ANALYZING STRUCTURAL CHANGES AND TRADE IMPACTS IN THE TOMATO INDUSTRY

A Thesis

by

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ABSTRACT

Almost half of the tomatoes consumed in the U.S. are imported. In 2014, Mexico accounted for more than 80 percent of the tomato imports and Canada for around 10 percent, being the two largest importers of fresh tomato. The accelerated increase of Mexican exports of tomato into the United States has resulted in trade disputes with domestic growers. Under this perspective, the role played by agricultural and economic policy to cope with these matters is studied. Tests for endogenous breakpoints provide information about any policy or economic intervention that could have caused a structural change in the tomato industry from 1970 until 2014. The empirical analysis uses a Vector Autoregressive Model (VAR) model in which the innovation accounting method and Directed Acyclic Graphs (DAGs) are used to show causal flow of information between the variables of interest in contemporaneous time. Results show breakpoints for imports from Canada, imports from Mexico and imports from the rest of the world. This suggests that NAFTA and pricing policies might have caused structural changes especially in the tomato importing industry. DAGs also reveal that these factors have important implications in the tomato industry changing causal relations among variables of interest. Therefore, this study indicates that agricultural policies do affect the underlying causal structure of the U.S. tomato industry.

DEDICATION

To my parents

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The trade flows and structure of the fruit and vegetable industry in the United States have been affected by several factors. Some of them are policy changes, trade agreements, technology and demand, among others (Pollack, 2001; Jerardo, 2004; Knutson et al., 2014; Johnson, 2014). Under this context, the tomato industry represents an important case study as nearly one half of the fresh tomato that is consumed in the United States is imported (USDA, 2015c). As of 2014, Mexico accounted for more than 80 percent of the tomato imports and Canada for around 10 percent, being the two largest importers of fresh tomato (USDA, 2015c).

Since 1978, Florida producers have argued that Mexico is dumping its tomatoes in the U.S. market (Baylis and Perloff, 2010). This has resulted in a “Great Tomato War” specifically between Florida and two provinces of Mexico, Sinaloa and Nayarit, which are the largest tomato exporters (Kosse, Devados and Luckstead, 2014). Until 1996, the antidumping investigation was suspended giving birth to a price floor for Mexican exports in order to protect U.S. producers (Baylis and Perloff, 2010). These disputes have caused trade tensions and changes in policies for the tomato industry. Nevertheless, Mexican exports to the U.S. continue to rise as exports and market share from domestic production becomes smaller.

The North American Free Trade Agreement (NAFTA), technological advances in Mexican production, and the devaluation of the peso in the mid-1990s are often cited as the major factors in the growth of Mexican exports into the U.S. (Almonte-Alvarez and

Conley, 2003). However, it is certain that the accelerated increase of Mexican exports of tomato into the United States has resulted in trade disputes with Florida growers. Under this scope it is interesting to analyze the role played by agricultural and economic policy to cope with these issues.

In order to be able to find which policies and factors have affected the tomato industry, a Bai and Perron (2003) test is applied for multiple structural break points. This methodology allows determining endogenous structural changes in the industry based on the data used. The empirical analysis uses a Vector Auto-Regressive (VAR) model to show causal relations between the variables of interest through Directed Acyclic Graphs (DAG). Moreover, the Forecast Error Variance Decomposition (FEVD) and Impulse Response Functions (IRF) are also analyzed to capture contemporaneous and lagged effects of shocks throughout the variables of interest.

The objective of this research is to analyze how trade flows in the tomato industry have changed from 1970 to 2015 and, if possible, link any structural changes to policy interventions occurred during the same period of time. In order to accomplish this objective, this paper: (1) finds breakpoints in exports, domestic production and price of tomato, as well as imports from Canada, imports from Mexico and imports from the rest of the world; (2) evaluates causal patterns between the innovations of the variables of interest; and (3) analyze the contemporaneous and lagged effects of trade agreements and policy changes in the tomato industry.

2. INDUSTRY OVERVIEW

The U.S. is the world's third largest tomato producer after China and India; Mexico ranks tenth and Canada thirty fifth (FAOSTAT, 2013). Most of the production originates from Florida and California (USDA, 2015d). Still, imports to the U.S., mainly coming from Mexico and Canada, have risen dramatically over the years (Figure 1). A smaller portion of the imports comes from Europe and Central America, whose imports have been also increasing during the last years.

On the other side, Canada and Mexico are the two main destinations of U.S. tomato exports. Though, exports have been declining over the last decades. In 2000, U.S. exports peaked at 186,133 Metric Tons (MT) but by 2014 this quantity has declined by 45 percent. This represents the second lowest value in the history of tomato exports after 1989 (USDA, 2015c), which was the first year the U.S. started significantly exporting tomato after the Canada-U.S. Free Trade Agreement (CUSFTA) was signed in 1989.

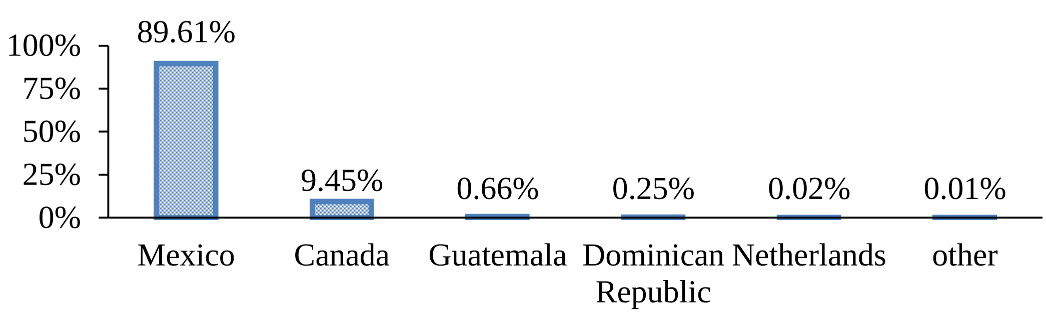

Figure 1. Fresh Tomato Imports to the U.S. 2014.
Source: Adapted from USDA (2015c).

Domestically, tomato is the fifth most important crop after maize, soybean, sugar beet and potato (FAOSTAT, 2013). Additionally, the declining domestic production over the last decade and the fact that most of the tomato imports come from Mexico and Canada, make the tomato industry a very important case study. Also, the tomato industry is very interesting as it has been subject of trade disputes and numerous policy changes during the past decades.

Much of the current situation of the tomato industry could be explained by trade agreements, such as NAFTA, Mexican peso devaluation in the mid 90's, Mexican technological improvements, pricing policies and Florida weather conditions, among other factors. Still, there is not a consensus on which are the main causes of structural changes in the tomato industry. Under this context, tomato represents an important case study for economic policies and trade debates.

2.1.Supply

U.S., Canada and Mexico are three large producers and consumers of fresh tomatoes. They compete for market share and they have been specializing and invested in increasing their competitive advantage by strategies as producing certain varieties of tomato, investing in infrastructure or competing with prices. Demand for tomatoes have been increasing as new varieties are being supplied. Besides the traditional round, red, ripe tomato, now it is possible to find grape tomatoes, roma or plum, cherry, mature greens, on the vine, hydroponic, greenhouse, organically grown, heirloom and colored tomatoes. Most of these varieties are available the whole year (Estes, 2003).

2.1.1. United States

Commercial production of fresh tomatoes occurs in around 16 States. However, in 2014 California and Florida produced around 70 percent of the fresh tomato followed by Tennessee, South Carolina, North Carolina and Virginia (USDA, 2015e). Florida is first and California second in acres planted and harvested, but California's yield per acre is higher. Nevertheless, Alabama and Tennessee showed the highest yield per acre for 2014 (USDA, 2015e).

Tomato production in Florida goes from October to June with its highest production in April-May and November-January. In California, production goes year round except for the winter (USDA, 2012). During the winter season, Mexico provides fresh tomatoes to most of the west coast, and Florida to most of the eastern U.S (Boriss and Brunke, 2005).

In 2014, around 13 percent of the domestic production was exported and imports accounted for almost double of what was domestically produced. The main destination of fresh tomato exports are Canada and Mexico, where the U.S. sends around 7 and 90 percent of the total exports respectively (USDA, 2015c).

2.1.2. Mexico

Tomato is produced all over Mexico through the whole year and it represents the most important agroindustry in the country with respect to exports and employment creation (Barron and Rello, 2000). Sinaloa produced around 37 percent of the 2013 total followed by Baja California, Zacatecas, San Luis Potosi, Jalisco and Baja California Sur, which together produced 30 percent (SIAP, 2014). Tomato is the main Mexican exporting produce whose major destinations are the U.S and Canada, accounting for around 95 percent of total tomato exports (SAGARPA, 2013; 2010). The great majority of the tomato that is exported is from Sinaloa, whose production peaks between January and March, and from Baja California whose main productive months are from June to November (Padilla-Bernal and Thilmany, 2003). Mexico has a big advantage in the fact that it can produce more tomatoes than U.S. and Canada during the winter (Cook and Calvin, 2005).

Even though most of the Mexican production was from open field and protected environment, lately it has been specializing in green house tomato. The country has invested in improving the infrastructure and logistics in order to increase its exports (SAGARPA, 2013).

2.1.3. Canada

Since the 1970's the U.S. has been an important supplier of tomato to the Canadian Market. In 1985, about 85 percent of the Canadia tomato imports were supplied mostly by Florida, and the remaining 15 percent by Mexico. Canada was not a big tomato producer even though its demand was increasing. Because of this, tariffs were increased and more resources were invested into the development of the greenhouse industry (Darko-Mensah and Prentice, 1987).

During the early 1990's the North American Greenhouse tomato industry expanded rapidly, especially in Canada who has turned into the largest greenhouse tomato producer. In 1992, field tomatoes represented 65 percent of fresh tomato production and in 2003 it was only 11 percent. Greenhouse tomatoes are mainly produced in Ontario (64 percent of total production), British Columbia (22 percent) and Quebec (11 percent) mainly from March through December (Agriculture and Agri-Food Canada, 2013). Most of the Canadian tomato exports are greenhouse, and go to the U.S. market. These exports have been growing through the years while U.S exports to Canada have remained stable (Agriculture and Agri-Food Canada, 2013).

In the last two decades North American greenhouse tomato production has been taking a big portion of the total fresh tomato world market. Mexico is the only North American country that still produces a considerable amount of field grown tomatoes. Greenhouse tomatoes are affecting the whole fresh tomato market as they can be grown any time of the year (Calvin and Cook, 2005) (Figure 2).

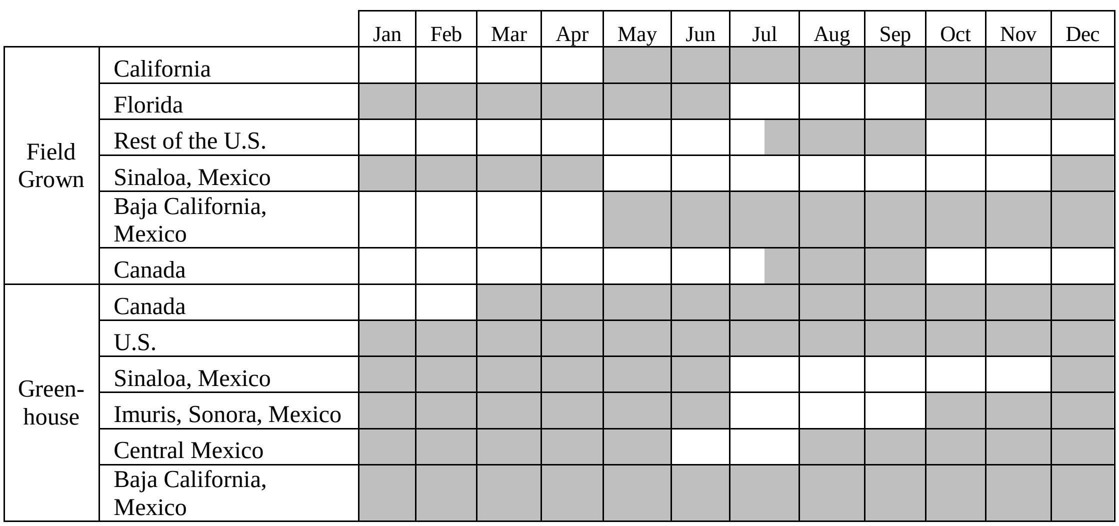

Figure 2. North America Fresh Tomato Shipping Seasons by Region.
Source: Adapted from Cook and Calvin (2005).

