$.

$$a^U \sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial \bar{p}_1} + \frac{\partial \Pi_i^M (p_i)}{\partial \bar{p}_1} + \frac{\partial QR_i^M (p_i)}{\partial \bar{p}_1} - \frac{\partial B_i^M}{\partial \bar{p}_1} \right].$$

$$\frac{\partial L_1^M}{\partial \bar{p}_1} + \frac{\partial \Pi_1^M \left(p_1^M (\bar{p}_1)\right)}{\partial \bar{p}_1} + \frac{\partial QR_1^M \left(p_1^M (\bar{p}_1)\right)}{\partial \bar{p}_1} - \frac{\partial B_i^M}{\partial p_i^M} =$$

$$y_1^M \frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M \left(p_1^M (\bar{p}_1)\right) - c_1^M \left(p_1^M (\bar{p}_1)\right) - y_{3,1}^{M,d} \left(p_3^M, p_1^M (\bar{p}_1)\right)\right] \left(1 - \frac{\partial p_1^M}{\partial \bar{p}_1}\right)$$

$$+ \left(\bar{p}_1 - p_1^M (\bar{p}_1)\right) \left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^M}{\partial p_1^M}\right] \frac{\partial p_1^M}{\partial \bar{p}_1}$$

$$\frac{\partial L_2^M}{\partial \bar{p}_1} + \frac{\partial \Pi_2^M \left(p_2^M (\bar{p}_2)\right)}{\partial \bar{p}_1} + \frac{\partial QR_2^M \left(p_2^M (\bar{p}_2)\right)}{\partial \bar{p}_1} - \frac{\partial B_2^M}{\partial p_2^M} = 0$$

$$\frac{\partial L_3^M}{\partial \bar{p}_1} + \frac{\partial \Pi_3^M \left(p_1^M (\bar{p}_1), p_3^M\right)}{\partial \bar{p}_1} - \frac{\partial B_3^M}{\partial p_3^M} = -y_3^{d,M} \frac{\partial p_1^M}{\partial \bar{p}_1}$$

$$\frac{\partial L_j^M}{\partial \bar{p}_1} + \frac{\partial \Pi_j^M \left(p_j^M\right)}{\partial \bar{p}_1} - \frac{\partial B_j^M}{\partial \bar{p}_1} = 0,\ j \neq 1-3.$$

$$a^U \left[y_1^M \frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{M,d}\right] \left(1 - \frac{\partial p_1^M}{\partial \bar{p}_1}\right) + \left(\bar{p}_1 - p_1^M (\bar{p}_1)\right) \left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^M}{\partial p_1^M}\right] \frac{\partial p_1^M}{\partial \bar{p}_1} - y_3^{d,M} \frac{\partial p_1^M}{\partial \bar{p}_1} \right] \tag{5}$$

For Mexican total welfare,

$$a^M a^U \left[\sum_{i=1}^{n^*} \frac{\partial L^M}{\partial \bar{p}_1} + \sum_{i=1}^{n^*} \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial \bar{p}_1} + \sum_{i=1}^{2} \frac{\partial QR_i^M \left(p_i^M (\bar{p}_i)\right)}{\partial \bar{p}_1} + \sum_{i=1}^{n^*} \frac{\partial CS^M \left(p_i^M\right)}{\partial \bar{p}_1} \right].$$

$$\frac{\partial L^M}{\partial \bar{p}_1} = 0$$

$$\frac{\partial \Pi_1^M \left(p_1^M (\bar{p}_1)\right)}{\partial \bar{p}_1} + \frac{\partial QR_1^M \left(p_1^M (\bar{p}_1)\right)}{\partial \bar{p}_1} = y_1^M \frac{\partial p_2^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right] \left(1 - \frac{\partial p_1^M}{\partial \bar{p}_1}\right) + \left(\bar{p}_1 - p_1^M\right) \left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right] \frac{\partial p_1^M}{\partial \bar{p}_1}$$

$$\frac{\partial \Pi_2^M \left(p_2^M (\bar{p}_2)\right)}{\partial \bar{p}_1} + \frac{\partial QR_2^M \left(p_2^M (\bar{p}_2)\right)}{\partial \bar{p}_1} = 0$$

$$\frac{\partial \Pi_3^M \left(p_3, p_1^M (\bar{p}_1)\right)}{\partial \bar{p}_1} = -y_3^{M,d}$$

$$\frac{\partial \Pi_j^M\left(p_j^M\right)}{\partial \bar{p}_1} = 0,\ j \neq 1-3$$
$$\frac{\partial CS^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial \bar{p}_1} = -c_1^M\frac{\partial p_1^M}{\partial \bar{p}_1}$$
$$\frac{\partial CS^M\left(p_j^M\right)}{\partial \bar{p}_1} = 0,\ j \neq 1$$

$$a^M a^U\left[y_1^M\frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right]\left(1-\frac{\partial p_1^M}{\partial \bar{p}_1}\right) + \left(\bar{p}_1 - p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]\frac{\partial p_1^M}{\partial \bar{p}_1} - y_3^{M,d}\frac{\partial p_1^M}{\partial \bar{p}_1} - c_1^M\frac{\partial p_1^M}{\partial \bar{p}_1}\right] \tag{6}$$

Summing (3) and (4), the U.S. contribution to the joint welfare equation is

$$a^M\left[y_1^U - y_{3,1}^{U,d}\right] + a^M a^U\left[y_1^U - y_{3,1}^{U,d} - c_1^U\right].$$

