Causality Relations between International Trade and Growth *Within* NAFTA*

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Abstract

The causal relation between international trade and growth has been studied widely in the literature, but only taking into account individual countries. The idea in this paper is to test the direction of the causality between international trade and growth, but within a trade bloc as NAFTA. We extend the traditional empirical strategy to use both total production and bilateral trade considering only the real value of specific exports as a measured of trade, to account for the contribution of bilateral trade on growth or vice versa. Although the empirical strategy is not novel, so is the inclusion of specific trade instead of either total exports or imports. We also structured a dynamic panel framework in order to contrast the export-led growth and growth-driven exports hypotheses. Analyzing Mexico and Canada, we find that there is evidence to ensure that Mexico has been benefited of trade with Canada but the opposite is not true. For US and Canada we find that there is no evidence of long run relationship among variables. Lastly for US and Mexico we find that exports in both countries are Granger caused by the other three variables, while US GDP is Granger caused for the other variables. However, this is counterintuitive, since US does not exhibit dependency of trade.

1 Introduction

The relation between international trade and growth has been studied widely in the literature. There are mainly two hypotheses that are contrasted in the literature. First is the export-led growth hypothesis, where international trade is treated as a source of economic growth and development. Weather the openness is originated unilaterally or as a result of negotiations with other countries, the theoretical idea is that with domestic markets exposed to foreign competition countries might be benefited of trade and boost growth (Balassa, 1978). Another channel throughout which countries may grow more is the access of economies of scale (Helpman and Krugman, 1985). This is relevant for countries with small domestic markets. Furthermore, foreign trade helps developing countries to have access to higher levels of technologies and capital and by this channel affects positively the long run growth (McKinnon, 1964). Lastly, it promotes the diffusion of technological progress (Grossman and Helpman, 1991).

Although there are theoretical reasons behind the export-led hypothesis, it is important to note that economic growth may promote exports as well. As it is mentioned by Salvatore and Hatcher (1991) and Ghartey (1993), productivity may cause exports in a country where the degree of openness is low and with relatively abundant resources. On the other hand, both Lancaster (1980) and Krugman (1984) stated that in an intra-industry framework similar economies may have incentives to trade even if those goods are not produced based on comparative advantages and accordingly it is not expected to create international trade. Thus, productivity growth might increase exports throughout specialization and because growth is creating better conditions to compete in international trade (Kónya, 2004). This is the second hypothesis traditionally considered in this literature: growth-driven exports.

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The answer to the question as to whether international trade impulses economic growth or if it is growth, which conveys international trade is important from an economic policy perspective because it may determine the relevant strategies to impulse economic growth and development. If export-led hypothesis is the one which helps to cause growth, countries may have incentives to not only sign more trade agreements, but also take unilateral decisions regarding tariffs and non-trade barriers to impulse exports.

If the growth-driven exports hypothesis holds, countries may decide strategically to stimulate those sectors where productivity and competitiveness indicate that they can have access to international trade in better conditions to compete. In this area the industrial policies might have an important role since it would be necessary to implement policies where improvements in productivity are central to have better conditions of accessing international markets.

The empirical strategies conducted to test the two hypotheses include cross-country studies, cross-sectional regression analysis and time series techniques on a unique country basis[1]. As Kónya (2004) notes, most of the empirical exercises use the third technique. Although it can be found in the literature reasons for and against of each methodology [2], in this paper we first follow time series techniques as we expect to extend the literature, adding up a characteristic not considered in any paper until now: we include other countries which are part of a free-trade area. Traditionally time series techniques use Granger causality and cointegration analysis. The first one in order to find the direction of the causality and the second one when there is evidence of long run relationships among variables used in the empirical analysis.

Despite the existence of several studies in this literature, we consider that the proliferation of preferential trade agreements (Lake and Roy, 2014), beyond unilateral openness to international trade, may affect the empirical results. The aim of forming trade blocs is to reduce or eliminate barriers to trade, and in turn increase specialization and, ultimately, the comparative advantages. Many of them try to exploit geographical proximity as well.

The second empirical framework tries to analyze the impact of trade *within* a commercial bloc estimating a dynamic panel. The aim of this section is to go beyond of Granger causality and to infer more about causality since a microeconometric perspective.

This is the main contribution of the paper: we may account for either of two hypothesis *within* a free trade area. To achieve this objective we use data from the North American Free Trade Agreement (NAFTA), which has been active since 1994. This agreement was signed by Canada, Mexico and United States and it can be considered as a step forward to the agreement signed in 1987 by Canada and US.

Additionally to this introduction, the paper has five sections. Second one presents the extensive literature in this area. We next present the data and then the methodology. We finally present results and conclusions.

2 Literature Review

The export-led growth and growth-driven exports hypotheses have been tested in several papers and using different methodologies. The empirical method most widely used is time series techniques (Granger causality and cointegration) and the main characteristic of this empirical literature is that the analysis is made only in one-country basis.

The basic empirical framework used to test both hypotheses is to take into account production (GDP) and exports. Moreover, until 1980s, most of them are related to correlation instead of causality [3].

Later it starts to emerge literature where the main idea is to analyze causality in Granger sense using bivariate models. In this tradition Jung and Marshall (1985), Ghartey (1993) and Dutt and Ghosh (1994, 1996) are good examples. Jung and Marshall (1985) is one of the first attempts of using Granger causality between exports and GDP, using of 37 developing countries. They present a comprehensive summarize about what had been done until 1984, where the common characteristic is analysis based on correlation. Although the export-led hypothesis is prevalent, they also show that the results may vary across countries. Ghartey (1993) may be identified as one of the first papers where stationarity is treated carefully and a vector autorregresive model is estimated. He uses a sample of three countries and obtains results for the two hypotheses. Dutt and Ghosh (1994, 1996) are papers where both cointegration and Granger causality are explored. In Dutt and Ghosh (1994) is included a test of cointegration, considering that previous to its publication there were few works with this test. However they do not test causality. Dutt and Ghosh (1996) integrate both concepts: they correct by cointegration and then test causality.

[1] Salykova (2012) shows a comprehensive summarize and categorizes the econometric methods used in the literature.

[2] For instance Shan and Sun (1998) and Rodriguez and Rodrik (2001) present arguments against cross-country empirical exercises.

[3] For instance, Kavoussi (1984) calculates the Spearman rank correlation for seventy-three developing countries to analyze the statistical dependence between exports and GDP. His conclusions are related to correlation instead of causality.

Unlike previous work, Riezman et al. (1996) and Shan and Sun (1999) assure that the results might be spurious if imports are excluded of the model. Riezman et al. (1996) use the whole Summers-Heston data set[4]. They find, as it is usual in this literature, that for some countries the export-led growth hypothesis applies, for some others the growth-driven exports and for others the causality is presented in both directions.

Then it appears several papers where causality in Granger sense is analyzed using the methodology proposed by Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996). The results are mixed and the methodologies proposed include both Granger causality and cointegration or only one of them. The ultimate goal is to find evidence to support either of two hypotheses or both at the same time.

As it was mentioned before, there are several papers in this tradition[5]. For this paper Zestos and Tao (2002) is relevant because they work with Canada and US data, but considering one-country basis analysis, as it has been traditionally done in this literature. They work with GDP, exports and imports. They find that Canadian GDP, exports and imports are closely related and that causality is presented in either direction, whereas US exhibits a weak relation between trade and growth. These results are in the same direction as most of the results obtained in other empirical exercises.