2.2. Market Structure

U.S. fresh tomato market involves foodservice and retail consumer sales. During the 90's around 70 percent of the fresh tomato was consumed at home and 30 percent away (USDA, 2012). For many, this market is oligopolistic and vertically integrated (Thompson and Wilson, 1997). A similar situation applies to Canada, where during the early 2000's around 5 firms produced nearly 82% of the exports to the US (Agriculture and Agri-Food Canada, 2013). Likewise, in Mexico it is estimated that around 12 growers harvest most of the exporting production in a vertically integrated industry (Padilla- Bernal and Thilmany, 2000; Thompson and Wilson, 1997).

According to industry interviews prepared for this research study, some retail stores located in Texas rely on Mexican imports only. They receive tomatoes from Coahuila, San Luis and Jalisco from May through December and from Sinaloa from December until May. Most retail stores around the U.S. offer different varieties of fresh tomatoes such as plum (Roma) tomatoes, grape and cherry tomatoes, greenhouse and hydroponic from different origins (USDA, 2012).

2.3.Background of Policies, Agreements and Trade

Tomato was originated in South America and first introduced to Europe in the 1600s, during the colonial period, and to the U.S. during the late 1700s. Its commercial production in the U.S. began in the mid-1800s, when tomato started being recognized as a popular produce in the American diet (Boriss and Brunke, 2005).

Earlier disputes regarding tomato started during the 1890s, when the U.S. was sued by tomato importers, after imposing a 10 percent tariff on imported vegetables. Importers claimed that tomatoes should be classified as fruits rather than vegetables and consequently they would not be charged with the tariff. Supreme Court ruled in favor of treating the tomatoes as vegetables from then on (USDA, 2013).

2.3.1. U.S. and Mexico

Mexico emerged as winter tomato supplier for the U.S. market right after the interruption of imports from Cuba during the1960s. As a consequence, both Mexican and Florida producers have been competing for market share and facing constant trade disputes (Thomson and Wilson, 1997). The first dispute between producers from Florida and Mexico was in 1968, when local producers wanted to reduce imports from Mexico by pushing laws that set requirements on size. This legislation was valid until 1975. Afterwards, country of origin label (COOL) started to be a primary concern for local producers, especially for Florida who passed a law of COOL for the State and an antidumping investigation in 1978. This happened after Mexico voluntarily agreed on an export quota.

Since 1978 Florida producers, have argued that Mexico is dumping its tomatoes in the U.S. market (Baylis and Perloff, 2010). This has resulted in a “Great Tomato War” specifically between Florida and two provinces of Mexico, Sinaloa and Nayarit, which are the biggest tomato exporters (Kosse, Devados and Luckstead, 2014). However, in 1984 it was determined that Mexico was not dumping tomato into the U.S. (Bredahl, Schmitz and Hillman 2010; Thompson and Willson, 1997) and in 1986 Mexico signed the General Agreements on Trade and Tariffs (GATT).

After years of negotiations, NAFTA was signed in 1992 and came into force in 1994. Under this agreement, tomatoes received special treatment through a seasonal tariff-rate quota for summer and winter. These quotas were eliminated in 1998 and 2003, respectively (Kosse, Devados and Luckstead, 2014). From 1992 until 1996, imports from Mexico increased around 93 percent and domestic production fell around 21 percent (Baylis, 2003). Many argue this happened because of NAFTA and/or the Mexican peso devaluation.

As a result of Mexican imports growth, Florida and some other southern states, filed another antidumping petition (Gunter and Ames, 2001). In 1996 the antidumping investigation was suspended giving birth to a price floor of $5.17 per 25 pound box ($0.2068 per pound) for Mexican exports in order to protect U.S. producers. In 1998, an amendment to the 1996 agreement was done. In it, the floor price was divided into two seasons, one for summer (July 1st - October 22nd) of $0.2108 per pound, and another one for winter (October 23rd – June 30th) of $0.1720 per pound (Baylis and Perloff, 2010). Many Mexican exporters did not approve this last amendment and did not sign it so an antidumping investigation started again until 2002 when a new agreement was signed. In this agreement winter price floor was increased to $0.2169 per pound while the summer one remained the same ($0.1720 per pound) (ITA, 2003). In 2008 the antidumping investigation was suspended and a new agreement was renewed after a similar process. In this agreement, prices stablished on 2002 remained (ITA, 2013).

In 2013, the 1996 Mexican Suspension Agreement was ended giving birth to a new agreement that increased the price floor. In this agreement, the winter price floor was raised again and set differently for greenhouse, field grown, loose specialty and packed specialty (Table 1), after another antidumping investigation was suspended (ITA, 2015). Recent changes caused trade tensions and changes in policies for the tomato industry. However, Mexican exports to the U.S. continue to rise as exports and market share for U.S. producers become smaller.

Table 1. Suspension Agreement Minimum Prices
Source: ITA (2015)

Fresh Tomato Category	*Summer Price (July 1- October 22)*	*Winter Price (October 23- June 30)*
Field	$0.2458/Lb.	$0.31/Lb.
Greenhouse	$0.3251/Lb.	$0.41/Lb.
Loose Specialty	$0.3568/Lb.	$0.45/Lb.
Packed Specialty	$0.4679/Lb.	$0.59/Lb.

2.3.2. U.S. and Canada

Even though, the greatest and more continuous tomato trade disputes have been between Mexico and the U.S., Canada has also been subject of antidumping investigations. In 2001, after the rapid growth of the Canadian greenhouse fresh tomato industry, six greenhouse local producers filed an antidumping petition against Canada. They argued that the industry was being injured because Canadian tomatoes were being sold at less than fair value. At the end, it was concluded that industry was not being injured by Canadian imports. However, the process used to determine a resolution of the case has been criticized (VanSickle, Evans and Emerson, 2003).

Table 2. Timeline of Relevant Policies and Trade Agreements in the Tomato Industry

Year	***Event***
1968	First tomato dispute between Mexico and the U.S.
1975	End of size requirements for imported produce
1978	Antidumping investigation on Mexican imports of Tomato COOL established for Florida State
1986	Mexico signed the GATT
1992	NAFTA signature
1994	NAFTA came into force
1996	Floor price for imported tomatoes
1998	Elimination of NAFTA tariff rate quota for summer imports
2001	Antidumping petition filed against Canadian tomato exporters
2002	New agreement after antidumping investigations on Mexican exporters
2003	Elimination of NAFTA tariff rate quota for winter imports
2008	Renewal of trade agreement for tomatoes
2013	New agreement that increased floor prices

3. LITERATURE REVIEW

3.1. Break Points

As this research deals with time series data on economic variables such as quantities and prices of the tomato industry, it is possible to find structural changes. These changes could be caused by financial crises, policy changes in the vegetable industry and trade agreements, among other factors that we are not necessarily aware of.

One of the earliest approaches to structural breaks was done by Quandt (1958, 1960). He started to estimate the parameters of a linear regression system resulting from two separate regimes with a specific point in time where the shift from one regime to the other happened. The method is based on the maximum likelihood function and a likelihood ratio test that assumes that error terms are independent from each other and from explanatory variables. The process also depends on the knowledge of specific number of breaking points, which should be at least one.

Chow (1960), started testing for structural changes using a covariance test and a prediction test. The former focuses on testing if additional observations belong to the same regression as the first sample, and the later tests whether or not the coefficients in two regressions are identical (Chow 1960). However, they only work under the strong assumptions that we have some previous knowledge about the structural changes and that the regression error term is not auto-correlated or heteroskedastic.

Both studies tested that no break point took place versus the alternative that one breakpoint occurred and they are based on very strong assumptions. Nevertheless, further research focused on overcoming the limitations encountered by Quandt (1958, 1960) and Chow (1960).

Considering the Quandt log-likelihood ratio statistic and extending Chow (1960) tests, Brown (1975) proposed a method based on cumulative sum (cusum) and cumulative sum of squares (cusumsq) of recursive residuals (Page 1954) tests (Brown and Durbin 1968). These infer the time location of the break point assuming non-stochastic regressors and excluding auto-regressive models.

Cusum tests were performed for ordinary least squares residuals concluding that it is a very uniformly similar approach (Ploberger and Krämer 1992). Furthermore, tests were applied nonstandard dynamic models for which asymptotic properties remain valid (Ploberger, Krämer, and Alt 1989). Brown and Durbin (1975) results were also validated by Goldfeld and Quandt (1973), who argued that the cusum test accomplishes its purpose in samples with 30 to 60 observations. However, cusum and cusumsq may have undesirable asymptotic properties as demonstrated in preliminary Monte Carlo studies performed by Farley (1970, 1975). Farley (1970, 1975) also compared the power of their own methods with Chow test (Chow 1960) concluding that their test is the most powerful uniformly in the place of the real break point. The cusum and cusumq have been utilized by many, especially in finance and macroeconomics (Babula, Ruppel and Bessler, 1995; Kim, Latham and Bessler, 2007; Bahmani-Oskooee and Chomsisengphet, 2002; Bahmani-Oskooee and Bohl, 2000).

LaMotte (1978) developed an exact test of the hypothesis of a model generated by a fixed coefficient regression versus the alternative that parameters in the model vary. The test assumes uncorrelated errors between time periods where random vectors distribute multivariate normal and with Monte Carlo simulations demonstrates that the estimate is good for a range of parameter values. This approach was further discussed by Nyblom and Makelainen (1983) and Nyblom (1989) who tested against the alternative hypothesis that regression coefficients change with respect to a random walk process. They perform a locally most powerful test with stronger results than the ones found by LaMotte (1978).

Most of the study done on structural change has been focused on the case where there is a single break. However, the cases where there are multiple changes and models are nonstandard have been getting an increasing consideration over time.

Tests like the Lagrange multiplier, Wald or Likelihood Ratio do not hold for nonstandard models. However, Andrews and Ploberger (1994) derive asymptotically optimal tests for approaching this type of models and even the problems with more than one unknown break (Andrews, Lee, and Ploberger 1996). Andrews (1991, 1993) addresses the limitation that was previously found for the existence of serial correlation. He proposes a solution that includes the estimation of the covariance matrix and finding an optimal estimator. In the same direction, Liu, Wu and Zidek (1997) develop two information criteria for selecting multiple structural changes.

Some of these methods are later considered by Garcia and Perron (1996) and Bai and Perron (1998, 2003). Their results are primarily based on Bai (1997a, 1997b) who developed an asymptotic distribution for a break date estimator (Picard 1985) in order to construct confidence intervals for a breakpoint and for simultaneous breaks in multiple time series (Bai, Lumsdaine, and Stock 1998). Bai and Perron (1998 and 2003) develop a sequential method that tests for multiple breaks. It starts testing for one breakpoint, then after the null hypothesis is rejected in favor of the existence of a structural break, the sample divides into two and tests is subsequently applied to the remaining sample. The process repeats until the tests suggest there is no break in the remaining subsamples. The method is estimated by least squares and it is empirically implemented by Bai and Perron (2003).

However, the methods used by Bai and Perron (1998 and 2003) do not take into account the existence of new regimes or forecast happening outside the estimated sample (Pesaran, Pettenuzzo, and Timmermann 2006). Nevertheless, for the present research, the unknown structural breakpoints in the series will be found using Bai and Perron tests. The detailed procedure is presented in the Methods Section.

3.2. Historical Dynamics

3.2.1. Vector Autoregressive Models

As mentioned above, there is a vast literature on statistics and econometrics focusing on structural changes. Accordingly, testing for break points in time series data has been applied to many VAR problems in agriculture, trade macroeconomics and finance (Blanchard and Simon, 2001; Herrera and Pesavento, 2005; Kim, Leatham and Bessler 2007; Sensier and van Dijk, 2004; Stock and Watson, 2002; Bessler and Babula, 1987; Palma et al., 2010).

Based on the work of Sims (1980), VAR models have become popular as they are useful tools for analyzing observational or non-experimental data. VAR models are often interpreted and analyzed on the light of impulse response functions (IRF) and forecast error variance decomposition (FEVD) (Sims, 1980). These make it possible to capture contemporaneous and lagged effect of shocks throughout the variables. This is, tracking the evolution of economic shocks within the system of variables. VAR models can be estimated as restricted or unrestricted. Unrestricted VAR are those with same number of lags for every variable. Here ordinary least squares can be used equation, by equation but its forecast is not strong enough (Bessler and Kling 1986).

After Sims (1980) VAR models analyses through IRF's and FEVD have been widely applied. A problem in this approach, is that covariance matrix of residuals indicate a contemporaneous correlation among errors. This problem has been solved by the orthogonalization of the matrix through Choleski decomposition whose only limitation is that the ordering is altered. Ordering is decisive to get accurate interpretation of the results. To this extent Bernanke (1986) suggest alternative methods, all of which assume correct specifications of the structural model of the errors.

To strengthen this assumption, Swanson and Granger (1997) suggested a method for testing structural models of the errors in a VAR model. This way they also reinforce what Granger (1988) propose with the use of VAR models to answer causality questions, for linear combination of residuals in equations with variance zero suggesting causality tests are useful to evaluate policy (Heckman, 2003).