Summing the four components yields the U.S. welfare-maximizing equation:

$$\begin{aligned} & a^M\left[y_1^U - y_3^{U,d}\right] + a^M a^U\left[y_1^U - y_{3,1}^{U,d} - c_1^U\right] \\ & +a^U\left[y_1^M\frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right]\left(1-\frac{\partial p_1^M}{\partial \bar{p}_1}\right) + \left(\bar{p}_1 - p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]\frac{\partial p_1^M}{\partial \bar{p}_1} - y_{3,1}^{M,d}\frac{\partial p_1^M}{\partial \bar{p}_1}\right] \\ & +a^M a^U\left[y_1^M\frac{\partial p_1^M}{\partial \bar{p}_1} + \left[y_1^M - c_1^M - y_{3,1}^{d,M}\right]\left(1-\frac{\partial p_1^M}{\partial \bar{p}_1}\right) + \left(\bar{p}_1 - p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]\frac{\partial p_1^M}{\partial \bar{p}_1} - y_{3,1}^{M,d}\frac{\partial p_1^M}{\partial \bar{p}_1} - c_1^M\frac{\partial p_1^M}{\partial \bar{p}_1}\right] \\ = \ & 0. \end{aligned} \tag{7}$$

Recall the world market-clearing conditions

$$m_1^U - x_1^M + m_1^C = 0 \tag{8}$$

$$m_2^U - x_2^M - x_2^C = 0 \tag{9}$$

$$x_3^U - m_3^M = 0. \tag{10}$$

To obtain $\frac{\partial p_1^M}{\partial \bar{p}_1}$, we find the total derivative of (8):

$$\frac{\partial c_1^U}{\partial \bar{p}_1} d\bar{p}_1 + \frac{\partial y_{3,1}^d}{\partial p_3^U} dp_3^M + \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} d\bar{p}_1 - \frac{\partial y_1}{\partial \bar{p}_1} d\bar{p}_1 - \left(\frac{\partial y_1^M}{\partial p_1^M} dp_1^M - \frac{\partial c_1^M}{\partial p_1^M} dp_1^M - \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} dp_3^M - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M} dp_1^M \right) + \frac{\partial c_1^C}{\partial p_1^C} dp_1^M - \frac{\partial y_1^C}{\partial p_1^C} dp_1^M = 0.$$

Similarly, the total derivative of processed tomatoes from (10) is

$$\frac{\partial y_3^U}{\partial p_3^U} dp_3^M + \frac{\partial y_3^U}{\partial \bar{p}_1} d\bar{p}_1 - \frac{\partial c_3^U}{\partial p_3^U} dp_3^M - \left(\frac{\partial c_3^M}{\partial p_3^M} dp_3^M - \frac{\partial y_3^M}{\partial p_3^M} dp_3^M - \frac{\partial y_3^M}{\partial p_1^M} dp_1^M \right) = 0.$$

Find below the previous equations in matrix form.

$$\begin{bmatrix} -\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} + \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C} & \frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \\ \frac{\partial y_3^M}{\partial p_1^M} & -\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \end{bmatrix} \begin{bmatrix} dp_1^M \\ dp_3^M \end{bmatrix} = \begin{bmatrix} -\frac{\partial c_1^U}{\partial \bar{p}_1} d\bar{p}_1 - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} d\bar{p}_1 + \frac{\partial y_1}{\partial \bar{p}_1} d\bar{p}_1 \\ -\frac{\partial y_3^U}{\partial \bar{p}_1} d\bar{p}_1 \end{bmatrix}$$

Cramer's Rule is employed to solve for $\frac{dp_1^M}{d\bar{p}_1}$ and $\frac{dp_3^M}{d\bar{p}_1}$:

$$\frac{dp_1^M}{d\bar{p}_1}=\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \tag{11}$$

$$\frac{dp_3^M}{d\bar{p}_1}=\frac{\left(\frac{\partial y_1^M}{\partial p_1^M}-\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}+\frac{\partial y_1^C}{\partial p_1^C}-\frac{\partial c_1^C}{\partial p_1^C}\right)\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)-\frac{\partial y_3^M}{\partial p_1^M}\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}. \tag{12}$$

After substituing for $\frac{\partial p_1^M}{\partial \bar{p}_1}=p_1^{M'}$, the governments reach a joint maximum welfare when

$$\begin{aligned}
& a^M\left[y_1^U-y_{3,1}^{U,d}\right]+a^U\left[y_1^M p_1^{M'}+\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)\left(1-p_1^{M'}\right)+\left(\bar{p}_1-p_1^M\right)\left(y_1^{M'}-c_1^{M'}-y_{3,1}^{d,M'}\right)p_1^{M'}-y_{3,1}^{M,d}p_1^{M'}\right]\\
& +a^M a^U\left[y_1^U-y_{3,1}^{U,d}-c_1^U\right]\\
& +a^M a^U\left[y_1^M p_1^{M'}+\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)\left(1-p_1^{M'}\right)+\left(\bar{p}_1-p_1^M\right)\left(y_1^{M'}-c_1^{M'}-y_{3,1}^{d,M'}\right)p_1^{M'}-y_{3,1}^{M,d}p_1^{M'}-c_1^M p_1^{M'}\right]\\
= {} & 0
\end{aligned}$$

Further simplifying,

$$\begin{aligned}
& a^M y_1^U-a^M y_{3,1}^{U,d}+a^U y_1^M p_1^{M'}-a^U y_{3,1}^{M,d}p_1^{M'}+a^U x_1^M-a^U x_1^M p_1^{M'}+a^U\left(\bar{p}_1-p_1^M\right)x_1^{M'}p_1^{M'}-a^M a^U m_1^U\\
& \quad +a^M a^U x_1^M+a^M a^U\left(\bar{p}_1-p_1^M\right)x_1^{M'}p_1^{M'}=0
\end{aligned}$$

Substitute (11) into the above equation.