On the other side, there are empirical studies where the authors contrast both hypotheses but in a panel data framework. [6]. Hsiao and Hsiao (2006) perform both time series techniques and panel data estimation. They use GDP, exports and foreign direct investment, FDI. Although the results are diverse, as it is common in export-led and growth-driven exports literature, they recognize that the identifications assumptions made in panel data allow them to obtain superior results over the time series analysis as the parameters can be considered as causal, though they do not control for endogeneity and run regressions in all possible directions. Meanwhile Won et al. (2008) use the same framework as Hsiao and Hsiao (2006) but from a demand-side perspective. They do not control for endogeneity either. To avoid the problems of cointegration in panel data with many years, they follow Toda and Yamamoto (1995) methodology to analyze Granger causality.

Emirmahmutoglu and Kose (2011) perform meta analysis in mixed panels, analyzing the finite sample properties of causality test via Monte Carlo experiments. They only use GDP and exports and show results for OECD countries. They find evidence that supports the export-led growth hypothesis for all countries.

Nasreen (2011) finds evidence of a cointegration relation among production and exports. They find diverse evidence for both hypotheses. Although they take in consideration cointegration, she does not solve the endogeneity problem.

Meanwhile Kılavuz and Topcu (2012) estimates a panel data considering GDP, investment, population, high and low-tech manufacturing industry exports and high and low-tech manufacturing industry imports. They find that only high-tech manufacturing industry exports, investment and low-tech manufacturing industry imports have a positive and significant effect on growth. However, they did not deal with endogeneity problem.

Lastly Haghnejad et al. (2014) perform a four-stage econometric procedure to identify the direction of causality. They test first if the series have unit root. Then check for the existence of cointegrating relations. Third, they estimate the cointegration vector and four they estimate a panel VEC using the Generalized Method of Moments (GMM) estimator. So that, they may consider that the parameters are causal, since they solve the endogeneity problem following Arellano and Bover (1995).

3 Data

Data for GDP, total exports and imports are taken from Organization for Economic Cooperation and Development (OECD) and Haver Analytics. The available data cover the period between 1960 and 2013. The values are in constant 2005 US dollars.

For country specific exports, we used data from Direction of Trade of International Monetary Fund (DT-IMF) and Haver Analytics. We compute the share of exports from one country to another and then we use it to calculate

[4]This is the first empirical paper where the Penn-World table is used in the context of the two hypotheses considered in this paper.

[5]Giles and Williams (2000a,b) and Salykova (2012) present a comprehensive, extensive and detailed literature review. Although there are several recent papers dealing with the two hypotheses considered in this one, all of them follow the traditional methodology: one-country basis. The extensions are related with the inclusion of new variables (for instance demand of electricity or tourism) but not with the inclusion of more countries in the same framework.

[6]This is important for the empirical exercise where we include the countries in the same framework to deal with the curse of dimensionality originated by the fact that if all countries are included in the VEC model, there is no enough degrees of freedom.

the country-specific real exports of data from OECD. This is important for the model when we use commercial blocs by pairs and whole NAFTA.

The frequency used is annual. As Dutt and Ghosh (1996) argue, the relation between exports (international trade) and GDP implies dynamic effects that are accounted not only in the short run but also, and most important, in the long run.

The evolution of variables is shown in Figures 1 and 2, where we are showing GDP, total exports and imports in levels without any transformation. We are also showing the evolution of country specific exports in Figure 3. It can be seen that the commercial relations between Mexico and Canada are not so important, even after NAFTA. The participations of exports from Canada to Mexico are around 0.4% on average before 1994 and 0.7% with NAFTA. In the same way, the shares of exports from Mexico to Canada are 1.4% and 2.3% respectively.

The trade with US is more important for Canada and Mexico. The share of total exports from Canada to US is 66% before NAFTA and 82% after NAFTA. For Mexico those values are 62% and 84%. For US the trade with each of those two countries is important, but not as much as in Canada and Mexico. The shares are 20.5% and 21.5% to Canada and 5.2% and 12% to Mexico, respectively. What it is clear is that the shares of exports to US from both Canada and Mexico and from US to Mexico changed dramatically with the free trade agreement.

Figure 1: GDP (constant 2005 US Mill. Dollars)

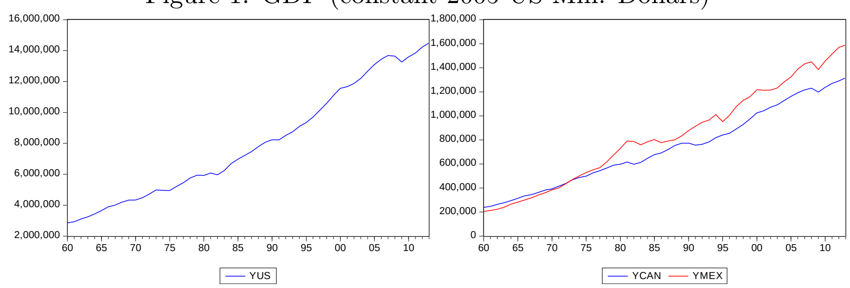
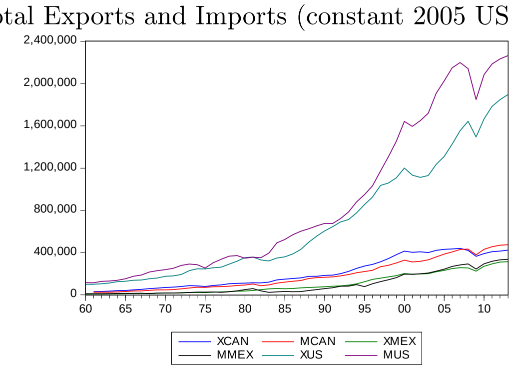


Figure 2: Total Exports and Imports (constant 2005 US Mill. Dollars)

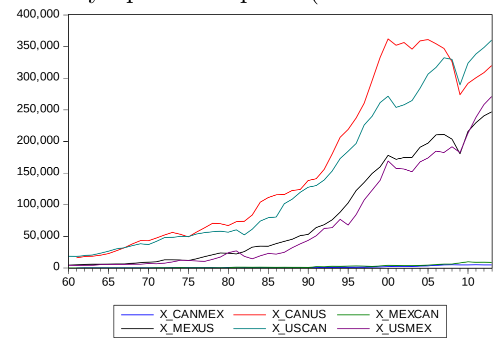


4 Methodology

In order to analyze the causal relations between growth and trade, we follow the traditional procedure of time series analysis. First, we need to check if the series have unit root. Any VAR using series with unit root is spurious in levels and it has an omitted variable problem in first differences since does not take into account the likely long run relationship among variables. To do this, we perform two types of unit root test: we test the hypothesis of the existence of a unit root taking individually each series and also taking the whole panel.

For the unit root test for each series, we run the traditional Augmented Dickey-Fuller tests with null hypothesis $\gamma = 0$ for the three types of regression one can run: a pure random walk model ($\Delta y_t = \gamma y_{t-1} + \varepsilon_t$), a random walk model with drift ($\Delta y_t = \mu + \gamma y_{t-1} + \varepsilon_t$), and including both drift and a deterministic linear trend ($\Delta y_t = \mu + \gamma y_{t-1} + \beta t + \varepsilon_t$). Dickey and Fuller (1979) shows that the test is sensitive to the specification, so the critical values for the test depends upon if the regression includes drift and linear trend.

Figure 3: Total Country Specific Exports (constant 2005 US Mill. Dollars)



We also include autoregressive terms of Δy_t into the regression and the appropriate order is chosen according to the Schwartz Information Criterion (SIC). The idea is to correct for autocorrelation of ε and generate a white noise term.

We also perform a Phillips-Perron test of unit root. This test is a nonparametric alternative method which modifies the augmented Dickey-Fuller test, running the same regression by OLS but calculating different critical points in order to take into account the possibility of serial correlation (Hamilton, 1994).

Finally, we run a set of panel unit root tests, as the first part of the empirical exercise is to check the causal relations between growth and trade in each country separately. That is, we perform a panel unit root tests for the GDP, exports and imports panel for each country. In this sense, we exploit the advantage of having a panel data[7].