3.2.2. Contemporaneous Causal Structure

Causality plays an important role in economic problems and shapes economic theory through different approaches. It is important in a field such as economics, where not only correlations in the data are important, but also causation (Wright, 1921). First foundations on causation and its definition are provided by Hume (1748) who introduces a probabilistic approach to the concept. Parting from his definition many approaches have been introduced to economics. One of such is the one that emphasizes on the structural model and another that bases on the process. Both of them can be grounded on a priori assumptions to explain the data or on the inference from the data (Hoover, 2005; 2008).

From a structural perspective, Simon (1953) defines causation from a model or statement within the context of inference. Likewise, the inferential approach to apply time series dynamic models is followed by Granger (1969) and Sims (1980).

Granger (1969) exposes what could be considered by many, the most influential methodology to causality in economics (Hoover, 2005 and 2008). His method bases on the data without requiring any a priori knowledge on the background or economic theory. Granger causation refers to the ability of one time series to cause another; this is, saying that a variable x_t causes a variable y_t with respect to a universe z_t. This way we can have a better prediction of y_t by using past values of x_t than by not using them (Bessler and Bradnt, 1982).

3.2.3. Directed Acyclic Graphs

To support the notions of causation, Pearl (2000) and Spirtes, Glymour and Scheines (2000) extend to observational studies what was first developed by Wright (1921). They use DAG to observe causal patters of contemporary relationships between innovations, and to test conditional independence on the residuals (Haigh and Bessler, 2004). DAG incorporates the causation approach to explain causal flow between variables.

Spirtes, Glymour and Scheines (2000) developed PC algorithms, which uses observational data to infer on DAG and incorporating the Pearl (1995) d-separation concept. PC Algorithm is an arranged set of commands that starts a general unrestricted set of associations between variables and then begins to eliminate edges between variables to direct the causal flow (Bessler, 2015; Bessler, Kolari and Maung, 2011). It can be done using the software TETRAD V (Schines et al., 1996).

Some of the first authors to apply DAG into economic problems were Bessler and Akleman (1998). The causal patter proposed by DAG can be used into VAR models to construct the FEVD and interpret results incorporating contemporaneous causal patters (Awokuse, Chopra, and Bessler 2009; Swanson and Granger 1997; Bessler, Yang, and Wongcharupan 2003; Demiralp and Hoover 2003).

Some these methods have been applied to Agricultural Economics analysis. This is the case of the studies performed by Bizimana et al. (2011), Palma et al. (2010), Palma, Ribera and Bessler (2013), Bessler and Babula (1987), Babula et al. (2004) and Babula and Rich (2001), among others.

3.3. Trade Studies for Policy Analysis

3.3.1. International Trade in Agriculture

Historically, agricultural trade has represented a substantial portion of the total trade shaping foreign and national policy. Accordingly, it has been a topic widely studied by economists and agricultural economists. Nourse (1924), Schultz (1935) and Samuelson (1948) did some early contributions to the trade literature on how the U.S. could be seriously affected by world agricultural trade flows, setting the bases for modern trade history.

Influential studies have been done on the interaction between trade flows and exchange rates (Schuh, 1976; Batten and Belongia, 1986; Chambers and Just, 1981; Schiff and Valdes, 2002), storage policies and price stability (Hueth and Schmitz; 1972; Feder, Just and Schmitz, 1977; Newberry and Stiglitz, 1981), and structural changes in agricultural prices series (Singer ,1950; Cashin and Mc Dermott, 2002; Ocampo and Parra, 2003). Additionally, agricultural policies regarding national tariffs, political economy on agricultural trade (Hoekman, Ng and Olarreaga, 2004), as well as the link between commodity trade and agricultural development (Anderson and Martin, 2005; Stiglitz and Charlton, 2005), have also been researched through time. However, it was not until the appearance of the Computable General Equilibrium (CGE) modeling for policy analysis that most of these studies made use of economic theory, time series analysis and econometric modeling to explain agricultural trade data (Josling et al. 2010). Other things that have influenced trade literature are trade agreements and the availability of more data.

3.3.2. North American Trade Agreement

NAFTA is one of the largest and the first agreements signed between developed and underdeveloped countries. It has been discussed and studied throughout the years by authors like Krugman (1993) who argued that NAFTA is to be considered more a foreign policy than an economic matter to the U.S. In this sense, big changes in trade flows were not only to be expected from this agreement, but from other factors. Krueger (1999) also explores the effects of NAFTA concluding that the exports expansion experienced by

Mexico between 1992 and 1998 was more an effect of the Mexican exchange rate crisis than by NAFTA. This study uses a gravity model, which is a widely used approach to trade analysis (Susanto, Rosson and Adcock, 2007; Susanto Rosson and Costa, 2012; Deardoff, 2004; Disdier and Head, 2008). Bursfisher (2001), agree with Kruger (1999) results adding that NAFTA had a bigger impact on Mexico than on Canada. They also discuss how NAFTA caused structural changes specifically for the agriculture, auto, and textile industries. Nevertheless, many studies have encountered difficulties in distinguishing between the effects of trade agreements and other economic policies and changes such as the Mexican peso devaluation (De Hoyos and Lacovone, 2013; Easterly et al., 2003; Romalis, 2007).

It is considered that since 2001 there has been an increase in the literature regarding the economic effects of NAFTA using econometric modeling (De la Cruz, Riker and Voorhees, 2013). Some of the most influential and relevant include Easterly et al (2003), who use time series modeling to show that Mexican income converges to U.S. income due to improvements in their institutions, especially after NAFTA. However, after the use of an autoregressive integrated moving average model (ARIMA), there is not enough strong evidence supporting the fact that NAFTA was the only factor helping the Mexican economy.

Similarly, Oladipo and Vasquez (2009) use multivariate time series models to analyze if the growth in Mexico's exports since NAFTA could shape Mexico's output growth. They find that exports were a valid predictor of total output in Mexico, meaning that after NAFTA entered in force, exports caused Mexican output. They find evidence that the Mexican economic growth explained by the exports is bigger than the one explained by the foreign direct investment. In addition to this literature, some research also studied the impact of the NAFTA on Mexican wage differentials (Chiquiar, 2008; Hanson, 2003; Esquivel and Rodriguez-Lopez, 2003).

Most of the studies about trade in North America emphasize on regional impacts of NAFTA in Mexico (Chiquiar, 2008). However, Canada was also affected by economic integration. Even though the Canadian-U.S. free trade agreement (CUSFTA) was already in rule when NAFTA was implemented, it enlarged Canadian economic activity especially with the U.S. (Trefler, 2004). These agreements affected trade from the region. However some argue that even though NAFTA definitely increase the U.S.-Mexico trade, the U.S.-Canada and Mexico-Canada trade remains the same, as one can attribute the U.S.-Canada trade to the CUFSTA (Gould, 1998). NAFTA had important effects on trade quantities and less effect in prices or welfare in the region (Romalis, 2007). It also affected some non-regional partner in the sense that, for example, the share of U.S. imports increased after CUSFTA but they did not reduce imports from other parts of the world for some products (Clausing, 2001).

3.3.3. Tomato Studies

For the tomato industry, most research goes as far back as the 1970s, when tomato trade disputes between Mexico and U.S. started. Schmitz, Firch and Hillman (1981) highlight the early stages of the trade dispute that have been going on since the 1970s until today. He recommended that highly perishable commodities should not be allowed to go into antidumping suits; otherwise economists should develop models applied for this kind of produce incorporating variables other than cost of production. Similarly, Hamming and Mittelhammer (1982) evaluate these issues but from the Canadian producers perspective, who according to them were more protected than US producers. Bredahl, Schmitz and Hillman (1987) also did some preliminary studies on the "great tomato war" between U.S. and Mexico. They argue that Florida producers were unable to increase their income through quotas or tariffs and failed to form a coalition with Mexican producers. Because of these reasons, the only way in which both could gain the most was meant to be free trade.

Jordan and VanSickle (1995) studied the dispute using a dynamic model of special trade adjustment. They pointed out that Florida determined prices, while Mexico responded to this prices and pushed prices to decline. For the analysis, they examined the industry as an oligopoly. This work was continued in VanSickle, Evans and Emerson (2003). From the firm level perspective, Thomson and Wilson (1997) analyze tomato trade disputes between both countries and agree with Jordan and VanSickle (1995) saying that tomato market is closely to behave like an oligopoly rather than perfect competition

From the firm level perspective, Thomson and Wilson (1997) analyze tomato trade disputes between both countries and agree with Jordan and VanSickle (1995) saying that tomato market behaves like an oligopoly. Their study suggests that investment on Mexican production process and strategic position of market favor them towards the tomato exports. This investment and growth of the industry turned tomato into the most important agroindustry as it has contributed to poverty and unemployment reduction (Barron and Rello, 2000).

Also, Padilla-Bernal and Thilmany (2000 and 2003), claim that the increase in tomato trade between Mexico and the U.S. is not only explained by NAFTA and the exchange rate. Rather they argue that other supply and demand factors also took place. Using a simultaneous equation system and a two stage least squares (2SLS) procedure, they find that tariffs are not significant in explaining increasing tomato trade flows. In accordance with these results, Malaga, Williams and Fuller (2001), explain that the increase in Mexican tomato exports could be highly explained by the peso devaluation rather than by reduction in tariffs. They also found that the own price elasticity of tomato demand is smaller for Mexico than for the U.S. This goes in line with the fact that if Mexican producers raise prices when the dollar values, then this will result in antidumping, which are protectionist tools (Raafat and Mehdi, 2002). In addition to the tariffs discussion, Guajardo and Elizondo (2003) argue these are less significant than transportation costs in explaining surplus loss. They state that NAFTA was what turned Mexico into a tomato exporter to the U.S. and not the exchange rate as argued by other authors.

Involving other econometric methods, using time series data in an autoregressive model, Bayard, Chen and Thompson (2007) estimated the effect of NAFTA to Alabama tomato production. They found that imports and peso devaluation negatively affected production. More econometric methods applied to tomato industry are the Tobit model estimated by GLS methods on Baylis (2003). He analyzes spillover effects of trade policies, in specific, the 1996 Voluntary export restraint (VER) imposed to tomatoes going from Mexico to the US. Apparently, VER lead to further disputes and encouraged the tomato processed industry competition in the U.S. Besides VER, other regulations such as Country of origin labeling (COOL) may have also worsened this dispute (Johnecheck, Wilde and Caswell, 2010).

Similarly, voluntary price restraint (VPR) on tomato industry was analyzed by Baylis and Perloff (2010). VPR reduced protectionist effects by increasing shipments from Canada and other parts of the world into the U.S. and by encouraging Mexican processing industry. Correspondingly, Kosse, Devados and Luckstead (2014) explore the debate and historical background of the tomato dispute between Mexico and the U.S. on the light of trade laws. They conclude that the minimum price and other protective policies for the U.S. industry help local producers and in some cases, Mexican producers, while U.S. consumers and processing plants are negatively affected. This goes in line with Jung (2009), who found that the minimum price affect consumer welfare in a negative way, and with early studies done by Ames, Dofman and Soares (1996).

4. METHODS

This section introduces the empirical procedures and methods used to study the historical dynamics of the tomato industry. Endogenous breakpoints in the data are estimated using Bai and Perron (2003) and a vector autoregressive (VAR) model is used to perform the empirical analysis and to show causal relations with directed acyclic graphs (DAG). IRF and FEVD analyses are applied to explore the flow of information among the variables of interest.

4.1. Structural Break Points

In order to determine potential factors that affect the structure of the tomato industry, Bai and Perron (2003) tests are applied to find multiple breakpoints. These breakpoints constitute endogenous structural changes based on the time series data and without any knowledge of economic or policy intervention occurred during this period of time. This method will reveal whether or not any policy or trade intervention caused a structural change in the tomato data. This test does not require any information about the timing of the possible breaks or the number of breaks as it is only based on the data, and allows for correlation and heteroscedasticity.

First a multiple linear regression with *m* breaks is considered following Bai and Perron (2003):

$$y_t = x'_t\beta + z'_t\delta_j + u_t \qquad\qquad t = T_{j-1} + 1, \dots, T_j$$

Where y_t is the observed dependent variable, x_t is a (p X 1) vector with coefficient β and z_t is a (q X 1) vector with coefficient δ_j and u_t the error term at time t, for $j = 1, \dots, m + 1$.

Here $T_1, \dots, T_m$ are the unknown breakpoints, where $T_0 = 0$ and $T_{m+1} = T$.