$$
\begin{aligned}
&a^M y_1^U - a^M y_{3,1}^{U,d} + a^U y_1^M \left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) + \left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) - \left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \right) \\
&-a^U y_{3,1}^{M,d} \left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) + \left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) - \left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \right) \\
&+a^U x_1^M - a^U x_1^M \left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) + \left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) - \left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \right) \\
&+a^U \left(\bar{p}_1 - p_1^M\right) x_1^{M\prime} \left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) + \left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) - \left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \right) \\
&-a^M a^U m_1^U + a^M a^U x_1^M \\
&+a^M a^U \left(\bar{p}_1 - p_1^M\right) x_1^{M\prime} \left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^d}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) + \left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M}\right) - \left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)} \right) = \\
&0
\end{aligned}
$$

Substituting $m_1^U = x_1^M - m_1^C$ and simplifying,

$a^U \left(1 + a^M\right) \left(\bar{p}_1 - p_1^M\right) =$

$$
\frac{a^{M} y_1^{U}}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$
+\frac{-a^{M} y_{3,1}^{U,d}}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$
+\frac{a^{U} y_1^{M}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$
+\frac{\cdots -a^U y_{3,1}^{M,d}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$
+\frac{a^U x_1^M}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$
+\frac{-a^U x_1^M\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}{-x_1^{M'}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}
$$

$$+\frac{a^M a^U m_1^C}{-x_1^{M\prime}\left(\frac{\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^d}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\left(\frac{\partial y_3^U}{\partial \bar{p}_1}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\left(\frac{\partial y_3^M}{\partial p_1^M}\right)\left(\frac{\partial y_{3,1}^d}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)}\right)}$$

From (2), we examine the corresponding equation for the Mexican FOC.

The U.S. lobbying contributions are

$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial p_1^M}+\frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial p_1^M}-\frac{\partial B_i^U}{\partial p_1^M}\right]$.

$\frac{\partial L_i^U}{\partial p_1^M}+\frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial p_1^M}-\frac{\partial B_i^U}{\partial p_1^M}=0,\ i=i=1,\ ...,\ n.$

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial p_1^M}+\frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial p_1^M}-\frac{\partial B_i^U}{\partial p_1^M}\right]=0$$

The U.S. welfare component is

$$a^U a^M\left[\sum_{i=1}^n \frac{\partial L^U}{\partial p_1^M}+\sum_{i=1}^n \frac{\partial \Pi_i^U\left(\bar{p}_i\right)}{\partial p_1^M}+\sum_{i=1}^n \frac{\partial CS^U\left(p_i^U\right)}{\partial p_1^M}\right]=0.$$

The Mexican lobby contribution are

$a^U \sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial p_1^M}+\frac{\partial \Pi_i^M\left(p_i^M\right)}{\partial p_1^M}+\frac{\partial QR_i^M\left(p_i^M\right)}{\partial p_1^M}-\frac{\partial B_i^M}{\partial p_1^M}\right]$

$\frac{\partial L_1^M}{\partial p_1^M}+\frac{\partial \Pi_1^M\left(p_1^M\right)}{\partial p_1^M}+\frac{\partial QR_1^M\left(p_1^M\right)}{\partial p_1^M}-\frac{\partial B_1^M}{\partial p_1^M}=y_1^M+\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)(-1)+\left(\bar{p}_1-p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M}-\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]$

$\frac{\partial L_2^M}{\partial p_1^M}+\frac{\partial \Pi_2^M\left(p_2^M\right)}{\partial p_1^M}+\frac{\partial QR_2^M\left(p_2^M\right)}{\partial p_1^M}-\frac{\partial B_2^M}{\partial p_1^M}=0$

$$\frac{\partial L_3^M}{\partial p_1^M}+\frac{\partial \Pi_3^M\left(p_3^M\right)}{\partial p_1^M}+\frac{\partial QR_3^M\left(p_3^M\right)}{\partial p_1^M}-\frac{\partial B_3^M}{\partial p_1^M}=-y_{3,1}^{d,M}$$

$$\frac{\partial L_j^M}{\partial p_j^M}+\frac{\partial \Pi_j^M\left(p_j^M\right)}{\partial p_j^M}+\frac{\partial QR_j^M\left(p_j^M\right)}{\partial p_j^M}-\frac{\partial B_j^M}{\partial p_j^M}=0,\ j\neq 1-3.$$

$$a^U\left[y_1^M-\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)+\left(\bar{p}_1-p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M}-\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]-y_{3,1}^{d,M}\right]$$

Mexican total welfare is

$$a^Ua^M\left[\sum_{i=1}^n\frac{\partial L^M}{\partial p_i^M}+\sum_{i=1}^n\frac{\partial \Pi_i^M\left(p_i^M\right)}{\partial p_i^M}+\sum_{i=1}^n\frac{\partial QR_i^M\left(p_i^M\right)}{\partial p_i^M}+\sum_{i=1}^n\frac{\partial CS^M\left(p_i^M\right)}{\partial p_i^M}\right].$$

$$\frac{\partial L^M}{\partial p_1^M}+\frac{\partial \Pi_1^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_1^M}+\frac{\partial QR_1^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_1^M}+\frac{\partial CS^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_1^M}=$$

$$y_1^M-\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)+\left(\bar{p}_1-p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M}-\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]-c_1^M$$

$$\frac{\partial \Pi_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_1^M}+\frac{\partial QR_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_1^M}+\frac{\partial CS^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_1^M}=0$$

$$\frac{\partial \Pi_1^M\left(p_3^M,p_1^M\left(\bar{p}_1\right)\right)}{\partial p_1^M}+\frac{\partial QR_1^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_1^M}+\frac{\partial CS^M\left(p_3^M,p_1\left(\bar{p}_1\right)\right)}{\partial p_1^M}=-y_{3,1}^{d,M}$$

$$\frac{\partial L^M}{\partial p_1^M}+\frac{\partial \Pi_j^M\left(p_j^M\right)}{\partial p_1^M}+\frac{\partial QR_j^M\left(p_j^M\right)}{\partial p_1^M}+\frac{\partial CS^M\left(p_j^M\right)}{\partial p_1^M}=0,\ j\neq 1-3$$

$$a^Ua^M\left[y_1^M-\left(y_1^M-c_1^M-y_{3,1}^{d,M}\right)+\left(\bar{p}_1-p_1^M\right)\left[\frac{\partial y_1^M}{\partial p_1^M}-\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_{3,1}^{d,M}}{\partial p_1^M}\right]-c_1^M-y_{3,1}^{d,M}\right]$$