The general panel data model is expressed as following

$$y_t = \gamma_i y_{t-1} + x_{it}\beta_i + \varepsilon_t,$$

where x_{it} represent exogenous variables in the model, which includes fixed effects and individual trends. The tests differ in terms of

- whether $\gamma_i = \gamma \forall i$
- rate at which $N, T \to \infty$.

We perform Im-Pesaram-Shin test which allows having N fixed with $T \to \infty$. In this case, the implicit assumption is that there are not common roots, that is $\gamma_i \neq \gamma \forall i$. Although panel unit root tests increase the power of the test, have some limitations. The null hypothesis of Im-Pesaram-Test is the existence of unit root. However, "rejection of null hypothesis means that at least one of the γ_i differs from zero" (Enders, 2009, pp. 246). It is not possible to know which one of the γ_i's are different from zero.

Once we define that the series are $I(1)$ and after the respective transformation (working with differenced series), it is necessary to find the number of lags to be included in both the VAR and the VEC model. In order to choose the appropriated number of lags, we follow the procedure described by Enders (2009). We estimate a VAR using the variables in levels varying the number of lags sequentially. Then we use the Schwartz Information Criterion (SIC) to decide the optimal number of lags.

The general model is

$$\mathbf{z}_t = \mathbf{A}_0 + \sum_{i=1}^{p} \mathbf{A}_i \mathbf{z}_{t-i} + \varepsilon_t. \tag{1}$$

After defining the order of the VAR, we performed a Johansen's test in order to check if there are cointegrating vectors.

In general, for vector $\mathbf{z}_t$ of variables $\{ly_t, lx_t, lm_t\}$ we express model (1)

[7] We are not exempt from problems as N is not that large (the number of countries). That is, asymptotically we have large T and small N. However, we believe that including these tests, we are adding power to detect whether the series are stationary or not than unit root tests based on individual series (Enders, 2009; Baltagi, 2013).

$$\mathbf{z}_t = \mathbf{A}_0 + \rho \mathbf{z}_t + \sum_{i=1}^{p-1} \psi_i \Delta \mathbf{z}_{t-i} + \varepsilon_t,$$

where p is defined previously, $\rho = \sum_{i=1}^{p} \mathbf{A}_i$ and $\psi_i = -\sum_{j=i+1}^{p} \mathbf{A}_j$, for $i = 1, \ldots, p-1$. Now, subtracting $\mathbf{z}_{t-1}$ from both sides, we obtain

$$\Delta \mathbf{z}_t = \mathbf{A}_0 + \psi \mathbf{z}_{t-1} + \sum_{i=1}^{p-1} \psi_i \Delta \mathbf{z}_{t-i} + \varepsilon_t,$$

where $\psi_0 = -(I - \rho)$. If there are cointegration, we have

$$\Delta \mathbf{z}_t = \mathbf{A}_0 - \mathbf{B}\mathbf{A}\mathbf{z}_{t-1} + \sum_{i=1}^{p-1} \psi_i \Delta \mathbf{z}_{t-i} + \varepsilon_t, \tag{2}$$

where $\mathbf{A}$ is a $h \times 3$ matrix of cointegrating vectors, $\mathbf{A}\mathbf{z}_{t-1}$ is a $h \times 1$ vector of $I(0)$ variables, $\mathbf{B}$ is a $3 \times h$ matrix such that $\mathbf{B}\mathbf{A} = \mathbf{I} - \sum_{i=1}^{p} \mathbf{A}_i$ and h is the rank of $\mathbf{A}$ and shows the number of cointegrating relations. Model (2) is the Error Correction Model and can be estimated by OLS since all variables are $I(0)$[8].

The next step is to determine the rank of cointegration, that is, h. In order to do this, we need to find the appropriate format for the cointegration model, using the number of lags found previously. In Eviews, it is possible to obtain the result from 5 different models: 1) level data without deterministic trends and cointegrating equations with intercepts; 2) level data without deterministic trends and cointegrating equations with intercepts; 3) level data with linear trends, but the cointegrating equations with just intercepts; 4) level data and cointegrating equations with linear trends; and 5) level data with quadratic trends and cointegrating equations with linear trends.

Then we estimate the VEC model and perform the statistical tests to check Granger causality in both short and long-run. At this point is important to note that if series are $I(1)$, the causality analysis in Granger sense might be incorrect (Toda and Yamamoto, 1995; Dolado and Lütkepohl, 1996). Toda and Yamamoto (1995) states that

"*...the conventional asymptotic theory is, in general, not applicable to hypothesis testing in levels VAR's if the variables are integrated or cointegrated. When the series are non-stationary, the conventional asymptotic theory is not applicable to hypothesis testing*" (Toda and Yamamoto, 1995, pp. 225-226).

So that we follow Toda and Yamamoto (1995) when we are testing for causality in Granger sense. The procedure might be described as follows: it is necessary to pick the optimal number of lags of the VAR, p. It is necessary that the VAR is properly specified, that is, there is no serial correlation of the residuals[9]. Then, define the maximal order of integration of involved series, let us say is m. We have to estimate a $p+m$th-order VAR in *levels*, regardless of the order of integration. Lastly, we test for Granger (non) causality, that is, if we want to check if x causes in Granger sense y, we perform a Wald test where the null hypothesis is if the first p lagged values of x are zero.

This procedure is valid even in the presence of cointegration, so if Johansen's test shows cointegration relations among variables, both procedures will work as a cross-check validity of causality results.

After estimating three VEC models for the sub-blocs, we estimate a dynamic panel data of the whole bloc, following Arellano and Bover (1995). This alternative is used as in models where the coefficient of the lagged endogenous variable is likely close to 1, the estimator is downward biased (Arellano and Bover, 1995; Baltagi, 2013). For this part of the paper, we perform a 4-stage econometric procedure. The aim is to identify properly the causal

[8] After defining the number of lags, we performed a Johansen's test in order to check if there are cointegrating vectors. In general, for vector $\mathbf{z}$ of variables $\{ly, lx, lm\}$ we run the model

$$\mathbf{z}_t = A_1 \mathbf{z}_{t-1} + A_2 \mathbf{z}_{t-2} + \varepsilon_t$$

which is the VAR representation. Subtracting $\mathbf{z}_{t-1}$ from both sides, we obtain

$$\begin{aligned} \mathbf{z}_t - \mathbf{z}_{t-1} &= A_1 \mathbf{z}_{t-1} - \mathbf{z}_{t-1} + A_2 \mathbf{z}_{t-1} - A_2 \mathbf{z}_{t-1} + A_2 \mathbf{z}_{t-2} + \varepsilon_t \\ \Delta \mathbf{z}_t &= (A_1 + A_2 - I)\mathbf{z}_{t-1} - A_2 \Delta \mathbf{z}_{t-1} + \varepsilon_t \end{aligned}$$

and it is possible to decomposed $A_1 + A_2 - 1$ in the 3×3 matrix $\alpha\beta'$ and the system is reduced to

$$\begin{aligned} \Delta \mathbf{z}_t &= \alpha \left(\beta' \mathbf{z}_{t-1} \right) - A_2 \Delta \mathbf{z}_{t-1} + \varepsilon_t \\ \Delta \mathbf{z}_t &= \alpha \gamma_{t-1} - A_2 \Delta \mathbf{z}_{t-1} + \varepsilon_t \end{aligned}$$

which is the Error Correction Model for a second order VAR.