The goal is to find the unknown coefficients for T observations on y_t, x_t, z_t

This is a partial structural change model in which β is not allowed to change, however when p = 0, the model turns into a pure structural change model where all coefficients are subject to change:

$$y_t = z'_t\delta_j + u_t$$

Which can be expressed in matrix form as,

$$Y = \bar{Z}\delta + U$$

With $Y = (y_1, \dots, y_T)'$, $U = (u_1, \dots, u_T)'$, $\delta = (\delta'_1, \delta'_2, \dots, \delta'_{m+1})'$, and $\overline{Z}$ is a diagonal matrix $\bar{Z} = diag(Z_1, \dots, Z_{m+1})$.

Based on least squares the estimators $(\delta_1, \delta_2, \dots, \delta_{m+1})$ the break points $(T_1, \dots, T_m)$ are calculated for T observations on (y_t, z_t). For every *m* partitions, least squares estimation is applied by minimizing the sum of square residuals (SSR):

$$SSR_T(T_1, \dots, T_m) = (Y - \bar{Z}\delta)'(Y - \bar{Z}\delta) = \sum_{i=1}^{m+1} \sum_{t=T_{i-1}+1}^{T_i} (y_t - z'_t\delta_i)^2$$

For which $\hat{\delta}(\{T_j\})$ stands for the estimator for the m partition$\{T_j\}$. If this estimator is plugged into the objective function where the estimated breakpoints are the global minimizers of the objective:

$$argmin_{T_1,\dots,T_m} SSR_T(T_1, \dots, T_m) = (\hat{T}_1, \dots, \hat{T}_m)$$

Through a dynamic programing algorithm, the Bai and Perron (2003) test determines the number of break points. The test starts considering the SSR for zero breaks and for one break. In order to decide whether we should evaluate for one break or none of them, the minimum number of Bayesian Information Criterion (BIC) between the SSR for one break and the one for zero breaks is picked. This procedure can also be repeated to test for multiple breaks.

Before running the test, the correct number of lags for the model and specification must be determined. According to this result, series are treated as function of previous values of the other series for the optimum lags and are then estimated by ordinary least squares and tested for breaks.

4.2. Vector Autoregressive Model

In a VAR model, each variable can be treated symmetrically in a way that the time path of each variable is affected by current and past realizations of itself and of the other variables of interest (Enders, 2004).

After finding the optimal number of breakpoints in the data and the optimal number of lags, the p-order structural VAR can be defined as:

$$x_t = c + \Psi_1 x_{t-1} + \Psi_2 x_{t-2} + \cdots + \Psi_s x_{t-s} + u_t$$

$$= c + \sum_{s=1}^{p} \Psi_s x_{t-s} + u_t$$

The vector for the variables of interest is defined by x_t, where DP_t is the domestic production of tomatoes, Exp_t is the quantity of tomatoes exported from the U.S., PR_t is the shipping point price of tomato, $ImpM_t$ is the imported quantity of tomatoes from Mexico, $ImpC_t$ is the imported quantity of tomatoes from Canada and $ImpR_t$ is the imported quantity of tomatoes from the rest of the world, where t is an index describing the monthly period of time observed for *t* going from January, 1970 until December, 2014.

$$x_t = \begin{pmatrix} DP_t \\ Exp_t \\ PR_t \\ ImpM_t \\ ImpC_t \\ ImpR_t \end{pmatrix}$$

Where $\mathrm{E}(u_t) = 0$ and $\mathrm{E}(u_t u'_t) = \Sigma_u$. Also, u_t is the innovation or shock in x_t and the elements in this vector are white noise disturbances uncorrelated between individual equations. Each variable x affects each other and is stationary, meaning that mean and variance do not change over time. Ψ_s is a N order matrix of the contemporaneous effect of a unit change of x_{t-s} on x_t where N is the number of variables in x_t for *s*=0, 1, 2, …, *p*.

Let Ψ_0 be an upper triangular matrix with ones in the diagonal. It represents causal dependency between variables. If Ψ_0^{-1} is multiplied by both sides of the equation, contemporaneous dependency is allowed in the model:

$$x_t = \Psi_0^{-1}c + \Psi_0^{-1}\Psi_1 x_{t-1} + \Psi_0^{-1}\Psi_2 x_{t-2} + \cdots + \Psi_0^{-1}\Psi_s x_{t-s} + \Psi_0^{-1}u_t$$

Let x_t be a (Nx1) vector containing each of the N variables included in the VAR, $\Psi_0^{-1}c = d$ a (Nx1) vector of intercept terms, $\Psi_0^{-1}\Psi_s = \Gamma_k$ a (NxN) matrix of coefficients and $\Psi_0^{-1}u_t = v_t$ an (Nx1) vector of error terms. Now v_t are composite of the u_t shocks so the structural VAR can be written in standard form as:

$$X_t = d + \Gamma_1 x_{t-1} + \Gamma_2 x_{t-2} + \cdots + \Gamma_s x_{t-s} + v_t$$

Where $\mathrm{E}(v_t) = 0$ and $\mathrm{E}(v_t v'_t) = \Sigma_u \Psi_0 \Psi'_0 = \Omega_v$ assuming that all elements of Ω_v are time independent and v_t for all N variables are individually serially uncorrelated (Enders, 2004). Hence, the equations can be estimated by Ordinary Least Squares (OLS) which are consistent and asymptotically efficient.

However, errors are correlated between the equations and covariance matrix is not diagonal implying that the innovations are not orthogonal. When this happens, innovations are correlated and the matrix can be orthogonalized through Choleski factorization, Eigen decomposition or structural decomposition (Bernanke, 1986; Sims, 1986). Structural decomposition, imposes an economic structure and allows the specification of an ordering of the VAR variables. Once orthogonalized, innovations are uncorrelated across time and between equations. This is very convenient as it is possible to get variances of linear combinations of innovations, and it allow the examination of shocks to the set of variables that have historically moved together.

The structural decomposition method consists of decomposing the innovation terms including a certain order. To achieve this, the method starts by taking $\Psi_0^{-1} u_t = v_t$ and expressing it as $u_t = \Psi_t v_t$. Here, Ψ_t imposes $((N^2 - N)/2)$ restrictions so the system of equations can be identified. This number of restrictions is based on the variance-covariance matrix (Ω_v) dimensions (Enders, 2004). By doing this, u_t are attributed to shocks in v_t including a sequence or ordering of the variables which implies a type of causality between the variables. Directed Acyclic Graphs (DAGs) offer a way to explain the causal flow between the variables of interest.

In general, the interpretation of the VAR model is not simple (Swanson and Granger, 1997; Sims, 1980; Lutkepohl and Saikkonen, 1999) so a Moving Average Representation (MAR) can be used to analyze the results.

4.3. Directed Acyclic Graphs

DAG are applied to the innovations of the VAR model. As the VAR estimation provides the correlation matrices for each period of time determined by Bai and Perron (2003), DAGs offer evidence on ordering of variables in contemporaneous time, based on the data (Bessler and Akleman, 1998). This ordering is important for VAR interpretation through IRF and FVED.

A directed graph represents causal flow between a set of variables. It is composed by a set of variables, symbols attached to undirected edges and ordered pairs. Variables are connected by edges that could be independent (○ ○), undirected (○−−○), directed (→), bi-directed (↔) or partially directed (○→). If there is a set of variables (vertices) {A, B, C, D, E} then it is possible to have undirected graphs (with edges like B− C), directed graphs (with edges like A→B), inducing path graph (with directed and bi-directed edges like C↔ D) or partially oriented inducing graphs (with directed, bi-directed, undirected and partially directed) (Bessler and Lee, 2002). A DAG is a design where there are not directed paths and all variables appear only once. This are the type of graphs used for the analysis.

Additionally a DAG usually has a set of nodes $(x_1, x_2, x_3, \dots, x_{n)}$ and edges. As defined by Bessler and Akleman (2002), a DAG shows "conditional independence as implied by the recursive product decomposition":

$$\Pr(x_1, x_2, x_3, \dots, x_n) = \prod_{i=1}^{n} \Pr(x_i | pa_i)$$

Where, Pr is the probability of variables $x_1, x_2, x_3, \dots, x_n$ and $pa_i$is the realization of the precedent variable x_i. The graphical characterization of this conditional independence relations is proposed by Pearl (1995) with the concept of d-separation. This concept surge when a variable blocks the information between two other variables. D separation occurs when there are inverted causal forks ($x_1 \rightarrow x_2 \longleftarrow x_3$) or causal forks ($x_1 \longleftarrow x_2 \rightarrow x_3$) and causal chains ($x_1 \rightarrow x_2 \rightarrow x_3$) conditioned on the middle variable.

This notion is incorporated into PC algorithm by Spirtes, Glymour and Scheines (1998) and starts with an unrestricted set of associations among variables, meaning that all variables in the set are connected by undirected edges. Then, it starts removing edges by connecting variables to direct causal flow based on zero or partial correlation between the variables based on Fisher's Z statistic (Bessler and Akleman, 1998). The significance level used for Fisher's Z test should increase when the sample size becomes smaller. It is important to consider the proper significance level based on the sample size because PC algorithm can omit edges when the sample is too small (usually when there are less than 200 observations) (Spirtes et al., 2000). The PC algorithm is applied in the software TETRAD V (Schines et al., 1996).

Graphical models are useful as they show a dependence or causal structure in a given data set by the direction in which information flows. Also, the results from the PC algorithm can be used to provide an ordering by placing zeros into the Ψ_t matrix defined through the structural decomposition (Bernanke ordering). This makes it possible to analyze the model through innovation accounting.

4.4.Innovation Accounting

After calculating the MAR representation of the model and the DAGs, the analysis of IRF and FEVD for every period found through Bai and Perron (2003) tests, will allow a better interpretation of the model results.

4.4.1. Impulse Response Functions

VAR can be expressed in a MAR fashion (Sims, 1980). This allows to write variables as function of the time path of the innovations in the VAR system. MAR is achieved by using the brute force method to iterate the structural VAR backwards and getting:

$$x_t = \gamma + \sum_{i=0}^{\infty} \varphi_i \, u_{t-i}$$

The coefficient, or impact multiplier φ_i explains the effect of u_t shocks on the time path of the variables of interest, x_t (Enders, 2004). They can be expressed as impulse response functions $\varphi(i)$ for every variable interpreted as $\varphi(i) = \frac{\partial x_{t+i}}{\partial u_t}$ (Lu and Xin, 2010). When these functions are graphed it is easy to understand the behavior of the series to shocks in innovations. This can be achieve after restrictions are imposed and the system is identified through structural decomposition, as described earlier.

4.4.2. Forecast Error Variance Decomposition

The Forecast error variance decomposition is another element of analysis of the VAR model. It provides information on the percentage of the movements in a sequence due to its own shocks versus the shocks to the other variables (Enders, 2004).

Let the MAR be calculated for *n* steps ahead:

$$x_{t+n} = \gamma + \sum_{i=0}^{\infty} \varphi_i \, u_{t+n-i}$$

So the forecast error of the *n* period, which is defined as $x_{t+n} - E(x_{t+n})$ is:

$$x_{t+n} - E(x_{t+n}) = \sum_{i=0}^{n-1} \varphi_i \, u_{t+n-i}$$

5. RESULTS

This section explains how the empirical methods are used to find structural breaks in the data and to interpret the VAR model for the tomato industry. Also, DAGs will explain the causal relations among variables of interest. RATS and TETRAD V are the software chosen to apply these methods

5.1. Data Description

5.1.1. Data Source

For the empirical analysis, monthly data from January 1970 until December 2014 is obtained from the Agricultural Marketing Service (AMS) (USDA, 2015a), the National Agricultural Statistics Service (NASS) (USDA, 2015e) and Economic Research Service (ERS) (USDA, 2015b). The data for quantities is expressed in Metric Tons (MT) and in dollars per metric ton for prices (Table 3Table 3). Even though the data from prices is from two different sources, these were found to be very similar but available for different years due to updates done by the different USDA agencies.

Table 3. Data Source and Units of Each Variable

	Imports			**Exports**	**Domestic Production**	**Price**
	Rest of the World	**Canada**	**Mexico**			
	Metric Tons [MT]			Metric Tons [MT]		$/Metric Tons [$/MT]
1970-2012	ERS	ERS	ERS	ERS	AMS	ERS
2012-2014	ERS	ERS	ERS	ERS	AMS	NASS

5.1.2. Summary Statistics

The data for tomato exports reveals that, the largest quantity exported was reached in August, 2001. NAFTA increased the trend as average mean went from 6,885.9 MT to 12,188.8 MT in the post-NAFTA period. However, exports have been steadily decreasing in the last five years reaching an average of 9,383.0 MT. These reflect the decreasing trend in the domestic production for the past six years (Figure 3).

Imports from Mexico were relatively low during the early 1990s but they started to slowly increase after mid 1990s. The maximum imported quantity was 177,161.9 metric tons in March, 2014. Imports from Canada started to represent a larger amount after the mid 1990s, this could be explain by NAFTA and by the increase in greenhouse tomato production. Imports from rest of the world started to significantly increase after late 1990s with two peaks of 88,635.2 MT and 80,077.3 MT in 2010 and 2001, respectively (Table 4). These could be attributed to the fact that new free trade agreements between the U.S. and Central and South America were signed and the fact that these regions started to produce more exporting tomato.