Summing the components of the Mexican FOC yields

$$
\begin{aligned}
& a^U \left[y_1^M - \left(y_1^M - c_1^M - y_{3,1}^{d,M} \right) + \left(\bar{p}_1 - p_1^M \right) \left(\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M} \right) - y_{3,1}^{d,M} \right] \\
& + a^U a^M \left[y_1^M - c_1^M - y_{3,1}^{d,M} - \left(y_1^M - c_1^M - y_{3,1}^{d,M} \right) + \left(\bar{p}_1 - p_1^M \right) \left(\frac{\partial y_1^M}{\partial p_1^M} - \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_{3,1}^{d,M}}{\partial p_1^M} \right) \right] \\
= \; & 0.
\end{aligned} \tag{13}
$$

Simplying the above equation leads to

$$a^U y_1^M - a^U y_{3,1}^{d,M} - a^U x_1^M + a^U \left(1 + a^M\right) \left(\bar{p}_1 - p_1^M\right) x_1^{M'} = 0.$$

Setting the U.S. and Mexican FOCs equal to each other, we solve for optimal large tomato price wedge.

$$
\begin{aligned}
& \frac{-a^M y_1^U \left[\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) - \frac{\partial y_3^M}{\partial p_1^M} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right) \right]}{x_1^{M'} \left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^{d,U}}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) + \frac{\partial y_3^U}{\partial \bar{p}_1} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right)} \\
& + \frac{a^M y_{3,1}^{U,d} \left[\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) - \frac{\partial y_3^M}{\partial p_1^M} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right) \right]}{x_1^{M'} \left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^{d,U}}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) + \frac{\partial y_3^U}{\partial \bar{p}_1} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right)} \\
& + \frac{-a^U y_1^M}{x_1^{M'}} + \frac{a^U y_{3,1}^{M,d}}{x_1^{M'}} + \frac{a^U x_1^M}{x_1^{M'}} \\
& + \frac{-a^U x_1^M \left[\left(-\frac{\partial y_1^M}{\partial p_1^M} + \frac{\partial c_1^M}{\partial p_1^M} - \frac{\partial y_1^C}{\partial p_1^C} + \frac{\partial c_1^C}{\partial p_1^C} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) - \frac{\partial y_3^M}{\partial p_1^M} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right) \right]}{x_1^{M'} \left[\left(-\frac{\partial c_1^U}{\partial \bar{p}_1} - \frac{\partial y_{3,1}^{d,U}}{\partial \bar{p}_1} + \frac{\partial y_1}{\partial \bar{p}_1} \right) \left(-\frac{\partial c_3^U}{\partial p_3^U} + \frac{\partial y_3^U}{\partial p_3^U} + \frac{\partial y_3^M}{\partial p_3^M} - \frac{\partial c_3^M}{\partial p_3^M} \right) + \frac{\partial y_3^U}{\partial \bar{p}_1} \left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U} + \frac{\partial y_{3,1}^{d,M}}{\partial p_3^M} \right) \right]}
\end{aligned}
$$

$$+\frac{-a^M a^U m_1^C\left[\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}-\frac{\partial y_1^C}{\partial p_1^C}+\frac{\partial c_1^C}{\partial p_1^C}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)-\frac{\partial y_3^M}{\partial p_1^M}\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\right]}{x_1^{M'}\left[\left(-\frac{\partial c_1^U}{\partial \bar{p}_1}-\frac{\partial y_{3,1}^{d,U}}{\partial \bar{p}_1}+\frac{\partial y_1}{\partial \bar{p}_1}\right)\left(-\frac{\partial c_3^U}{\partial p_3^U}+\frac{\partial y_3^U}{\partial p_3^U}+\frac{\partial y_3^M}{\partial p_3^M}-\frac{\partial c_3^M}{\partial p_3^M}\right)+\frac{\partial y_3^U}{\partial \bar{p}_1}\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\right]}$$

$$-a^U\left(1+a^M\right)\left(\bar{p}_1-p_1^M\right)=$$

$$a^U y_1^M - a^U y_{3,1}^{d,M} - a^U x_1^M + a^U\left(1+a^M\right)\left(\bar{p}_1-p_1^M\right)x_1^{M'}$$

Further simplification yields the final result.

$$\left(\bar{p}_1-p_1^M\right)=$$

$$\underbrace{\frac{a^M y_1^U\left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+m_1^{C'}\right)\left(m_3^{M'}-x_3^{U'}\right)}^{(+)}+\overbrace{\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)}\right]}{a^U\left(1+a^M\right)\left(1+x_1^{M'}\right)x_1^{M'}\left[-m_1^{U'}\left(\acute{x}_3^{U'}-m_3^{M'}\right)+\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}\right]}}_{(+)}$$

$$+\frac{a^M y_{3,1}^{U,d}\left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+m_1^{C'}\right)\left(x_3^{U'}-m_3^{M'}\right)}^{(-)}\overbrace{-\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(+)}\right]}{a^U\left(1+a^M\right)\left(1+x_1^{M'}\right)x_1^{M'}\left[-m_1^{U'}\left(\acute{x}_3^{U'}-m_3^{M'}\right)+\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}\right]}$$