[9] If it is necessary, it is necessary to increase p until the problem is solved.

effects. First, we run the Im-Pesaram-Shin panel unit root test described before[10]. If the series are integrated, we then evaluate if there does exist cointegrating relations among variables. To do that, we carry out the Pedroni panel cointegrating test (Baltagi, 2013, ch. 12). If some cointegrating relation is found, it is necessary to estimate the cointegrating relations, which is performed using the panel fully modified ordinary least squares, based on Pedroni methology described in Baltagi (2013). Lastly, we estimate a panel vector error correction model and then we test causality using Wald tests. If the series are not cointegrated, we skip the third stage and in the fourth one we estimate a panel VAR. The number of lags of either the VAE or the VEC models is decided according to SIC.

5 Results

5.1 Mexico

Following the procedure described in methodology, we first check the dynamic conditions of the series for each country (The results are presented in Table 5.1). According to the augmented Dickey-Fuller (ADF) test results, if trend and constant are included, ly has not unit root. However, if either an intercept ($\mu \neq 0$) or none of deterministic terms ($\mu, \beta = 0$), the logarithm of GDP exhibits a dynamic behavior with unit root. If the test is run in differences, the null hypothesis if the existence of unit root is rejected in all specifications.

If instead of ADF test it is ran the Phillips-Perron (PP) test, something similar happens. The null hypothesis is not rejected if an intercept is included ($p = 0.0052$), but it is rejected in the other two specifications. If the variable is the growth rate of GDP, the null hypothesis is rejected in all specifications. We conclude that ly is $I(1)$.

If the variable is exports, lx, both tests result in not rejection of the null hypothesis. According to both ADF and PP tests, the logarithm of total exports shows unit root in levels but it is stationary in first difference. As the logarithm of GDP, the logarithm of exports is $I(1)$.

Finally, the logarithm of imports, lm, is also $I(1)$, since the null hypothesis is not rejected when both tests are run at levels and is rejected when the variable is transformed to first difference. This is true for all specifications.

Table 5.1: Unit Root Tests for Mexico (Probability)

	ADF Test			Phillips-Perron Test		
	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$
Level						
ly	0.7628 [0]	0.0027 [0]	0.9996 [1]	0.7640	0.0052	1.0000
lx	0.9174 [0]	0.5963 [0]	1.000 [0]	0.8933	0.5369	1.0000
lm	0.1367 [1]	0.9260 [0]	0.9989 [0]	0.2036	0.9527	1.0000
First difference						
Δly	0.0001 [0]	0.0003 [0]	0.0052 [0]	0.0001	0.0003	0.0085
Δlx	0.0001 [0]	0.0000 [0]	0.0008 [0]	0.0000	0.0000	0.0011
Δlm	0.0001 [0]	0.0000 [0]	0.0000 [0]	0.0000	0.0000	0.0000

H_o : Series has unit root. The number in brackets is the optimal p selected by SIC.

As it is shown, all series are $I(1)$ in levels, although production (ly) looks stationary in levels when it is included only an intercept. However, when intercept and trend are included ($\mu, \beta \neq 0$) or neither intercept nor trend are included ($\mu, \beta = 0$), the null hypothesis is not rejected. Then, we will work with ly as a $I(1)$ series, since in difference there is not any doubt about the first difference being stationary.

Now we report the analysis of unit roots in panel using GDP, exports and imports. The null hypothesis is not rejected in levels, but rejected in first differences, according to the results reported in Table 5.2.

[10]We also run the Levin-Lin-Chu test as a robustness check (see Baltagi, 2013, ch. 12)

Table 5.2: Panel Unit Root Test for Mexico (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.2430	0.7081
Variable		
ly	0.0027 [0]	0.7628 [0]
lx	0.5963 [0]	0.9174 [0]
lm	0.9260 [0]	0.1367 [1]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
ly	0.0003 [0]	0.0001 [0]
lx	0.0000 [0]	0.0000 [0]
lm	0.0000 [0]	0.0000 [0]

Note: The number in brackets is the optimal p selected by SIC.

Following the procedure explained in section 3, we run different VAR models in order to explore which one is the number of lags more appropriate for the variables of Mexico. If we include, for instance, 4 lags and then use the Wald test to check the statistical significance, we found that one lag is the best dynamic model for this set of data. We obtained the same result checking the SIC. Since one is the number of lags included in the VAR, we will have a VEC model without lags. However, we later run a VAR of order 2 in order to test if a VEC model with one lag describes the behavior of GDP, total exports and imports for Mexican economy.

Now we check if there are cointegrating relations among variables. Since we do not know a priori the mathematical representation of cointegrating equations, we run a general Johansen cointegration test and decide the appropriate representation using the SIC and critical values constructed by Osterwald-Lenum (1992). According to this criterion, the number of cointegrating equations is one, the level data $\mathbf{z}_t$ have linear trends and the cointegrating equation has only intercept. The cointegration test results are presented in Table 5.3.

Table 5.3: Cointegration Test of Mexican Data

H_0 : Rank=r	Eigenvalue	Trace statistic	0.05 Critical value	0.01 Critical value
None$^{(**)}$	0.605190	58.09033	29.68	35.65
At most 1	0.111687	8.834758	15.41	20.04
At most 2	0.047116	2.557916	3.76	6.65
None$^{(**)}$	0.605190	49.25557	20.97	25.52
At most 1	0.111687	6.276842	14.07	18.63
At most 2	0.047116	2.412136	3.76	6.65

Trace and Max-Eigen tests indicates 1 cointegrating equation at both 5% and 1% levels.

* (**) denotes rejection of the hypothesis at the 5%(1%) level. Osterwald-Lenum critical values.

After determining the number of cointegration equation, we run a vector error correction model (VEC). The equation is represented as following:

$$Az_{t-1} = 6.95 + ly_{t-1} - 7.01lx_{t-1} + 5.17lm_{t-1}, \tag{3}$$

Results presented in equation (3) show that exports are positively related to production and imports negatively. According with this result, it seems that for Mexico, exports are negatively related to production while imports are positively related to production. Even though this relation can be thought as a "macroeconomic identity result", it is surprising not having a positive relation between production and imports since emerging economies tend to import capital goods and technology, key for production and long run development.

The VEC model can be represented as follows:

$$\Delta ly_t = \rho_1 + \alpha_{ly}\gamma_{t-1} + \epsilon_{1t} \quad (4)$$
$$\Delta lx_t = \rho_2 + \alpha_{lx}\gamma_{t-1} + \epsilon_{2t} \quad (5)$$
$$\Delta lm_t = \rho_3 + \alpha_{lm}\gamma_{t-1} + \epsilon_{3t} \quad (6)$$

since it was not included a lag terms for the three endogenous variables.

With this system, it is not possible to evaluate short run causality, since the result from the VAR analysis resulted in one lag and in the setting up of the cointegration model that lag disappears. At this point we only may test for long run causality, testing if $\alpha_l y = 0$, $\alpha_l x = 0$ and $\alpha_l m = 0$ separately. Since the variables are cointegrated ($I(1)$) and γ_{t-1}) is stationary by construction, we may use a standard t-test. We find that all coefficients are statistically significant.

Regarding Granger causality in this context, with non-stationary data, we follow Toda and Yamamoto (1995). In this case, we have reasonable evidence of Granger causality in all possible directions for all variables.

In order to evaluate short run causality, we also run a second order VAR (as a second best model) as its correspondent VEC model would have one lag. Its representation is as follows

$$\Delta ly_t = \rho_1 + \alpha_{ly}\gamma_{t-1} + \beta_{11}\Delta ly_{t-1} + \beta_{12}\Delta lx_{t-1} + \beta_{13}\Delta lm_{t-1} + \epsilon_{1t} \quad (7)$$
$$\Delta lx_t = \rho_1 + \alpha_{lx}\gamma_{t-1} + \beta_{21}\Delta ly_{t-1} + \beta_{22}\Delta lx_{t-1} + \beta_{23}\Delta lm_{t-1} + \epsilon_{2t} \quad (8)$$
$$\Delta lm_t = \rho_1 + \alpha_{lm}\gamma_{t-1} + \beta_{31}\Delta ly_{t-1} + \beta_{32}\Delta lx_{t-1} + \beta_{33}\Delta lm_{t-1} + \epsilon_{3t} \quad (9)$$

The data modeled with a VAR(2) is still stable, does not have problems of autocorrelation.