Prices appear to be highly seasonal. For the 2005-2011 they appear to reach high levels and to fluctuate in bigger proportions (Figure 3). This could have been caused by extreme weather conditions in Florida especially on 2010, which destroyed 60% to 70% of the tomato crop. During this period, California and Mexico started to increase their supply to the U.S. market.

Table 4. Summary Statistics

	Exports	*Imports from Canada*	*Imports from Mexico*	*Imports from Rest of the World*	*Domestic Production*	*Price*
Average	9596.31	4004.06	43345.34	6863.56	91474.39	615.10
Std. Dev	4176.61	6680.29	37368.55	13523.02	36732.72	323.11
Min	107.00	0	494.60	0	1976.49	173.02
Max	21562.10	26932.50	177162.90	88635.20	172880.38	2342.41

5.1.3. Plots of Series

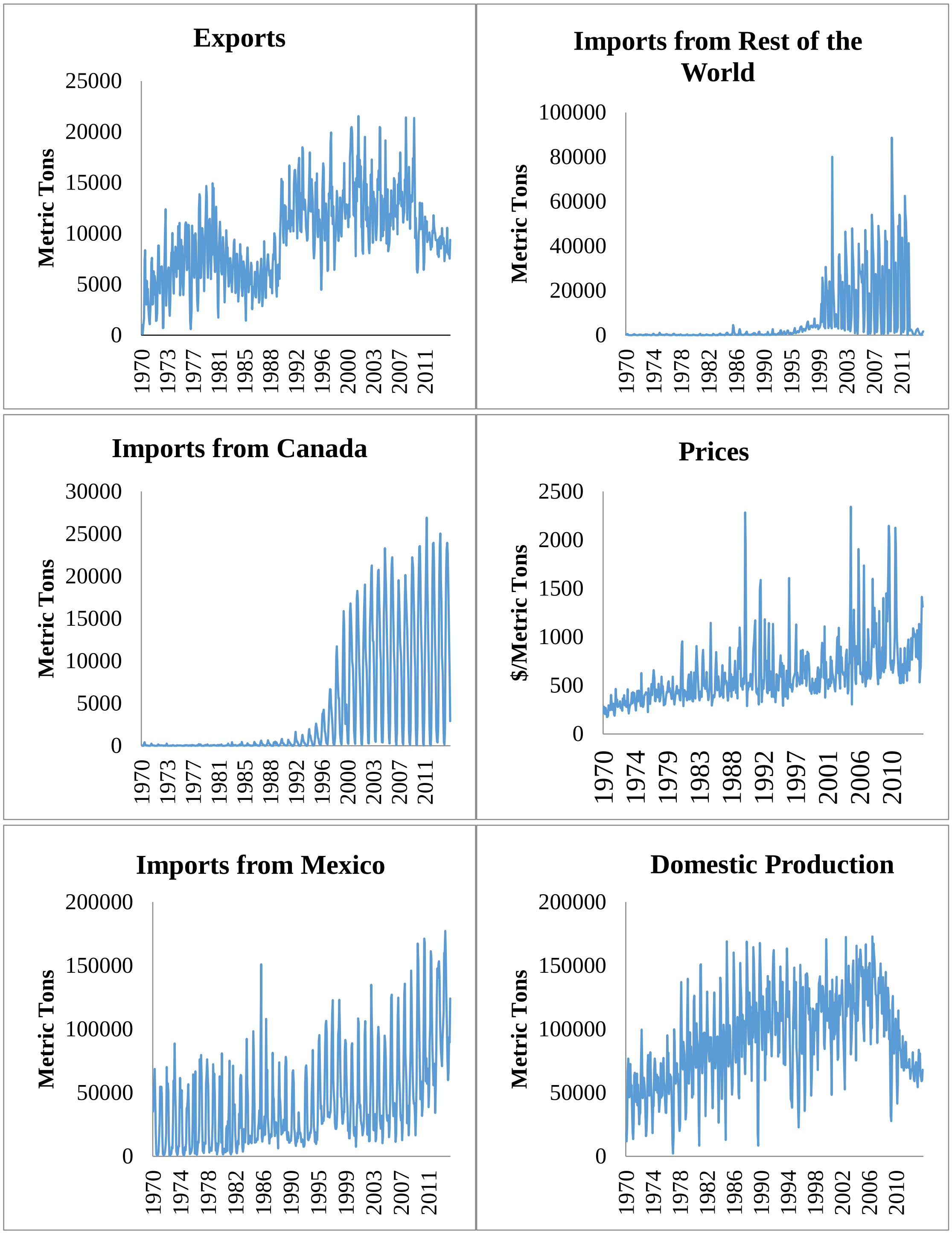

Figure 3. Series for the Variables of Interest from 1970 to 2014.

5.2. Structural Break Points Estimation

The first step is to calculate the optimal lag length. In RATS this is done according to the Schwarz loss Information Criteria (SIC). This allow us to use an overall lag length which based on the series and SIC is 2, including seasonal variables and constant (Figure 4 and Table 5).

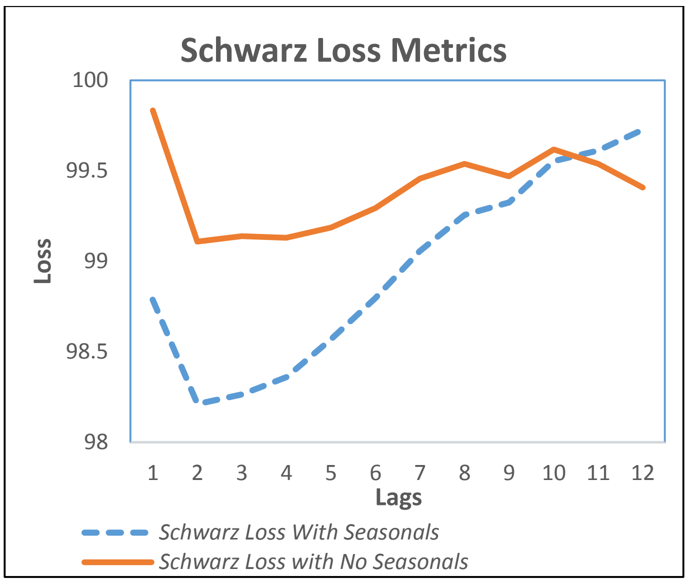

Figure 4. Schwarz Loss Metrics

Table 5. Schwarz Information Criteria (SIC)

Sample Period	*SIC*	*Lag Order*
Entire sample period	98.2104	2

Once the optimal lag length is determined, Bai and Perron (2003) test is applied to the data set. This test procedure could be repeated for multiple breaks. The results for the test are summarized in Table 6.

The test concludes that that there is no structural break point for the variables Exports, Domestic Production and Price. Nevertheless, the variables for imports have structural breaks for the period analyzed. Imports from Canada appear to have one break on September 1999, Imports from Mexico one break on January 1992 and Imports from rest of the world one break in July, 1999 (Table 6). These suggest that imports are driving structural changes in the industry due to events happening during the period analyzed. The first break, found for 1992 could be attributed to NAFTA signature and affected the trade flow as revealed by literature. The second break in 1999, happened together with the elimination of the NAFTA summer tariffs imposed for tomato, and three years after the price floor was set for Mexican tomatoes. Both of these policy changes could have encouraged importers from countries other than Mexico as well.

Table 6. Bai and Perron (2003) Test Results

Series	*Possible Number of Breaks*	*BIC*	*Break Date*
Exports	0	15.49	None
Imports from Canada	1	13.86	September, 1999
Imports from Mexico	1	19.62	January, 1992
Imports from Rest of the World	1	17.55	July, 1999
Domestic Production	0	19.85	None
Price	0	11.01	None

Based on these results, the data is divided into three periods: 1) from January, 1970 through December, 1991; 2) from January, 1992 through July, 1999; and 3) from August, 1999 through December 2014 (Figure 5). For each one of the periods a VAR model is calculated in order to find the underlying causal structure of the variables of interest.

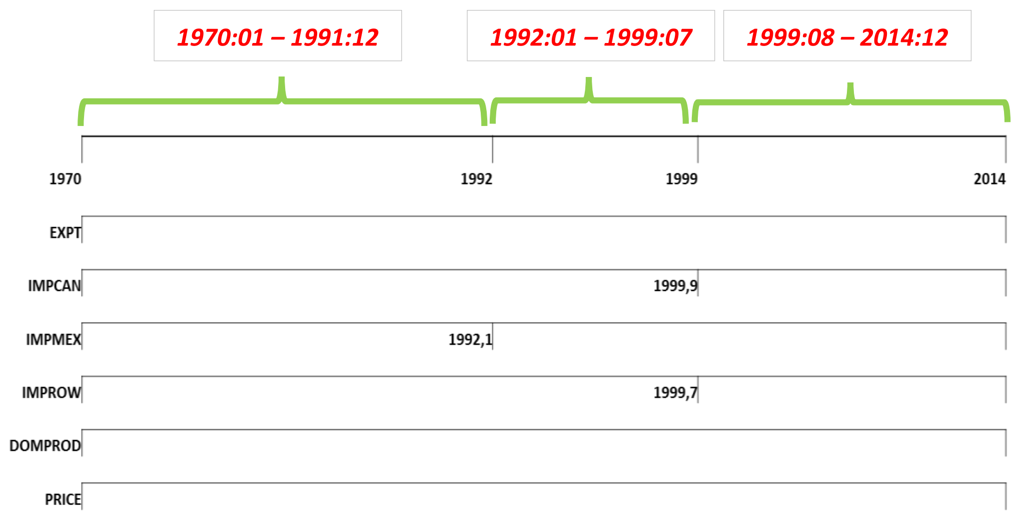

Figure 5. Timeline of the Data Divided by Break Points

5.3. Vector Autoregressive Model

After the optimal number of lags and the number of breaks are found using Bai and Perron (2003) tests, three vector autoregressive models are estimated according to the periods shown in the timeline above (Figure 5). The VAR model allows for feedback effects between the variables. For example, the exports equation allows for current and past values of the other variables to affect the time path of the exports. And the same happens for each variable equation. However, the coefficients of the model and the results are hard to interpret so an innovation accounting analysis is done below.

The results of the VAR model for $DP_t, Exp_t, PR_t, ImpM_t, ImpC_t, ImpR_t$ and the seasonal variables for each month named $Seas$, $Seas_1, Seas_2$, $Seas_3, Seas_4$, $Seas_5$, $Seas_6, Seas_7$, $Seas_8$, $Seas_9$, $Seas_{10}$ with a constant are shown in the Appendix 1. Results also include the matrix of correlation of each period which provide information on causality.

5.4.Directed Acyclic Graphs

After estimating the VAR, the correlation matrix for each period is used in order to construct the DAG and explain causal relations between the series in contemporaneous time. PC Algorithm is used to build each of the DAGs. The significance level of the PC algorithm is determined based on the number of observations (Sprites et al., 2000). For the first period there are 254 observations and the DAG is calculated with PC Algorithm at the 5% level of significance. For the Second period, there are 91 observations and PC Algorithm is used at the 20% level of significance. For the third period there are 185 observations and PC Algorithm is used at the 10% level of significance.

Figure 6, represents the DAG for the first period. As expected for the pre-NAFTA period, tomato imports did not play an important role in explaining the exports, the domestic production or the price of tomato. However, exports and price appear to be determinant in the quantity produced in contemporaneous time. Imports from Canada and imports from Mexico appear to be linked through an undirected edge.

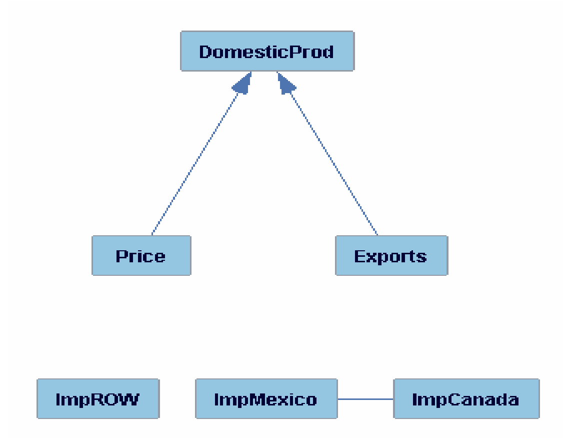

Figure 6. DAG 1970:01-1991:12

After the 1992 break, imports from the rest of the world and from Mexico started playing an important role in the tomato industry and explaining the domestic production (Figure 7). NAFTA effect is clearly seen in a more opened industry. Canada appears to be outside the DAG because after NAFTA, trade relations with Canada were not drastically affected as CUSFTA was already in rule since 1988. CUSFTA did not seem to have structurally changed the industry. Also, Canadian contribution to the overall tomato trade was not significant in comparison to the one from Mexico.