$$+\overbrace{\frac{x_1^M}{\left(1+a^M\right)x_1^{M'}}}^{(+)}+\overbrace{\frac{-y_1^M}{\left(1+a^M\right)x_1^{M'}}}^{(-)}+\overbrace{\frac{y_{3,1}^{M,d}}{\left(1+a^M\right)x_1^{M'}}}^{(+)}$$

$$+\frac{x_1^M\left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+m_1^{C\prime}\right)\left(m_3^{M\prime}-x_3^{U\prime}\right)}^{(+)}+\overbrace{\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)}\right]}{\left(1+a^M\right)\left(1+x_1^{M\prime}\right)x_1^{M\prime}\left[-m_1^{U\prime}\left(\acute{x}_3^{U\prime}-m_3^{M\prime}\right)+\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}\right]}$$

$$+\frac{a^M m_1^C\left[\overbrace{\left(-\frac{\partial y_1^M}{\partial p_1^M}+\frac{\partial c_1^M}{\partial p_1^M}+m_1^{C\prime}\right)\left(m_3^{M\prime}-x_3^{U\prime}\right)}^{(+)}+\overbrace{\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^M}{\partial p_1^M}}^{(-)}\right]}{\left(1+a^M\right)\left(1+x_1^{M\prime}\right)x_1^{M\prime}\left[-m_1^{U\prime}\left(\acute{x}_3^{U\prime}-m_3^{M\prime}\right)+\left(\frac{\partial y_{3,1}^{d,U}}{\partial p_3^U}+\frac{\partial y_{3,1}^{d,M}}{\partial p_3^M}\right)\frac{\partial y_3^U}{\partial \bar{p}_1}\right]}$$

Cherry & Grape Tomatoes

In this minimum price/Voluntary Export Restraint model, selecting an import price is equal to selecting a domestic price $\bar{p}_i, i=1,2$. We first differentiate the U.S. FOC with respect to $\bar{p}_2$.

We will examine each term individually, starting with U.S. contribution schedule.

$$a^M\sum_{i\in L^U}\left[\frac{\partial L_i^U}{\partial \bar{p}_2}+\frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial \bar{p}_2}-\frac{\partial B_i^U}{\partial \bar{p}_2}\right]$$

$$\frac{\partial L_1^U}{\partial \bar{p}_2}+\frac{\partial \Pi_1^U\left(\bar{p}_1\right)}{\partial \bar{p}_2}-\frac{\partial B_1^U}{\partial \bar{p}_2}=0$$

$$\frac{\partial L_2^U}{\partial \bar{p}_2}+\frac{\partial \Pi_2^U\left(\bar{p}_2\right)}{\partial \bar{p}_2}-\frac{\partial B_2^U}{\partial \bar{p}_2}=y_2^U$$

$$\frac{\partial L_3^U}{\partial \bar{p}_2}+\frac{\partial \Pi_3^U\left(\bar{p}_1,p_3\right)}{\partial \bar{p}_2}-\frac{\partial B_3^U}{\partial \bar{p}_2}=0$$

$$\frac{\partial L_j^U}{\partial \bar{p}_2}+\frac{\partial \Pi_j^U\left(p_j\right)}{\partial \bar{p}_2}-\frac{\partial B_j^U}{\partial \bar{p}_2}=0\ ,\ j\neq 1-3.$$

$$a^M \left[y_2^U \right] \tag{14}$$

For Mexican cherry & grape tomatoes growers, the welfare function contains labor income, profits, and quota revenues, where $QR_2^M = \left(\bar{p}_2 - p_2^M\left(\bar{p}_2\right)\right)\left[y_2^M\left(p_2^M\left(\bar{p}_2\right)\right) - c_2^M\left(p_2^M\left(\bar{p}_2\right)\right)\right]$

$$a^U \left[\sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial \bar{p}_2} + \frac{\partial \Pi_i^M\left(p_i^M\right)}{\partial \bar{p}_2} - \frac{\partial B_i^M}{\partial \bar{p}_2} \right] + \sum_{i=1}^{2} \frac{\partial QR_i^M\left(p_i^M\left(\bar{p}_i\right)\right)}{\partial \bar{p}_2} \right]$$

$$\frac{\partial L_1^M}{\partial \bar{p}_2} + \frac{\partial \Pi_1^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial \bar{p}_2} - \frac{\partial B_1^M}{\partial \bar{p}_2} + \frac{\partial QR_1^M\left(p_1^M\left(\bar{p}_1\right)\right)}{\partial \bar{p}_2} = 0$$

$$\frac{\partial L_2^M}{\partial \bar{p}_2} + \frac{\partial \Pi_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial \bar{p}_2} - \frac{\partial B_2^M}{\partial \bar{p}_2} + \frac{\partial QR_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial \bar{p}_2} = y_2^M \frac{\partial p_2^M}{\partial \bar{p}_2} + \left[y_2^M\left(p_2^M\left(\bar{p}_2\right)\right) - c_2^M\left(p_2^M\left(\bar{p}_2\right)\right)\right]\left(1 - \frac{\partial p_2^M}{\partial \bar{p}_2}\right)$$

$$+ \left(\bar{p}_2 - p_2^M\left(\bar{p}_2\right)\right)\left[\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}\right]\frac{\partial p_2^M}{\partial \bar{p}_2}$$

$$\frac{\partial L_3^M}{\partial \bar{p}_2} + \frac{\partial \Pi_3^M\left(p_1^M\left(\bar{p}_1\right), p_3^M\right)}{\partial \bar{p}_2} - \frac{\partial B_3^M}{\partial \bar{p}_2} = 0$$

$$\frac{\partial L_j^M}{\partial \bar{p}_2} + \frac{\partial \Pi_j^M\left(p_j^M\right)}{\partial \bar{p}_2} - \frac{\partial B_j^M}{\partial \bar{p}_2} = 0,\ j \neq 1 - 3.$$

$$a^U \left[y_2^M \frac{\partial p_2^M}{\partial \bar{p}_2} + \left[y_2^M - c_2^M\right]\left(1 - \frac{\partial p_2^M}{\partial \bar{p}_2}\right) + \left(\bar{p}_2 - p_2^M\right)\left[\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}\right]\frac{\partial p_2^M}{\partial \bar{p}_2} \right] \tag{15}$$