According to SIC, there is only one cointegrating equation with neither intercept nor trend. If we estimate this VEC model, we obtain that both α_{ly} and α_{lx} are statistically different than zero.

To test Granger causality, we follow Toda and Yamamoto (1995) as before. We conclude that the causality goes in all possible directions. This result is consistent with the findings in the VEC model.

5.2 Canada

We present first the results regarding the dynamic characteristics of the individual series. As it is shown in Table 5.4, we have that for specification with only constant, both logarithm of GDP and exports exhibit stationarity (at 1% and at 5%, respectively) no matter the test run. When a Phillips-Perron test is performed for the three variables, the null hypothesis of existence of unit root is rejected.

When the two tests are run in differences, we may conclude that the rate of growth of those variables is stationary. We conclude that the three variables are $I(1)$.

Table 5.4: Unit Root Tests for Canada (Probability)

	ADF Test			Phillips-Perron Test		
	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$
Level						
ly	0.2743 [1]	0.0011 [0]	0.9998 [1]	0.5945	0.0040	1.0000
lx	0.9822 [0]	0.0411 [0]	0.9993 [1]	0.9822	0.0411	1.0000
lm	0.7509 [0]	0.3624 [0]	1.0000 [0]	0.8967	0.0072	1.0000
First difference						
Δly	0.0001 [0]	0.0003 [0]	0.0052 [0]	0.0001	0.0003	0.0085
Δlx	0.0001 [0]	0.0005 [0]	0.0220 [0]	0.0001	0.0006	0.0501
Δlm	0.0001 [0]	0.0000 [0]	0.0000 [0]	0.0000	0.0000	0.0000

H_o : Series has unit root. The number in brackets is the optimal p selected by SIC.

When the unit root test is run in levels taking into account panel data, there are some doubts when the specification is only with intercept. However, when we use first differences of the variables, both specifications allow us to conclude that the panel of data is stationary when we use the rate of growth of the variables. The results are shown in Table 5.4. We conclude that the three variables are $I(1)$.

Table 5.5: Panel Unit Root Test for Canada (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.0012	0.9006
Variable		
ly	0.0011 [0]	0.2743 [1]
lx	0.0411 [0]	0.9822 [0]
lm	0.3624 [0]	0.7509 [0]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
ly	0.0005 [0]	0.0001 [0]
lx	0.0001 [0]	0.0001 [0]
lm	0.0000 [0]	0.0000 [0]

Note: The number in brackets is the optimal p selected by SIC.

Once we define the order of integration, we proceed with the definition of lags. When we run a fourth order VAR, the appropriate number of lags to be included is 2. With $p = 2$, the model does not exhibit autocorrelation problem.

With that specification in the VAR, we run a cointegration test. As in Mexican case, we run first a general test, in order to test and check the best functional form of the cointegrating equation, if it exists. Once we find that the best functional form of the error correction term is with intercept but no trend, we run a Johansen's test which indicates that there are no cointegrating relations among the three variables. This conclusion is opposite to that from Zestos & Tao, 2002), where they defined that there is one cointegrating equation with intercept.

With our sample of Canadian data, we do not find any long run relation among the three variables used in this paper. Then, we run a first order VAR model in first differences in order to analyze the dynamic relations among Canada's production, total exports and imports. We conclude that we can reject the hypothesis of no causality from exports and imports to production while we cannot reject the null hypothesis neither from production and imports to exports nor from production and exports to imports. In this sense, we may say, as Zestos and Tao (2002), that Canadian economy is more trade dependent and an open economy since its external sector influences significantly its production.

However, if it is ran a generalized impulse-response exercise, we observe that there are strong interrelations among variables, although the variables adjust rapidly after two or three periods.

5.3 United States

Finally we analyze the characteristics of US production, total exports and imports. Taking the variables individually, we observe that in general they are $I(1)$. As in the previous cases, the level of logarithm of GDP exhibits stationarity in one of the three specifications. However, the growth rate of production is stationary in all specifications (Table 5.6).

A similar conclusion is obtained when we perform a panel unit root test. As it is showed in Table 5.7, the variables in levels exhibit a unit root, since it cannot be rejected the null hypothesis of existence of a unit root. However, when the variables are expressed in first differences, the panel is stationary, according to Im-Pesaram-Shin test. We may conclude that variables are $I(1)$ and this is a reason to check cointegration, since any VAR model run with variables in first differences would have an omitted variable bias.

Table 5.6: Unit Root Tests for US (Probability)

	ADF Test			Phillips-Perron Test		
	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$	$\mu, \beta \neq 0$	$\mu \neq 0, \beta = 0$	$\mu, \beta = 0$
Level						
ly	0.3349 [1]	0.0768 [0]	1.0000 [0]	0.8032	0.0632	1.0000
lx	0.3170 [1]	0.8186 [0]	1.0000 [0]	0.5232	0.8212	1.0000
lm	0.7558 [0]	0.7126 [0]	1.0000 [0]	0.6365	0.7124	1.0000
First difference						
Δly	0.0002 [0]	0.0001 [0]	0.0138 [0]	0.0003	0.0002	0.0295
Δlx	0.0001 [0]	0.0000 [0]	0.0013 [0]	0.0001	0.0000	0.0018
Δlm	0.0000 [0]	0.0000 [0]	0.0002 [0]	0.0000	0.0000	0.0002

H_o : Series has unit root. The number in brackets is the optimal p selected by SIC.

The first step is check for the number of lags to include in the VAR and, if proceeds, in the VEC model. According to the all criteria evaluated in E-views, the optimal number of p is 2. In this sense, if the variables are cointegrated, the VEC model should have p=1.

A second order VAR for US data does not have autocorrelation problem and satisfies stability condition since no root lies outside of unit circle.

Table 5.7: Panel Unit Root Test for US (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.4964	0.4653
Variable		
ly	0.0768 [0]	0.3349 [1]
lx	0.8186 [0]	0.3170 [1]
lm	0.7126 [0]	0.7588 [0]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
ly	0.0001 [0]	0.0002 [0]
lx	0.0000 [0]	0.0000 [0]
lm	0.0000 [0]	0.0000 [0]

Note: The number in brackets is the optimal p selected by SIC.

When we run a general cointegration test, we obtained that data should exhibit linear trend and the cointegrating equation has intercept but no trend. Running a Johansen's test with those characteristics, we find that there is one cointegrating equation according to trace statistic, but none with max-eigenvalue statistic, as it shows Table 5.7.

We decide to work with one cointegrating relation with intercept (as it is ran in Zestos and Tao, 2002). Doing this, the cointegrating equation is as follows

$$Az_{t-1} = -9.43 + ly_{t-1} - 0.40lx_{t-1} - 0.09lm_{t-1}$$

As it can be observed, both total exports and imports have a positive relation with GDP. As in Mexican case, we use two models represented by equations (4)-(6) and (7)-(9). The first important to say is that the error correction term is statistically significant only in first difference of the growth rate of production.

Regarding Granger causality, following Toda and Yamamoto (1995) methodology, that is, evaluate in a VAR model in levels, instead of using the VEC model. In this case, we find that marginally at 5% and at 1%, we may conclude that production and imports cause exports and production and exports cause imports while we cannot reject the null hypothesis of no causality from exports and imports to production.