As explained by the literature and the data, Imports from Mexico played a major role between 1992 and 1999 (Figure 7). Imports from Mexico appear to be a determinant of the domestic production as well as of U.S. exports. Domestic Production is explained by the quantity to be exported, which at the same time is explained by the Imports from Mexico. As discussed earlier, imports from Mexico gained an important share of the market and this explains its main role in affecting the quantity produced. This clarifies why many local growers, especially from Florida, decided to initiate dumping complaints against Mexican exporters of tomato. DAG results for the second period also show that prices of tomato influence the quantity to be exported but not directly the domestic production.

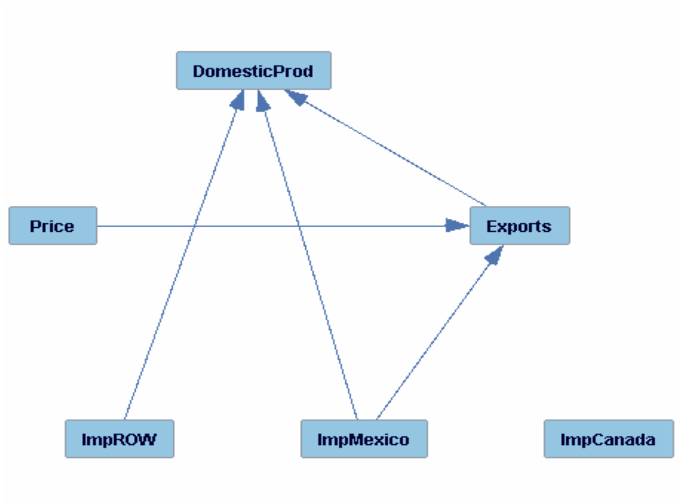

Figure 7. DAG 1992:01-1999:07

During the third period (Figure 8), prices start to cause changes in domestic production as well as exports. The causal direction between exports and domestic production also changes for this period. Now the domestic production is the one causing the quantity exported. There is also an undirected link between imports from rest of the world and imports from Mexico. Canada is still out of the DAG's connections even after its increasing exports to the U.S. during the 1990's.

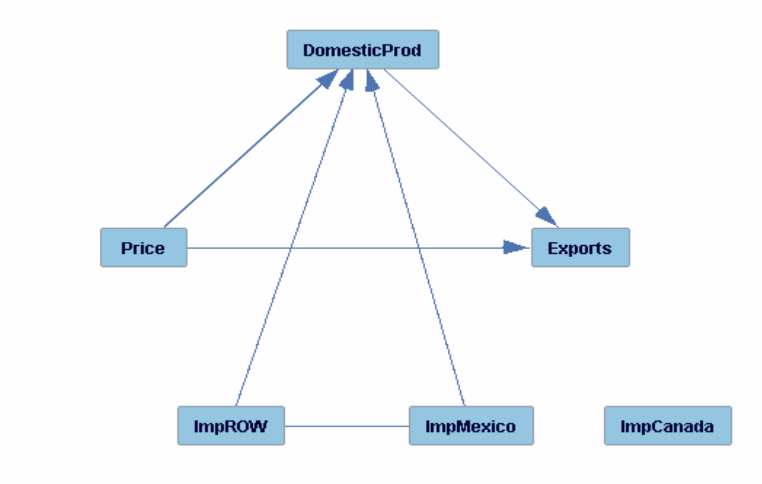

Figure 8. DAG 1999:08- 2014:12

5.5.Innovation Accounting

5.5.1. Impulse Response Functions

Using the DAGs information about causality between the variables, Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD) are estimated in order to interpret the results of the VAR models for every period. The impulse response function captures the response of the system to shocks in the innovations of the variables of interest which usually complements with FEVD results. The complete set of impulse responses is the moving average representation; however, it is more useful to interpret results graphically (Enders, 2004). Therefore, the results are presented in a matrix that shows the response of each variable to multiple shocks (Figure 9, Figure 10 and Figure 11).

In the first period, there is not much interaction between the variables as it is evident on Figure 9. It is clear that the response of innovations to own shocks is diminishing through time. The response of domestic production to shocks in price is increasing and then starts to decrease. Additionally, when there are shocks in exports' innovation, the response of domestic production is decreasing. These suggest that there is interaction between the two variables as DAGs anticipated (Figure 6).

During the second period, the IRFs reveal that there is interaction between imports from Canada and imports from rest of the world (Figure 10). After 1991 and NAFTA signature, it is clear that the variables for the tomato industry started to have more interaction between them. As markets started to get more integrated, trade variables are more responsive to shocks in innovations. This is especially true for domestic production, whose response to shocks in all of the variables' innovations is evident.

A shock in the innovations of imports from Mexico has a negative increasing effect on domestic production while a shock in the innovations of imports from the rest of the world has a positive effect on it. Also, the response of exports to an innovation shock in imports from Mexico appears to be negative and increasing through time. As imports from Mexico started taking a larger share of the market, domestic production must be reduced and this affects the exporting capacity. This causal relation is also evident in the DAGs. On the other side, some relations between variables are present in IRFs analysis but not in DAGs. This is the case of imports from Canada with imports from rest of the world and domestic production, which appear to be related (Figure 10).

Figure 11 also captures some interactions between the variables of analysis for the third period. However, it is not as evident as in the second period. Domestic production and imports from Mexico are still linked. Domestic production response to innovations shocks in imports from Mexico and prices are negative and positive, respectively. The IRF for the third period also highlights that all variables respond to shocks in innovations of imports from Mexico. Imports from Canada respond to shocks in imports from Mexico and from rest of the world innovations and Exports to innovations in imports from Mexico.

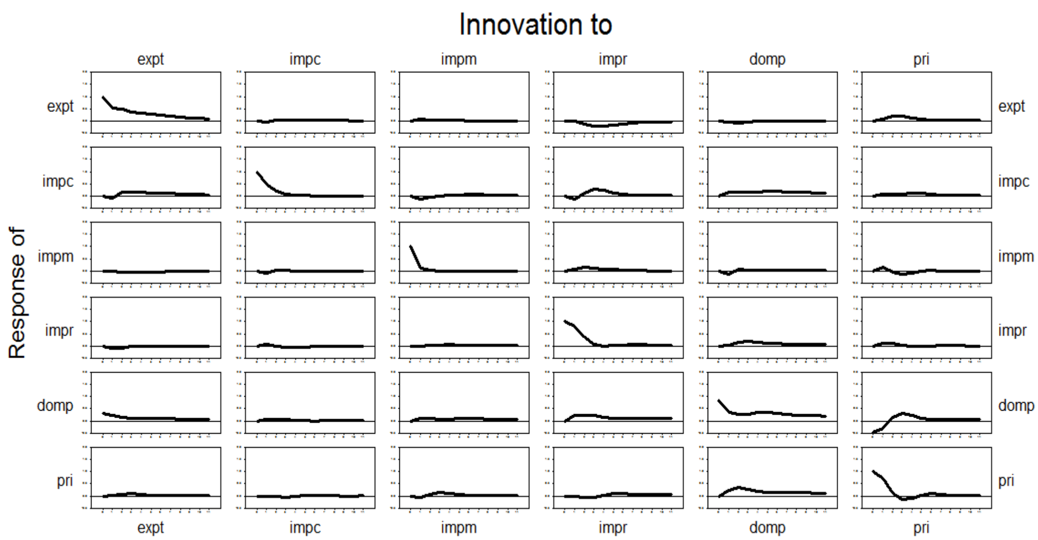

Figure 9. IRF 1970:01-1991:12

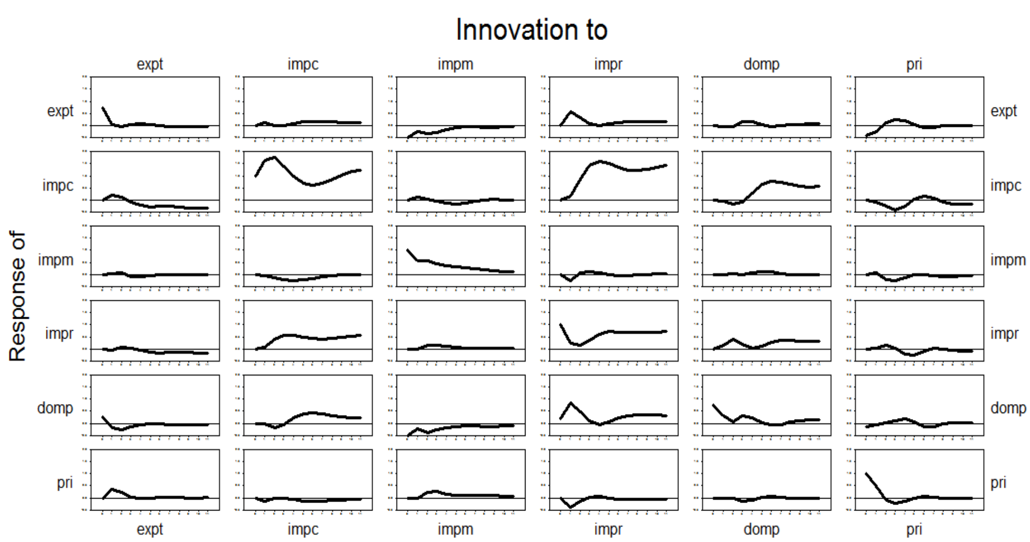

Figure 10. IRF 1992:01- 1999:07

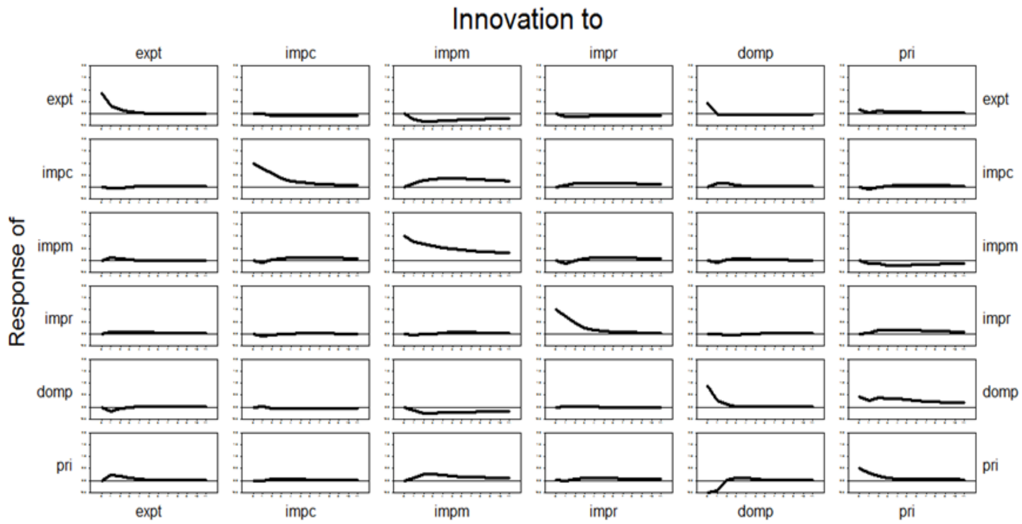

Figure 11. IRF 1999:08- 2014:12

5.5.2. Forecast Error Variance Decomposition

The results for the FEVD are presented in six tables, one for each of the endogenous variables of analysis. The first column of each table indicates the forecast step, the second one the standard error of the forecast for the table's variable. The following columns specify the decomposition or percentage of the variance of the variable that is explained by each of the other variables, for every step. Each row adds to a hundred percent (RATS user's guide, 2007). It is important to take into account that in the short run it is typical that variable can explain all of its FEV but a smaller proportion in the longer horizon. Also, the variance of the forecast error increases as the forecast horizon increases (Enders, 2014).

For Table 7, the standard error of the Exports' forecast is listed in the second column. The remaining columns show the percentage of the exports that is explained by each of the other variables and by exports itself for every forecast step. It seems that for the first period, the principal factors driving Exports are exports itself while price and imports from rest of the world percentages show a rapid growth. Although they only explain 6 and 5 percent of the variance of the 12 step forecast error respectively. The other variables have very little explanatory power. For the second period, 27% of the variance from the second through the twelfth forecast error is due to innovations in imports from rest of the world, which appears to become the prime mover. Imports from Mexico explain around 22% of the exports for the 12^{th} step forecast error. Imports from Mexico rapidly become an important mover of exports, especially in the third period, going from 0% to 34%. These suggest that Imports from rest of the world and from Mexico are primary movers of Exports especially for the second and third period, respectively.