For U.S. total welfare,

$$a^M a^U \left[\sum_{i=1}^{n} \frac{\partial L^U}{\partial \bar{p}_2} + \sum_{i=1}^{n} \frac{\partial \Pi_i^U\left(p_i^U\right)}{\partial \bar{p}_2} + \sum_{i=1}^{n} \frac{\partial CS^U\left(p_i^U\right)}{\partial \bar{p}_2} \right]$$

$$\frac{\partial L^U}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_1^U\left(\bar{p}_1\right)}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_2^U\left(\bar{p}_2\right)}{\partial \bar{p}_2} = y_2^U$$

$$\frac{\partial \Pi_3^U \left(p_3^U, \bar{p}_1\right)}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_j^U \left(p_j^U\right)}{\partial \bar{p}_2} = 0 \;, j \neq 1-3$$

$$\frac{\partial CS^U \left(p_i^U\right)}{\partial \bar{p}_2} = -c_2^U$$

$$\frac{\partial CS^U \left(p_j^U\right)}{\partial \bar{p}_2} = 0, \; j \neq 2$$

$$a^M a^U \left[y_2^U - c_2^U\right] \tag{16}$$

For Mexican. total welfare,

$$a^M a^U \left[\sum_{i=1}^{n^*} \frac{\partial L^M}{\partial \bar{p}_2} + \sum_{i=1}^{n^*} \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial \bar{p}_2} + \sum_{i=1}^{3} \frac{\partial QR_i^M \left(p_i^M \left(\bar{p}_i\right)\right)}{\partial \bar{p}_2} + \sum_{i=1}^{n^*} \frac{\partial CS^M \left(p_i^M \left(\bar{p}_i\right)\right)}{\partial \bar{p}_2}\right]$$

$$\frac{\partial L^M}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_1^M \left(p_1^M \left(\bar{p}_1\right)\right)}{\partial \bar{p}_2} + \frac{\partial QR_1^M \left(p_1^M \left(\bar{p}_1\right)\right)}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_2^M \left(p_2^M \left(\bar{p}_2\right)\right)}{\partial \bar{p}_2} + \frac{\partial QR_2^M \left(p_2^M \left(\bar{p}_2\right)\right)}{\partial \bar{p}_2} = y_2^M \frac{\partial p_2^M}{\partial \bar{p}_2} + \left[y_2^M - c_2^M\right] \left(1 - \frac{\partial p_2^M}{\partial \bar{p}_2}\right) + \left(\bar{p}_2 - p_2^M\right) \left[\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}\right] \frac{\partial p_2^M}{\partial \bar{p}_2}$$

$$\frac{\partial \Pi_3^M \left(p_3, p_1^M \left(\bar{p}_1\right), p_2^M \left(\bar{p}_2\right)\right)}{\partial \bar{p}_2} = 0$$

$$\frac{\partial \Pi_j^M \left(p_j^M\right)}{\partial \bar{p}_2} = 0, \; j \neq 1-3$$

$$\frac{\partial CS^M \left(p_i^M \left(\bar{p}_i\right)\right)}{\partial \bar{p}_2} = -c_2^M \frac{\partial p_2^M}{\partial \bar{p}_2}$$

$$\frac{\partial CS^M \left(p_j^M\right)}{\partial \bar{p}_2} = 0, \; j \neq 2$$

$$a^M a^U \left[y_2^M \frac{\partial p_2^M}{\partial \bar{p}_2} + \left[y_2^M - c_2^M \right] \left(1 - \frac{\partial p_2^M}{\partial \bar{p}_2} \right) + \left(\bar{p}_2 - p_2^M \right) \left[\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right] \frac{\partial p_2^M}{\partial \bar{p}_2} - c_2^M \frac{\partial p_2^M}{\partial \bar{p}_2} \right] \tag{17}$$

Summing the four components of the U.S. FOC yields

$$\begin{aligned} & a^M y_2^U + a^U \left[y_2^M p_2^{M'} + \left(y_2^M - c_2^M \right) \left(1 - p_2^{M'} \right) + \left(\bar{p}_2 - p_2^M \right) \left(y_2^{M'} - c_2^{M'} \right) p_2^{M'} \right] \\ & + a^M a^U \left[y_2^U - c_2^U \right] + a^M a^U \left[y_2^M p_2^{M'} + \left(y_2^M - c_2^M \right) \left(1 - p_2^{M'} \right) + \left(\bar{p}_2 - p_2^M \right) \left(y_2^{M'} - c_2^{M'} \right) p_2^{M'} - c_2^M p_2^{M'} \right] \\ = \ & 0 \end{aligned} \tag{18}$$

Substituting for m_2^U, x_2^M, and $x_2^{M'}$,

$a^M \left[y_2^U \right] + a^U \left[y_2^M p_2^{M'} + x_2^M \left(1 - p_2^{M'} \right) + \left(\bar{p}_2 - p_2^M \right) x_2^{M'} p_2^{M'} \right] + a^M a^U \left[-m_2^U \right] +$
$a^M a^U \left[x_2^M p_2^{M'} + x_2^M \left(1 - p_2^{M'} \right) + \left(\bar{p}_2 - p_2^M \right) x_2^{M'} p_2^{M'} \right] = 0.$

In order to solve for $p_2^{M'}$, the market clearing condition $m_2^U - x_2^M - x_2^C = 0$ is utilized by taking a total derivative.