Table 5.8: Cointegration Test of US Data

H_0 : Rank=r	Eigenvalue	Trace statistic	0.05 Critical value	0.01 Critical value
None$^{(**)}$	0.283255	30.70473	29.68	35.65
At most 1	0.198615	13.38688	15.41	20.04
At most 2	0.035385	1.873374	3.76	6.65
None$^{(**)}$	0.283255	17.31785	20.97	25.52
At most 1	0.198615	11.51350	14.07	18.63
At most 2	0.035385	1.873374	3.76	6.65

Trace and Max-Eigen tests indicates 1 cointegrating equation at both 5% and 1% levels.

* (**) denotes rejection of the hypothesis at the 5%(1%) level. Osterwald-Lenum critical values.

5.4 Growth and Trade by Bilateral Blocs

In this paper we go beyond of what has been done traditionally in the literature (section 2), and extend the analysis by commercial "sub-blocs", in order to check dynamic relations within NAFTA. The novelty is not the methodological approach, common in the literature, but the idea of using it to answer a specific question: is there any causality among countries within a zone with a trade agreement?

The data to be used is production and exports from one country to another. The idea of last variable is to capture both exports and imports. We begin reporting the results by pairs, working then with all countries in NAFTA.

5.4.1 Canada and Mexico

We first analyze Canada and Mexico as a subgroup. In section 5 we already reported the unit root test for production. It is only necessary to mention that individually both exports from Mexico to Canada and Canada to Mexico appear to have unit root. If it is ran a panel unit root, we may confirm that the series are $I(1)$, as Table 5.9 shows, so it is necessary to check cointegration.

Table 5.9: Panel Unit Root Test for Canada-Mexico (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.0206	0.1055
Variable		
lycan	0.0011 [0]	0.2743 [1]
lymex	0.0027 [0]	0.7628 [0]
lxcanmex	0.9139 [0]	0.3585 [0]
lxmexcan	0.7500 [0]	0.0143 [0]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
lycan	0.0005 [0]	0.0001 [0]
lymex	0.0003 [0]	0.0001 [0]
lxcanmex	0.0000 [0]	0.0000[0]
lxmexcan	0.0000 [0]	0.0000 [0]

Note: The number in brackets is the optimal p selected by SIC.

After we run a fourth order VAR for this group, we pick 1 as the appropriate number of lags to include in the model. However the model has serial correlation. We need to add two more lags in order to solve it. A third order VAR satisfies stability and not having serial correlation.

Now we run a cointegration test. According to SIC, we should choose a model where cointegrating equations include intercept and without a trend in the data. Since this atypical, we will run a model with linear trend for data. According to Table 10, we would have only one cointegrating equation.

Table 5.10: Cointegration Test of Canada-Mexico

H_0 : Rank=r	Eigenvalue	Trace statistic	0.05 Critical value	0.01 Critical value
None$^{(**)}$	0.535467	65.44758	47.21	54.46
At most 1	0.253794	27.11147	29.68	35.65
At most 2	0.203498	12.47378	15.41	20.04
At most 3	0.021711	1.097498	3.76	6.65
None$^{(**)}$	0.535467	38.33611	27.07	32.24
At most 1	0.253794	14.63769	20.97	25.52
At most 2	0.203498	11.37628	14.07	18.63
At most 3	0.021711	1.097498	3.76	6.65

Trace and Max-Eigen tests indicate 1 cointegrating equation at both 5% and 1% levels.

* (**) denotes rejection of the hypothesis at the 5%(1%) level. Osterwald-Lenum critical values.

The cointegrating equation is:

$$Az_{t-1} = -7.13 + lycan_{t-1} - 0.39lymex_{t-1} - 0.13lxcanmex_{t-1} - 0.03lxmexcan_{t-1}$$

There is a positive long-run relation between all variables. In the estimated VEC model, the coefficient for the error correction term is significant only in the equation for Canadian GDP. Moreover, the exogenous variable is not significant which indicates that the preferential trade agreement has not been important for the sample we have used. It is true that the share of exports between Mexico and Canada has increased, but its role has not been significant.

Regarding Granger causality test, we again use Toda and Yamamoto (1995) methodology. According to this test on VAR version of the model, including fourth lag as exogenous variable, we can reject the null hypothesis of no causality from Mexican and Canadian exports and Canadian GDP to Mexican GDP at 5% of significance and from Canadian and Mexican GDP and exports from Canada to Mexico to exports from Mexico to Canada at 10%. This means that there is evidence to ensure that Mexico has been benefited of trade with Canada but not the opposite. This is true at 10% of significance.

5.4.2 Canada and United States

Now we study Canada and United States sub-group. If specific exports series are analyzed individually, we may conclude that they are $I(1)$. The same applies when a panel unit root test is run for the set of variables as it is shown in Table 5.11.

We run a VAR model and then check the optimal number of lags. In this sub-group 2 is the appropriate number of lags to include. This second order VAR model satisfies both stability conditions as serial autocorrelation.

We now proceed with the cointegration test. The general test indicates that the data trend should be worked with linear trend and the cointegrating equation should have only intercept. If a Johansen's test is run, we may conclude that within this sub-group there is no evidence of long run relations among the variables included.

In that sense, we may run a first order VAR model in first differences, since there is no error correction term to include. After running this VAR model and analyzing Granger causality, there is evidence of causality among 4 variables included in the model.

This means that with this sample, there is evidence of short run dynamic relations among variables, but not in the long run.

Table 5.11: Panel Unit Root Test for Canada-US (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.0062	0.7653
Variable		
lycan	0.0011 [0]	0.2743 [1]
lymex	0.0768 [0]	0.3349 [1]
lxcanmex	0.2635 [1]	0.9103 [1]
lxmexcan	0.5877 [0]	0.8767 [0]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
lycan	0.0005 [0]	0.0001 [0]
lymex	0.0001 [0]	0.0002 [0]
lxcanmex	0.0007 [0]	0.0010 [0]
lxmexcan	0.0000 [0]	0.0000 [0]

Note: The number in brackets is the optimal p selected by SIC.

Table 5.12: Cointegration Test of Canada-US

H_0 : Rank=r	Eigenvalue	Trace statistic	0.05 Critical value	0.01 Critical value
None	0.355462	38.45888	47.21	54.46
At most 1	0.192641	16.05855	29.68	35.65
At most 2	0.068707	5.145251	15.41	20.04
At most 3	0.021711	1.097498	3.76	6.65
None	0.355462	22.40032	27.07	32.24
At most 1	0.192641	10.91330	20.97	25.52
At most 2	0.068707	3.630244	14.07	18.63
At most 3	0.029269	1.515007	3.76	6.65

Trace and Max-Eigen tests indicate no cointegration at both 5% and 1% levels.

* (**) denotes rejection of the hypothesis at the 5%(1%) level. Osterwald-Lenum critical values.

5.4.3 Mexico and United States

We need to check first the dynamic characteristics of series in the group. As it is observed from Table 5.13, the variables are $I(1)$ as there is evidence of existence of unit root.

Once we define the order of integration, we run a VAR model in order to analyze the optimal number of lags. Despite the recommended order is one, this VAR model has serial correlation problem. Adding an additional lag, we solve autocorrelation problem and the model satisfies stability condition.

We run then, first, a general cointegration test where we find that the data exhibits linear trend and the cointegrating equation has an intercept. Lastly, Johansen's test suggests existence of 2 cointegrating equations at 5% and only one at 1% (Table 5.14).