Likewise, imports from Canada are mainly driven by itself during the first period, by imports from rest of the world in the second period (47%) and imports from Mexico in the third one (28%). For the first period only a 14.6% is explained by domestic production. Any of the other variables seem to have much explanatory power on imports from Canada. However, it is clear that for each period, the percentages for all variables are increasing starting from zero percent (Table 8).

On the other hand, Table 9 shows that there is not any variable that have a considerable explanatory power on imports from Mexico. For most periods, this variable appears to be driven mainly by itself. On the first period, domestic production reaches a second place with only 5% of the variance in imports from Mexico. For the second period, innovations of imports from Canada explain 7.4% of the variance and for the third, domestic production explain 6.7%, which are very low values. However, imports from

Mexico do have a big explanatory power in the FEVD of all the other variables, especially in the third period. This reassures IRFs results for the third period.

Something similar happens to imports from the rest of the world (Table 10). It is evident that the only variable that has a considerable explanatory power on it is imports from Canada (27.9%) suggesting that these two variables are linked and explain each other, especially during the second period. Almost 10% of the variance of the forecast error is due to innovation in domestic production, and 8.5% due to innovation in price during the third period. However, the imports from rest of the world variable, takes big percentages in explaining exports, imports from Canada and domestic production on the second period. This goes in line with DAG results for period two and three.

From the FEVD of domestic production in Table 11, it is noticeable that during the first period price innovation account for around 20% of the variance and this number remains stable. In the second period, imports from rest of the world (36.8%), imports from Canada (19.5%), and imports from Mexico (14.7%) are the principal factors driving domestic production. During the third period price gets to take 40% effect on the variance of domestic production followed by imports from Mexico with 18.4%. Again, this reassures DAG results by proving that during the second period domestic production is explained by exports, imports from rest of the world and imports from Mexico while during the third period by prices, imports from rest of the world and imports from Mexico.

For the third period, the results of the prices' FEVD reveal that around 48.4% of the variation in price is explain by domestic production innovations, and 18.7% for the first period (Table 12). For the second period, domestic production does not seem to have an explanatory power on prices but all of the variables contribute in small amounts adding up to almost 35%.

Table 7. FEVD Exports

EXPORTS							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	1527.67	100.00	0.00	0.00	0.00	0.00	0.00
1	1757.00	98.91	0.07	0.39	0.00	0.18	0.46
2	1958.91	94.53	0.21	0.48	0.86	0.39	3.54
12	2342.24	87.15	0.62	0.52	5.21	0.31	6.19
1992:01 - 1999:07							
0	1384.68	57.90	0.00	25.96	0.00	0.00	16.15
1	1711.83	37.96	1.16	20.80	24.84	0.08	15.16
2	1844.67	32.83	1.00	24.42	27.43	0.10	14.22
12	2192.39	23.81	8.32	22.18	27.00	3.52	15.16
1992:01 - 1999:07							
0	1947.03	77.65	0.00	0.00	0.00	19.88	2.47
1	2118.34	74.18	0.00	5.64	0.93	16.89	2.35
2	2249.32	67.61	0.30	12.08	1.72	15.00	3.29
12	2774.26	44.75	2.51	34.45	3.85	10.07	4.39

Table 8. FEVD Imports from Canada

Imports From Canada							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	80.03	0.00	100.00	0.00	0.00	0.00	0.00
1	90.94	0.37	95.56	0.90	1.15	1.70	0.32
2	95.46	2.01	90.22	0.95	2.51	3.73	0.60
12	115.75	7.24	62.07	1.88	10.42	14.62	3.77
1992:01 - 1999:07							
0	611.24	0.00	100.00	0.00	0.00	0.00	0.00
1	1182.41	1.03	97.81	0.37	0.62	0.08	0.10
2	1688.57	0.70	87.92	0.23	9.88	0.35	0.93
12	3761.80	1.79	41.51	0.20	47.30	8.08	1.12
1992:01 - 1999:07							
0	1162.86	0.00	100.00	0.00	0.00	0.00	0.00
1	1512.13	0.16	95.87	1.39	0.28	2.04	0.26
2	1701.05	0.19	90.04	5.20	1.35	3.01	0.22
12	2239.37	0.50	60.78	28.05	6.69	2.50	1.49

Table 9. FEVD Imports from Mexico

Imports From Mexico							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	14919.77	0.00	0.00	100.00	0.00	0.00	0.00
1	15465.75	0.01	0.45	94.41	0.78	1.43	2.91
2	15775.69	0.29	0.65	90.83	3.20	1.99	3.03
12	16250.37	0.88	0.81	85.66	5.06	2.80	4.79
1992:01 - 1999:07							
0	7421.86	0.00	0.00	100.00	0.00	0.00	0.00
1	8683.26	0.05	0.15	95.07	4.31	0.01	0.41
2	9871.21	0.40	1.04	92.10	3.80	0.06	2.59
12	12444.47	0.78	7.43	82.05	3.53	1.51	4.71
1992:01 - 1999:07							
0	12276.85	0.00	0.00	100.00	0.00	0.00	0.00
1	15767.89	0.60	0.26	96.97	0.92	0.49	0.76
2	18107.38	0.69	0.26	96.45	0.70	0.44	1.47
12	25554.36	0.38	2.31	87.51	2.46	0.60	6.74

Table 10. FEVD Imports from Rest of the World

Imports From Rest Of The World							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	304.47	0.00	0.00	0.00	100.00	0.00	0.00
1	396.45	0.34	0.29	0.00	98.69	0.03	0.64
2	414.37	0.60	0.28	0.04	96.77	1.08	1.23
12	432.18	0.62	0.54	0.69	89.97	6.87	1.31
1992:01 - 1999:07							
0	787.35	0.00	0.00	0.00	100.00	0.00	0.00
1	824.45	0.21	0.71	0.00	96.72	2.15	0.21
2	958.30	0.56	11.36	1.37	73.46	11.61	1.64
12	2311.21	1.93	27.94	0.86	57.80	9.75	1.70
1992:01 - 1999:07							
0	7967.02	0.00	0.00	0.00	100.00	0.00	0.00
1	9933.43	0.37	0.41	0.16	98.98	0.01	0.06
2	10652.13	0.59	0.45	0.14	97.34	0.17	1.30
12	11585.62	1.49	0.46	1.06	87.83	0.61	8.55

Table 11. FEVD Domestic Production

Domestic Production							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	13975.52	10.31	0.00	0.00	0.00	68.80	20.89
1	16131.25	11.55	0.36	1.11	3.56	60.84	22.59
2	17344.06	11.46	0.65	1.76	7.23	57.86	21.04
12	23293.18	9.83	0.72	3.25	10.17	57.40	18.62
1992:01 - 1999:07							
0	13250.96	7.92	0.00	27.30	3.88	58.69	2.21
1	18248.68	5.95	0.00	16.71	40.18	35.91	1.25
2	20412.57	7.79	1.30	19.48	41.36	29.05	1.02
12	27774.43	4.97	19.60	14.74	36.90	21.05	2.74
1992:01 - 1999:07							
0	16136.22	0.00	0.00	0.00	0.00	81.78	18.22
1	17547.35	2.05	0.03	1.85	0.10	74.92	21.05
2	19150.17	2.03	0.27	5.65	0.10	63.91	28.04
12	25354.02	1.47	1.49	18.40	0.09	36.66	41.89

Table 12. FEVD Price

Price							
Step	**Std. Error**	**Exports**	**Imports Canada**	**Imports Mexico**	**Imports Rest Of The World**	**Domestic Production**	**Price**
1970:01 - 1991:12							
0	145.10	0.00	0.00	0.00	0.00	0.00	100.00
1	181.43	0.05	0.00	0.14	0.00	3.41	96.40
2	189.65	0.46	0.07	0.41	0.18	10.00	88.89
12	210.00	1.56	0.34	2.14	2.15	18.75	75.06
1992:01 - 1999:07							
0	138.67	0.00	0.00	0.00	0.00	0.00	100.00
1	171.32	8.28	1.12	0.02	9.62	0.00	80.96
2	179.13	10.58	1.10	3.54	10.02	0.01	74.75
12	197.02	8.82	4.58	10.28	9.50	1.58	65.23
1992:01 - 1999:07							
0	266.93	0.00	0.00	0.00	0.00	72.27	27.73
1	308.52	3.56	0.02	0.58	0.02	67.59	28.23
2	325.74	5.93	0.28	5.09	0.41	60.64	27.65
12	370.03	5.85	1.26	17.59	3.43	48.45	23.42

6. CONCLUSIONS

After analyzing the methods applied to the tomato industry data, it is clear that agricultural policies do affect the underlying causal structure on the U.S. tomato industry. Apparently, NAFTA had more influence in affecting the structural change in the tomato industry in the short run than price policies implemented in the industry. This suggests that opening to markets and not relying only on price policies have more certain and immediate effects in the domestic tomato industry.

Even though literature have argued that the NAFTA and the Mexican peso devaluation in the mid 1990's affected the structure of tomato trade, a structural breakpoint was found on 1992. This suggest that NAFTA signature had more influence in causing a structural change in the tomato industry. The peso devaluation could certainly affect the causal relations between the variables of interest but it did not caused a structural change. The peso devaluation in addition to the change in pricing policies, investment in greenhouse tomato, improvements Mexican infrastructure and technology, as well as the elimination of the summer quota on 1998, appear to cause the second structural change on 1999.

There is a clear spillover effect as a result of Mexican imports driving changes in the industry. Most of the agricultural policies applied for tomatoes have been oriented to mitigate the effects of Mexican imports in taking over the market. However, exports and domestic production continue to decrease as imports from Mexico keep consolidating in the market. It seems that policies implemented towards protecting the industry have not stopped Mexican tomatoes from taking an important share of the market. In these regards, the difference between a quota policy and a floor price is also evident in the analysis of results. Domestic production appears to be affected by prices during the first and third period, which had pricing policies such as tariffs and floor prices, respectively. This means that a quota policy does not have direct influence on the U.S. tomato production. Likewise, even though prices affect the availability of export a shock in their innovations do not have a big response from the exports (FEVD and IRF on the third period).

The first break point that was found on 1992 coincides with NAFTA signature. After that, imports from rest of the world and from Mexico started to turn into primary movers of the U.S. domestic production. While before NAFTA, prices and exports were the only factor causing the quantity to be produced. Exports however kept explaining the quantity to be produced, but price stopped being a primary mover of domestic production. After NAFTA, Imports from Mexico also turned into a strong determinant of the exports.

However after the 1999 break, mainly attributed to changes in pricing and tariffs policies to the Mexican imports, prices started to determine again the domestic production. Also as exports decreased, they started to be caused more by the quantity produced than by imports. During the second and last period imports from rest of the world and imports from Canada appear to be liked. As shown by DAGs, IRFs and FEVD imports from rest of the world appear to have more influence than expected. They affect domestic production even more than imports from Canada. This goes in line with the fact that Mexican imports are linked to imports from rest of the world while domestic production increases when Mexican imports decrease.

The series used for this study reveal that there is a similar seasonal pattern between the imports from Mexico and the ones from the rest of the world. It becomes more evident through time probably due to the fact that more Central American and South American countries started to trade with the U.S. This causes a link between the two variables during the third period of time analyzed as reflected in the DAG.

While Florida producers accused Canadian importers of dumping their tomatoes, imports from Canada do not have much explanatory power on the other variables and they are not explained by them. However, there appear to be a link between the imports from rest of the world and imports from Canada. This is not reflected in the DAG but the IRF and FEVD account this fact. This could be explained by the increase in quantities imported from Canada and the rest of the world after the mid 1990's. As a floor price to Mexican imports was stablished, it was expected to open an opportunity to increase the imports from other places to supply the U.S. demand.

This study does not account for a consistent data source especially for prices. However, the historical databases were found to be very similar. An improvement of this limitation could be to include price data from the same source. Additionally a closer analysis to each period of the data and product differentiation could expand this research.

As it can be seen on Figure 3, it is possible to think that there could be a break in the Exports data around 2010. Even though this was not concluded on the Bai and Perron (2003) tests used for the analysis, in the future it could be relevant to closely analyze the data for a shorter period. This would allow to determine if Florida's weather condition during 2010 or any other factor may have caused a different behavior in the data. Also, the differentiation between organic versus non organic, and field grown versus greenhouse tomatoes would be an interesting source of analysis. This could be appropriate, not only because floor prices were set differently for each product type on 2013, but also in the light of consumption trends, infrastructure, technological investment, or other regulations.

Another extension of this research work, could be based on analyzing the role played by the Mexican peso devaluation in the mid-1990s. As there is no consensus on what may have had a higher effect on Mexican exports, if the peso devaluation or the NAFTA, incorporating the exchange rate variable in this analysis could find a more conclusive answer.

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APPENDIX

The VAR model results are included below.