$c_2 \left(\bar{p}_2 \right) - y_2 \left(\bar{p}_2 \right) - \left[y_2^M \left(p_2^M \left(\bar{p}_2 \right) \right) - c_2^M \left(p_2^M \left(\bar{p}_2 \right) \right) \right] - \left[y_2^C \left(p_2^C \right) - c_2^C \left(p_2^C \right) \right] = 0$

$\frac{\partial c_2}{\partial \bar{p}_2} - \frac{\partial y_2}{\partial \bar{p}_2} - \left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) \frac{\partial p_2^M}{\partial \bar{p}_2} - \left(\frac{\partial y_2^C}{\partial p_2^C} - \frac{\partial c_2^C}{\partial p_2^C} \right) \frac{\partial p_2^C}{\partial \bar{p}_2} = 0$

$\left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) \frac{\partial p_2^M}{\partial \bar{p}_2} + \left(\frac{\partial y_2^C}{\partial p_2^C} - \frac{\partial c_2^C}{\partial p_2^C} \right) \frac{\partial p_2^C}{\partial \bar{p}_2} = \frac{\partial c_2}{\partial \bar{p}_2} - \frac{\partial y_2}{\partial \bar{p}_2}$

$\frac{\partial p_2^C}{\partial \bar{p}_2} = 1$ i.e., the price increase in the United States is equal to the price increase in Canada.

$\left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) \frac{\partial p_2^M}{\partial \bar{p}_2} + \left(\frac{\partial y_2^C}{\partial p_2^C} - \frac{\partial c_2^C}{\partial p_2^C} \right) = \frac{\partial c_2}{\partial \bar{p}_2} - \frac{\partial y_2}{\partial \bar{p}_2}$

$\left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M} \right) \frac{\partial p_2^M}{\partial \bar{p}_2} = \frac{\partial c_2}{\partial \bar{p}_2} - \frac{\partial y_2}{\partial \bar{p}_2} - \left(\frac{\partial y_2^C}{\partial p_2^C} - \frac{\partial c_2^C}{\partial p_2^C} \right)$

$$\frac{\partial p_2^M}{\partial \bar{p}_2} = \frac{\frac{\partial c_2}{\partial \bar{p}_2} - \frac{\partial y_2}{\partial \bar{p}_2} - \left(\frac{\partial y_2^C}{\partial p_2^C} - \frac{\partial c_2^C}{\partial p_2^C}\right)}{\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}}$$

$$p_2^{M'} = \frac{m_2^{U'} - x_2^{C'}}{x_2^{M'}}$$

After substituting $p_2^{M'}$ into (18) and simplifying,

$$a^M y_2^U + a^U \left[\frac{y_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} + \frac{x_2^M x_2^{M'}}{x_2^{M'}} - \frac{x_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} + \left(\bar{p}_2 - p_2^M\right)\left(m_2^{U'} - x_2^{C'}\right)\right] + a^M a^U \left[-m_2^U\right]$$
$$+ a^M a^U \left[\frac{x_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} + x_2^M - \frac{x_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} + \left(\bar{p}_2 - p_2^M\right)\left(m_2^{U'} - x_2^{C'}\right)\right] = 0.$$

Substitute $m_2^U = x_2^M + x_2^C$

$$a^M y_2^U + \frac{a^U y_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} - \frac{a^U x_2^M \left(m_2^{U'} - x_2^{C'} - x_2^{M'}\right)}{x_2^{M'}} + a^U \left(\bar{p}_2 - p_2^M\right)\left(m_2^{U'} - x_2^{C'}\right) - a^M a^U \left[x_2^M + x_2^C\right]$$
$$+ a^M a^U x_2^M + a^M a^U \left(\bar{p}_2 - p_2^M\right)\left(m_2^{U'} - x_2^{C'}\right) = 0$$

$$a^M y_2^U + \frac{a^U y_2^M \left(m_2^{U'} - x_2^{C'}\right)}{x_2^{M'}} - \frac{a^U x_2^M \left(m_2^{U'} - x_2^{C'} - x_2^{M'}\right)}{x_2^{M'}} - a^M a^U x_2^C + a^U \left(1 + a^M\right)\left(\bar{p}_2 - p_2^M\right)\left(m_2^{U'} - x_2^{C'}\right) = 0$$

We now differentiate the Mexican FOC with respect to p_2^M.

We will examine each term individually, starting with U.S. contribution schedule.

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial p_2^M} + \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial p_2^M} - \frac{\partial B_i^U}{\partial p_2^M}\right]$$

$$\frac{\partial L_i^U}{\partial p_2^M} + \frac{\partial \Pi_i^U \left(\bar{p}_1\right)}{\partial p_2^M} - \frac{\partial B_i^U}{\partial p_2^M} = 0,\ i = 1, ..., n.$$

$$a^M \sum_{i \in L^U} \left[\frac{\partial L_i^U}{\partial p_2^M} + \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial p_2^M} - \frac{\partial B_i^U}{\partial p_2^M} \right] = 0$$

For Mexican large fresh tomato growers, the welfare function contains labor income, profits, and quota revenues, where $QR_2^M = \left(\bar{p}_2 - p_2^M\left(\bar{p}_2\right)\right) \left[y_2^M\left(p_2^M\left(\bar{p}_2\right)\right) - c_2^M\left(p_2^M\left(\bar{p}_2\right)\right)\right]$

$$a^U \left[\sum_{i \in L^M} \left[\frac{\partial L_i^M}{\partial p_2^M} + \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial p_2^M} - \frac{\partial B_i^M}{\partial p_2^M} \right] + \sum_{i=1}^{2} \frac{\partial QR_i^M \left(p_i^M\left(\bar{p}_i\right)\right)}{\partial p_2^M} \right]$$

$$\frac{\partial L_1^M}{\partial p_2^M} + \frac{\partial \Pi_1^M \left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_2^M} - \frac{\partial B_1^M}{\partial p_2^M} + \frac{\partial QR_1^M \left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_2^M} = 0$$