We estimate the VEC model with two cointegrating equations. The cointegrating equations are:

$$\begin{aligned}\mathbf{A}_1\mathbf{z}_{1,t-1} &= -7.87 + lymex_{t-1} - 2.06lxmexus_{t-1} + 1.56lxusmex_{t-1} \\ \mathbf{A}_2\mathbf{z}_{2,t-1} &= -14.92 + lyus_{t-1} + 1.65lxmexus_{t-1} - 1.77lxusmex_{t-1}\end{aligned}$$

Table 5.13: Panel Unit Root Test for Mexico-US (Probability)

	Individual Intercept	Individual Intercept and Trend Level
Level		
Im, Pesaram and Shin (IPS)	0.1174	0.6305
Variable		
lymex	0.0027 [0]	0.7628 [0]
lyus	0.0768 [0]	0.3349 [1]
lxmexus	0.6922 [0]	0.9551 [0]
lxusmex	0.9212 [0]	0.0932 [1]
First Difference		
Im, Pesaram and Shin (IPS)	0.0000	0.0000
lymex	0.0003 [0]	0.0001 [0]
lyus	0.0001 [0]	0.0002 [0]
lxmexus	0.0000 [0]	0.0000[0]
lxusmex	0.0000 [1]	0.0000 [1]

Note: The number in brackets is the optimal p selected by SIC.

Table 5.14: Cointegration Test of Mexico-US

H_0 : Rank=r	Eigenvalue	Trace statistic	0.05 Critical value	0.01 Critical value
None(**)	0.466051	67.65962	47.21	54.46
At most 1(*)	0.345941	35.03198	29.68	35.65
At most 2	0.163014	12.95497	15.41	20.04
At most 3	0.068711	3.701659	3.76	6.65
None(**)	0.466051	32.62765	27.07	32.24
At most 1(*)	0.345941	22.07701	20.97	25.52
At most 2	0.163014	9.253313	14.07	18.63
At most 3	0.068711	3.701659	3.76	6.65

Trace and Max-Eigen tests indicate 2 cointegrating equation(s) at 5% and 1 at 1%.

* (**) denotes rejection of the hypothesis at the 5%(1%) level. Osterwald-Lenum critical values.

According to the results, the first error correction term is significant in 4 equations but the second one is statistically significant only in equations for both Mexican and US GDP. Any deviation of long run relation one will affect negatively to US economy and negatively to Mexican GDP, but positively to exports from Mexico to US.

Regarding the second long run relation, any deviation on it will impact negatively both Mexican and US growth rate of production.

If we follow Toda and Yamamoto (1995) methodology to analyze Granger causality, we find that exports in both countries are Granger caused by the other three variables, while US GDP is Granger caused for the other variables at marginally 10%. However, this is counterintuitive, since US does not exhibit a higher dependency of trade[11].

5.5 NAFTA

The same exercise was thought for the whole trade bloc, but given the fixed T the number of parameters to estimate is too large, and the methodology may not be applied. This is called the curse of dimensionality. However, we propose a new framework in order to test the two hypotheses considered in this paper. The idea is to work with a dynamic panel data framework and using Arellano and Bover (1995) methodology[12]. The advantage of this methodology is that we may obtain conclusions about causality since the right hand side being endogenous is instrumented with lags of the variables in levels[13].

[11]Zestos and Tao (2002) concludes that US is an economy less dependent on trade than Canada.

[12]Roodman (2006) presents a comprehensive explanation of GMM systems and its implementation.

[13]We may follow this methodology since, first, series are $I(1)$, according to the unit root test for panel performed in Stata; and second, the variables are not cointegrated according to the panel cointegration test using `pedroni` in Stata (Neal, 2014). Therefore we may

The structural model we assume may be described as following:

$$\begin{aligned} ly_{it} &= c_i^y + \delta_t^y + \mu_{1i}^y ly_{it-1} + \mu_{2i}^y ly_{it-2} + \mu_{3i}^y lx_{it-1} + \mu_{4i}^y lx_{it-2} + \mu_{5i}^y lm_{it-1} + \mu_{6i}^y lm_{it-2} + \varepsilon_{it}^y && (10) \\ lx_{it} &= c_i^x + \delta_t^x + \mu_{1i}^x ly_{it-1} + \mu_{2i}^x ly_{it-2} + \mu_{3i}^x lx_{it-1} + \mu_{4i}^x lx_{it-2} + \mu_{5i}^x lm_{it-1} + \mu_{6i}^x lm_{it-2} + \varepsilon_{it}^x && (11) \\ lm_{it} &= c_i^m + \delta_t^m + \mu_{1i}^m ly_{it-1} + \mu_{2i}^m ly_{it-2} + \mu_{3i}^m lx_{it-1} + \mu_{4i}^m lx_{it-2} + \mu_{5i}^m lm_{it-1} + \mu_{6i}^m lm_{it-2} + \varepsilon_{it}^m. && (12) \end{aligned}$$

According to SIC, we should include two lags in the model. We also include country and time fixed effects.
Table 5.15 summarize the preliminary results.

Table 5.15: Dynamic Panel (following Arellano and Bover 1995)

	ly	ly	lx	lx	lm	lm
ly_{t-1}	1.534*** (0.03)	1.559*** (0.02)	−0.047 (0.47)	−0.659* (0.31)	−0.362 (0.55)	−2.568** (0.50)
ly_{t-2}	−0.525*** (0.02)	−0.554*** (0.02)	0.057 (0.46)	0.630* (0.30)	0.422 (0.54)	2.588*** (0.48)
lx_{t-1}	−0.045 ((0.02))	−0.036** (0.01)	1.224*** (0.05)	1.264*** (0.18)	0.083 (0.18)	0.113 (0.10)
lx_{t-2}	0.061* (0.03)	0.048*** (0.01)	−0.232*** (0.06)	−0.465*** (0.13)	0.141 (0.23)	−0.081 (0.15)
lm_{t-1}	−0.077*** (0.01)	−0.047*** (0.01)	−0.080 (0.09)	0.180*** (0.05)	1.016*** (0.08)	1.489*** (0.08)
lm_{t-2}	0.051*** (0.01)	0.029** (0.01)	0.072* (0.03)	0.018 (0.05)	−0.278*** (0.03)	−0.549** (0.05)
Time fixed effects	no	yes	no	yes	no	yes

Note: Robust standard errors in parenthesis. *,** ,*** denote rejection of the hypothesis at the 10%, 5% and1% level.

What we observe in Table 5.15 is that in GDP equations, the inclusion of time fixed effects alters the statistical significance of exports. The remaining coefficients are still statistically significant. In order to analyze if exports have impact on production, we need to analyze both short and long run effects. In the short-run, exports lagged one period have a negative effect and lagged two periods have a positive effect on production. Regarding the long run effect, which is represented by $\frac{\mu_{3i}^y+\mu_{4i}^y}{1-\mu_{1i}^y-\mu_{2i}^y}$[14]. Hence, the long-run effect of exports on GDP is

$$\frac{-0.045+0.061}{1-1.534+0.525} = -1.78$$

without time fixed effects and

$$\frac{-0.036+0.048}{1-1.559+0.554} = -2.4,$$

with time fixed effects, which implies that there is preliminary evidence to conclude that the exports *within* NAFTA has negative impact on production, that is, exports do not led growth. The first long-run effect is significant at 1% and the second one at 5%.

Regarding the second hypothesis, we find that production is not significant neither in the short-run nor in the long-run when time fixed effects are included. However, this is not true when these fixed effects are included. Production lagged one period has a negative impact on exports, whereas lagged two periods has a positive impact. The long run impact is

$$\frac{-0.659+0.630}{1-1.264+0.465} = -0.14$$

and it is statistically significant.

These preliminary results show that neither of both hypotheses hold in a positive direction.

estimate a dynamic panel, that is, we do not need to correct by cointegration. In this sense, the model is not misspecified (Baltagi, 2013; Haghnejad et al., 2014).

[14] The long-run effect may be found by assuming steady state values and solving for the endogenous variable in equations (10), (11) and (12).

6 Conclusions

In this paper we use information from Canada, Mexico and US to test two hypotheses that are common in this kind of literature: whether export-led growth or growth-driven exports. We present evidence about causality in Granger sense of international trade and economic growth. We replicate what has been done in the literature, that is, we perform Granger causality and analyze cointegration in a one-country basis. The results obtained in this firs empirical exercise are on the same line of the literature.