VAR(2) estimated by Ordinary Least Squares for the first period (1970:01-1991:12)												
	Exports		Imports from Canada		Imports from Mexico		Imports from Rest of the World		Domestic Production		Price	
	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err
Exp_{t-1}	0.568***	0.068	-0.007**	0.003	0.380	0.655	-0.017	0.013	0.751	0.624	-0.004	0.006
Exp_{t-2}	0.212***	0.067	0.010***	0.003	-0.845	0.647	0.001	0.013	-0.138	0.616	0.000	0.006
$ImpC_{t-1}$	-0.732	1.234	0.492***	0.064	-14.137	11.792	0.270	0.241	12.784	11.219	0.010	0.114
$ImpC_{t-2}$	1.695	1.188	-0.027	0.061	17.609	11.352	-0.332	0.232	1.333	10.801	-0.127	0.110
$ImpM_{t-1}$	0.007	0.007	-0.000	0.000	0.125*	0.066	-0.000	0.001	0.112*	0.063	-0.000	0.000
$ImpM_{t-2}$	0.001	0.006	0.000	0.000	0.031	0.065	0.000	0.001	0.048	0.062	0.000	0.000
$ImpR_{t-1}$	0.012	0.324	-0.031*	0.016	4.582	3.098	0.811***	0.063	9.788***	2.948	0.002	0.030
$ImpR_{t-2}$	-0.57911*	0.345	0.072***	0.017	4.752	3.299	-0.315***	0.067	-0.555	3.138	-0.053*	0.032
DP_{t-1}	-0.005	0.008	0.000*	0.000	-0.154*	0.081	0.000	0.001	0.4388***	0.077	0.002***	0.000
DP_{t-2}	-0.001	0.008	-0.000	0.000	0.184	0.080	0.001	0.001	0.181**	0.076	0.000	0.000
PR_{t-1}	0.632	0.763	0.067*	0.039	11.492	7.292	0.263*	0.149	-8.976	6.937	0.836***	0.071
PR_{t-2}	1.231	0.782	0.016	0.040	-12.430*	7.475	-0.026	0.153	37.0391***	7.112	-0.366***	0.072
c	2928.346***	582.256	-111.263***	30.262	10445.791*	5563.382	-81.260	113.903	10295.595*	5293.114	24.791	54.174
$Seas$	-1351.527**	541.335	-7.497	28.135	-4988.260	5172.389	-50.418	105.897	1569.507	4921.115	-122.221**	50.366
$Seas1$	-3228.825***	545.084	-13.766	28.330	20150.06***	5208.211	75.072	106.631	-23812.778***	4955.196	135.503***	50.715
$Seas2$	-5092.408***	601.227	12.095	31.248	42038.53***	5744.648	222.914*	117.614	-35973.634***	5465.573	61.352	55.939
$Seas3$	-2958.685***	737.734	63.860*	38.343	28787.951***	7048.964	364.851**	144.318	-23737.674***	6706.526	151.890**	68.640
$Seas4$	-1021.204**	724.643	93.990**	37.662	31537.673***	6923.880	51.060	141.757	-5139.253	6587.519	112.848*	67.421
$Seas5$	1155.196**	674.687	124.092***	35.066	23518.071***	6446.557	-90.252	131.984	35196.521***	6133.384	31.875	62.774
$Seas6$	-308.2996	667.014	89.484**	34.667	12770.542**	6373.241	104.268	130.483	5936.357	6063.630	-43.871	62.060
$Seas7$	-499.391	632.644	-31.831	32.881	-6405.418	6044.842	-120.901	123.760	-16400.466***	5751.184	-180.822***	58.862
$Seas8$	-5570.397***	657.143	74.436**	34.154	-7325.909	6278.923	-56.179	128.552	-31406.000***	5973.893	-88.019	61.141
$Seas9$	-3338.056***	689.416	-30.046	35.832	-5309.430	6587.291	-101.678	134.866	-3718.969	6267.282	-38.301	64.144
$Seas10$	-648.447	530.480	-0.414	27.571	-1609.070	5068.671	-4.287	103.774	20565.091***	4822.436	10.954	49.356
Obs. 264												
*, **, and ***, stand for 10%, 5% and 1% significance levels, respectively.												
R2	0.76073		0.66183		0.66351		0.63668		0.84549		0.60612	

VAR(2) estimated by Ordinary Least Squares for the second period (1992:01-1999:07)												
	Exports		Imports from Canada		Imports from Mexico		Imports from Rest of the World		Domestic Production		Price	
	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err
Exp_{t-1}	0.099	0.167	0.055	0.065	0.482	0.909	-0.040	0.082	-3.080**	1.440	0.042**	0.018
Exp_{t-2}	0.071	0.167	-0.068	0.065	0.794	0.910	-0.017	0.082	1.306	1.442	-0.026	0.018
$ImpC_{t-1}$	0.200	0.238	1.617***	0.092	-0.674	1.299	0.189	0.117	-0.092	2.058	-0.005	0.026
$ImpC_{t-2}$	-0.435	0.317	-0.900***	0.123	-0.517	1.724	0.253*	0.155	-3.179	2.732	0.022	0.035
$ImpM_{t-1}$	-0.047*	0.028	0.018*	0.011	0.773***	0.155	0.006	0.014	-0.352	0.246	-0.002	0.003
$ImpM_{t-2}$	-0.011	0.031	-0.016	0.012	0.110	0.169	0.024*	0.015	-0.484*	0.268	0.003	0.0035
$ImpR_{t-1}$	0.946**	0.401	0.044	0.156	-1.225	2.185	0.295	0.197	11.020***	3.462	-0.0706	0.045
$ImpR_{t-2}$	-0.385	0.390	0.276*	0.151	3.508*	2.121	-0.062	0.191	-0.972	3.361	0.037	0.043
DP_{t-1}	0.012	0.016	0.005	0.006	-0.037	0.091	0.012	0.008	0.46***	0.145	-0.002	0.001
DP_{t-2}	-0.012	0.016	-0.004	0.006	0.019	0.091	0.012	0.008	-0.265*	0.145	0.001	0.001
PR_{t-1}	0.026	1.225	0.226	0.476	-3.474	6.665	1.101*	0.601	-10.296	10.560	0.633***	0.137
PR_{t-2}	1.755	1.220	-0.860*	0.475	1.546	6.640	-0.173	0.599	-1.826	10.519	-0.508***	0.137
c	9916.823**	3817.650	-625.709	1485.299	-5091.790	20762.396	-2831.114	1873.285	113461.066***	32892.248	426.240	429.577
$Seas$	789.601	1215.062	885.630*	472.733	4694.332	6608.1481	362.433	596.219	-537.821	10468.774	69.815	136.723
$Seas1$	-1514.292	1149.349	701.325	447.167	29872.123***	6250.767	767.846	563.975	-13101.072	9902.603	31.911	129.329
$Seas2$	-1783.265	1378.736	62.396	536.412	11740.516	7498.296	385.178	676.533	-21312.457*	11878.967	251.886*	155.141
$Seas3$	1292.419	1519.725	903.899	591.265	7281.164	8265.066	263.064	745.715	15543.101	13093.701	230.697	171.005
$Seas4$	2323.545	1531.553	1649.014***	595.867	-18984.893**	8329.395	-386.387	751.519	51887.626***	13195.612	-120.138	172.336
$Seas5$	2863.505*	1761.763	1809.470**	685.433	-28854.30***	9581.398	-294.809	864.481	61120.776***	15179.063	-13.429	198.240
$Seas6$	2577.782*	1474.729	775.824	573.759	-12994.572*	8020.355	-515.635	723.635	57732.579***	12706.024	-115.871	165.942
$Seas7$	3474.772***	1276.435	-105.410	496.611	-12258.695*	6941.928	340.993	626.335	28711.014**	10997.557	-100.217	143.629
$Seas8$	-365.981	1386.524	737.495	539.442	-12565.783*	7540.650	-1775.759***	680.354	10322.094	11946.065	-205.851	156.017
$Seas9$	-653.962	1549.615	1136.434*	602.895	-17848.566**	8427.627	-1023.043	760.382	14009.087	13351.233	-119.938	174.369
$Seas10$	1625.553	1279.758	1470.298***	497.904	-6150.489	6959.999	6.583	627.965	29171.292	11026.185	53.149	144.003
Obs. 91												
*, **, and ***, stand for 10%, 5% and 1% significance levels, respectively.												
R2	0.72877		0.96466		0.92013		0.85014		0.81733	0.50957		

VAR(2) estimated by Ordinary Least Squares for the third period (1999:07-2014:12)												
	Exports		Imports from Canada		Imports from Mexico		Imports from Rest of the World		Domestic Production		Price	
	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err	Coefficient	Std.Err
Exp_{t-1}	0.361***	0.091	-0.035	0.057	0.713	0.549	0.351	0.375	-1.463**	0.737	0.033***	0.011
Exp_{t-2}	0.037	0.091	0.034	0.057	-0.392	0.547	-0.116	0.374	0.491	0.735	-0.002	0.011
$ImpC_{t-1}$	-0.005	0.126	0.788***	0.078	-0.687	0.756	-0.548	0.517	0.274	1.016	-0.004	0.016
$ImpC_{t-2}$	-0.134	0.122	-0.057	0.076	1.393*	0.736	0.541	0.503	-1.228	0.989	0.021	0.015
$ImpM_{t-1}$	-0.040*	0.015	0.014	0.009	0.774***	0.090	-0.032	0.061	-0.196*	0.121	0.001	0.001
$ImpM_{t-2}$	-0.007	0.015	0.006	0.009	0.112	0.094	0.061	0.064	-0.143	0.127	0.004**	0.002
$ImpR_{t-1}$	-0.025	0.021	0.010	0.013	-0.190	0.129	0.733***	0.088	0.070	0.173	-0.000	0.002
$ImpR_{t-2}$	-0.004	0.021	0.008	0.013	0.315**	0.129	-0.080	0.088	-0.129	0.174	0.004*	0.002
DP_{t-1}	-0.014	0.012	0.005	0.008	-0.167**	0.076	-0.008	0.052	0.503***	0.103	-0.000	0.001
DP_{t-2}	0.011	0.012	0.004	0.007	0.107	0.074	0.055	0.051	0.193*	0.100	0.003**	0.001
PR_{t-1}	0.711	0.696	-0.740*	0.435	-3.156	4.181	1.354	2.859	8.185	5.615	0.570***	0.088
PR_{t-2}	0.491	0.730	0.695	0.456	-2.734	4.384	3.291	2.999	12.713**	5.889	-0.129	0.093
c	9900.788***	2263.467	-1483.814	1413.990	19997.682	13583.538	-16344.027*	9290.873	49976.532***	18244.667	-528.983*	288.106
$Seas$	1173.765	892.478	-3807.927***	557.532	9872.209*	5355.950	-2651.465	3663.365	11687.074	7193.820	-186.279*	113.599
$Seas1$	382.568	1141.913	-2511.998***	713.354	37770.328***	6852.863	2971.606	4687.223	-8693.291	9204.391	-319.109**	145.349
$Seas2$	394.520	1500.907	-2097.635**	937.618	-1307.492	9007.260	7661.209	6160.789	-15059.885	12098.060	-265.450	191.043
$Seas3$	1430.946	1618.610	427.213	1011.147	-33397.182***	9713.621	42311.245***	6643.926	12255.700	13046.806	-196.392	206.025
$Seas4$	1739.563	1649.269	7662.713***	1030.300	-20521.949**	9897.608	6193.216	6769.769	25334.750*	13293.927	-246.480	209.928
$Seas5$	3826.741**	1759.260	6949.861***	1099.011	-21501.638**	10557.690	15693.431**	7221.252	31035.532**	14180.513	-315.949	223.928
$Seas6$	2851.941**	1401.089	6083.273***	875.261	-28325.816***	8408.227	12848.228**	5751.062	10080.229	11293.472	-408.495**	178.338
$Seas7$	5272.626***	1290.441	4321.844***	806.140	-24207.225***	7744.207	-2241.297	5296.886	8133.340	10401.597	-678.584***	164.254
$Seas8$	2059.544*	1238.170	704.991	773.486	-31539.698***	7430.519	-1729.414	5082.329	20681.542**	9980.267	-589.052***	157.601
$Seas9$	2122.861*	1121.073	520.429	700.335	-46838.133***	6727.794	19371.214***	4601.679	14465.395	9036.406	-406.055***	142.696
$Seas10$	2101.869**	919.229	589.834	574.243	-15112.792***	5516.487	11789.118***	3773.169	12139.751	7409.445	-249.343**	117.004
Obs. 185												
*, **, and ***, stand for 10%, 5% and 1% significance levels, respectively.												
R2	0.64045		0.97363		0.92149		0.7917		0.74505		0.48249	