$$\frac{\partial L_2^M}{\partial p_2^M} + \frac{\partial \Pi_2^M \left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_2^M} - \frac{\partial B_2^M}{\partial p_2^M} + \frac{\partial QR_2^M \left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_2^M} = y_2^M + \left[y_2^M - c_2^M\right](-1) + \left(\bar{p}_2 - p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}\right)$$

$$\frac{\partial L_j^M}{\partial p_2^M} + \frac{\partial \Pi_j^M \left(p_j^M\right)}{\partial p_2^M} - \frac{\partial B_j^M}{\partial p_2^M} = j \neq 1 - 2$$

$$a^U \left[y_2^M - \left[y_2^M - c_2^M\right] + \left(\bar{p}_2 - p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M} - \frac{\partial c_2^M}{\partial p_2^M}\right) \right] \tag{19}$$

For U.S. total welfare,

$$a^M a^U \left[\sum_{i=1}^{n} \frac{\partial L^U}{\partial p_2^M} + \sum_{i=1}^{n} \frac{\partial \Pi_i^U \left(p_i^U\right)}{\partial p_2^M} + \sum_{i=1}^{n} \frac{\partial CS^U \left(\mathbf{p^U}\right)}{\partial p_2^M} \right]$$

For Mexican. total welfare,

$$a^M a^U \left[\sum_{i=1}^{n^*} \frac{\partial L^M}{\partial p_2^M} + \sum_{i=1}^{n^*} \frac{\partial \Pi_i^M \left(p_i^M\right)}{\partial p_2^M} + \sum_{i=1}^{3} \frac{\partial QR_i^M \left(p_i^M\left(\bar{p}_i\right)\right)}{\partial p_2^M} + \sum_{i=1}^{n^*} \frac{\partial CS^M \left(p_i^M\right)}{\partial p_2^M} \right]$$

$$\frac{\partial L^M}{\partial p_2^M} = 0$$

$$\frac{\partial \Pi_1^M \left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_2^M} + \frac{\partial QR_1^M \left(p_1^M\left(\bar{p}_1\right)\right)}{\partial p_2^M} = 0$$

$$\frac{\partial \Pi_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_2^M}+\frac{\partial QR_2^M\left(p_2^M\left(\bar{p}_2\right)\right)}{\partial p_2^M}+\frac{\partial CS^M\left(p_2^M\right)}{\partial p_2^M}=y_2^M+\left[y_2^M-c_2^M\right](-1)+\left(\bar{p}_2-p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M}-\frac{\partial c_2^M}{\partial p_2^M}\right)-c_2^M$$

$$\frac{\partial \Pi_3^M\left(p_3,p_1^M\left(\bar{p}_1\right)\right)}{\partial p_2^M}+\frac{\partial CS^M\left(p_3^M\right)}{\partial p_2^M}=0$$

$$\frac{\partial \Pi_j^M\left(p_j^M\right)}{\partial p_2^M}+\frac{\partial CS^M\left(p_j^M\right)}{\partial p_2^M}=0,\ j\neq 1-3$$

$$a^M a^U\left[y_2^M-\left[y_2^M-c_2^M\right]+\left(\bar{p}_2-p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M}-\frac{\partial c_2^M}{\partial p_2^M}\right)-c_2^M\right] \tag{20}$$

Summing the components of the Mexican FOC,

$$a^U\left[y_2^M-\left[y_2^M-c_2^M\right]+\left(\bar{p}_2-p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M}-\frac{\partial c_2^M}{\partial p_2^M}\right)\right]+a^M a^U\left[y_2^M-\left[y_2^M-c_2^M\right]+\left(\bar{p}_2-p_2^M\right)\left(\frac{\partial y_2^M}{\partial p_2^M}-\frac{\partial c_2^M}{\partial p_2^M}\right)-c_2^M\right]=0.$$

Futher simplification yields

$$a^U y_2^M-a^U x_2^M+a^U\left(1+a^M\right)\left(\bar{p}_2-p_2^M\right)x_2^{M\prime}=0.$$

Setting the two FOCs equal to each other, we solve for the optimal cherry & grape price wedge.

$$a^M y_2^U+\frac{a^U y_2^M\left(m_2^{U\prime}-x_2^{C\prime}\right)}{x_2^{M\prime}}-\frac{a^U x_2^M\left(m_2^{U\prime}-x_2^{C\prime}-x_2^{M\prime}\right)}{x_2^{M\prime}}-a^M a^U x_2^C+a^U\left(1+a^M\right)\left(\bar{p}_2-p_2^M\right)\left(m_2^{U\prime}-x_2^{C\prime}\right)=$$
$$a^U y_2^M-a^U x_2^M+a^U\left(1+a^M\right)\left(\bar{p}_2-p_2^M\right)x_2^{M\prime}$$

After considerable simplification, the final result is

$$\left(\bar{p}_2-p_2^M\right)=$$

$$\overbrace{\frac{a^M y_2^U}{a^U\left(1+a^M\right)\left(x_2^{M\prime}+x_2^{C\prime}-m_2^{U\prime}\right)}}^{(+)}+\overbrace{\frac{x_2^M}{\left(1+a^M\right)x_2^{M\prime}}}^{(+)}+\overbrace{\frac{-y_2^M}{\left(1+a^M\right)x_2^{M\prime}}}^{(-)}$$
$$+\overbrace{\frac{x_2^M}{\left(1+a^M\right)\left(x_2^{M\prime}+x_2^{C\prime}-m_2^{U\prime}\right)}}^{(+)}+\overbrace{\frac{-a^M x_2^C}{\left(1+a^M\right)\left(x_2^{M\prime}+x_2^{C\prime}-m_2^{U\prime}\right)}}^{(-)}.$$