However, we propose an extension in this tradition to go further in the research about trade and growth. Since in the last twenty years countries have signed several free trade agreements with other partners, we consider that this empirical framework may be used to assess whether trade *within* trade blocs is important for economic growth. We consider specific bilateral trade as the variable to analyze along with GDP. However, in a VAR or VEC framework as proposed is necessary to have quite a bit information since there are a lot of parameters to estimate. And our sample does not meet that requirement. So that our second step is to test the hypotheses in a *bilateral* framework, that is, taking into account only two countries.

We estimate VARs or VECs in a bilateral basis. For the pair Canada-Mexico, we find evidence to ensure that Mexico has benefited from trade with Canada but the opposite is not necessary true. For Canada-US there is no evidence of long run relationship among variables and in the short run relation the causality in Granger sense goes in both directions. Lastly, for Mexico-US we find that exports in both countries are Granger caused by the other three variables, whereas US GDP is Granger caused by the other variables but marginally. This result is novel in this literature, since US has been always considered as an economy where its trade depends upon its production, i.e. where the growth-driven exports hypothesis holds. These results might be driven by the fact that Mexican economy is smaller relative to Canadian and US economies, and its production depends on what it is traded.

Finally, we use dynamic panel data to estimate the causality of *intrabloc* exports and imports on growth and viceversa. We do not find evidence to conclude convincingly if either of the two hypotheses hold or if both are satisfied in NAFTA, as the results are counterintuitive. More analysis most be done in order to get more conclusive evidence of which hypothesis holds *within* NAFTA and it is necessary to investigate the structural reasons.

The main contribution of this paper is related to the fact that with the signature of free trade agreements, it is possible to think in empirical strategies that allow to test the causality between growth and trade but considering solely the trade bloc. This might help to evaluate the impact of the intra-bloc trade on economics growth and vice versa.

This paper may be extended making an analysis from a regional perspective, as the share of trade of the south of US with the north of Mexico is significantly important. It is necessary to think in an empirical framework to test the two hypotheses.

References

Arellano, M. and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1):29–51.

Balassa, B. (1978). Exports and economic growth: further evidence. *Journal of development Economics*, 5(2):181–189.

Baltagi, B. H. (2013). *Econometric Analysis of Panel Data*. Wiley, 5th edition.

Dickey, D. A. and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, 74(366a):427–431.

Dolado, J. J. and Lütkepohl, H. (1996). Making Wald tests work for cointegrated VAR systems. *Econometric Reviews*, 15(4):369–386.

Dutt, S. D. and Ghosh, D. (1994). An empirical investigation of the export growth-economic growth relationship. *Applied Economics Letters*, 1(3):44–48.

Dutt, S. D. and Ghosh, D. (1996). The export growth-economic growth nexus: a causality analysis. *The Journal of Developing Areas*, pages 167–182.

Emirmahmutoglu, F. and Kose, N. (2011). Testing for Granger causality in heterogeneous mixed panels. *Economic Modelling*, 28(3):870–876.

Enders, W. (2009). *Applied econometric time series*. John Wiley & Sons, 3rd edition.

Ghartey, E. E. (1993). Causal relationship between exports and economic growth: some empirical evidence in Taiwan, Japan and the US. *Applied Economics*, 25(9):1145–1152.

Giles, J. A. and Williams, C. L. (2000a). Export-led growth: a survey of the empirical literature and some non-causality results. Part 1. *Journal of International Trade & Economic Development*, 9(3):261–337.

Giles, J. A. and Williams, C. L. (2000b). Export-led growth: a survey of the empirical literature and some non-causality results. Part 2. *Journal of International Trade & Economic Development*, 9(4):445–470.

Grossman, G. and Helpman, E. (1991). *Innovation and growth in the world economy*. MIT Press.

Haghnejad, A., Mehrara, M., Meybodi, F. J., and Dehnavi, J. (2014). Dynamic Causal Relationships among GDP, Exports, and Foreign Direct Investment (FDI) in the Developing Countries. *International Letters of Social and Humanistic Sciences*, (03):1–19.

Hamilton, J. D. (1994). *Time series analysis*. Princeton University Press.

Helpman, E. and Krugman, P. R. (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT press.

Hsiao, F. S. and Hsiao, M.-C. W. (2006). FDI, exports, and GDP in East and Southeast Asia. Panel data versus time-series causality analyses. *Journal of Asian Economics*, 17(6):1082–1106.

Jung, W. S. and Marshall, P. J. (1985). Exports, growth and causality in developing countries. *Journal of development economics*, 18(1):1–12.

Kavoussi, R. M. (1984). Export expansion and economic growth: Further empirical evidence. *Journal of Development Economics*, 14(1):241–250.

Kılavuz, E. and Topcu, B. A. (2012). Export and Economic Growth in the Case of the Manufacturing Industry: Panel Data Analysis of Developing Countries. *International Journal of Economics and Financial Issues*, 2(2):201–215.

Kónya, L. (2004). Export-Led Growth, Growth-Driven Export, Both or None? Granger Causality Analysis on OECD Countries. *Applied Econometrics and International Development*, 4(1).

Krugman, P. (1984). Import protection as export promotion: International competition in the presence of oligopoly and economies of scale. In Kierzkowski, H., editor, *Monopolistic Competition and International Trade*, pages 180–93. Clarendon Press Oxford.

Lake, J. and Roy, S. (2014). Are global trade negotiations behind a fragmented world of "gated globalization"? Technical report, Southern Methodist University.

Lancaster, K. (1980). Intra-industry trade under perfect monopolistic competition. *Journal of international Economics*, 10(2):151–175.

McKinnon, R. I. (1964). Foreign exchange constraints in economic development and efficient aid allocation. *The Economic Journal*, pages 388–409.

Nasreen, S. (2011). Export-growth linkages in selected Asian developing countries: evidence from panel data analysis. *Asian Journal of Empirical Research*, 1(1):1–13.

Neal, T. (2014). Panel cointegration analysis with xtpedroni. *Stata Journal*, 14(3):684–692.

Riezman, R., Whiteman, C., and Summers, P. (1996). The Engine of Growth or its Handmaiden? In Durlauf, S., Helliwell, J., and Raj, B., editors, *Long-Run Economic Growth*, Studies in Empirical Economics, pages 77–110. Physica-Verlag HD.

Rodriguez, F. and Rodrik, D. (2001). Trade policy and economic growth: a skeptic's guide to the cross-national evidence. In *NBER Macroeconomics Annual 2000, Volume 15*, pages 261–338. MIT PRess.

Roodman, D. (2006). How to do xtabond2: An introduction to difference and system gmm in stata. *Center for Global Development working paper*, (103).

Salvatore, D. and Hatcher, T. (1991). Inward oriented and outward oriented trade strategies. *The Journal of Development Studies*, 27(3):7–25.

Salykova, L. N. (2012). *An investigation of foreign trade policy and its impact on economic growth: the case of Kazakhstan (1991-2008)*. PhD thesis, Robert Gordon University. Available from: http://openair.rgu.ac.uk.

Shan, J. and Sun, F. (1998). On the export-led growth hypothesis for the little dragons: an empirical reinvestigation. *Atlantic Economic Journal*, 26(4):353–371.

Shan, J. and Sun, F. (1999). Export-led growth and the US economy: some further testing. *Applied Economics Letters*, 6(3):169–172.

Toda, H. Y. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1):225–250.

Won, Y., Hsiao, F. S., and Yang, D. Y. (2008). FDI inflows, exports and economic growth in first and second generation ANIEs: Panel data causality analyses. Technical report.

Zestos, G. K. and Tao, X. (2002). Trade and GDP growth: causal relations in the United States and Canada. *Southern Economic Journal*, pages 859–874.