Charles University in Prague

Faculty of Social Sciences
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MASTER'S THESIS

The Impact of the U.S. and Mexican Monetary Policy on Mexican GDP and Prices

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Declaration of Authorship

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Prague, July 30, 2015

Signature

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Abstract

The NAFTA agreement was signed in 1994 and with it came a financial liberalization for Mexico and a stronger relationship between Mexico and the U.S. making the Latin American country more sensitive to external shocks. This master thesis studies this relationship between the two countries and analyzes how the monetary policies of these two players affect Mexico, dividing the timeline and setting this event as a breaking point. Through an empirical analysis with a block restriction this research attempts to identify the reactions of the Mexican macroeconomic variables to the U.S. monetary policy shocks.

JEL Classification	E52, E58, F41, F42
Keywords	NAFTA, monetary policy, impulse responses, Vector auto-regression, variance decomposition

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Acronyms

ADF	Augmented Dickey Fuller
CETES	Certificados de la tesoreria
CIA	Central Intelligence Agency
CPI	Consumer Price Index
CPIMX	Consumer Price Index Mexico
CPIUS	Consumer Price Index United States
ERMX	Exchange Rate Mexico
FEDV	Forecast Error Variance Decomposition
GDP	Gross Domestic Product
GDPMX	Gross Domestic Product Mexico
GDPUS	Gross Domestic Product United States
IMF	International Monetary Fund
IRMX	Interest Rate Mexico
IRUS	Interest Rate United States
KPSS	Kwiatkowski-Phillips-Schmidt-Shin test
MDF	Mundell Flemming Dornbusch
MXN	Mexican Peso
NAFTA	North America Free Trade Agreement
TIIE	Tasa de Interes Interbancaria de Equilibrio
US	United States
USD	United States Dollar
VAR	Vector Autoregression

Master Thesis Proposal

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Proposed Topic:

The impact of the U.S. and Mexican monetary policy on the Mexican GDP and prices.

Motivation:

After the NAFTA agreement came into force, the Mexican economy has gone through a process of trade and financial liberalization. This agreement and the fact that Mexico has large financial links to the U.S., has made Mexico more sensitive to external shocks.

In this paper, I would like to analyze the role of the Federal Reserve and the Mexican National Bank on the Mexican GDP and Mexican prices, which will help to a reader to understand the level of dependency of Mexico from the United States' economy.

Previously a lot of papers have analyzed how U.S. variables impact on the Mexican economy, nevertheless this has been done from the commercial-trade sector; how the U.S. exports and imports have affected Mexican output, however the monetary policy impacts haven't been completely investigated. This thesis will contribute to the previous literature with an analysis of how the U.S. monetary policy affects Mexican GDP and prices and with a broader outlook on how strong these economies are connected.

Hypotheses:

Hypothesis 1. GDP and Mexican prices are better explained by the domestic shocks even though to the large link between countries
Hypothesis 2. The U.S. monetary policy influence on Mexican GDP and prices is bigger than the Mexican counterpart before and after the NAFTA.
Hypothesis 3. Foreign monetary policy has long-lived effect on Mexican GDP and prices after the NAFTA and short-lived effects before the NAFTA.

Methodology:

This paper studies the influence of the U.S. and Mexican Central Banks on the Mexican GDP and prices. For the empirical analysis I will use a standard VAR model block exogenity restrictions, allowing the foreign variables to be completely exogenous from the Mexican economy, this means that the causality is unidirectional from the U.S. to Mexico. The U.S. shocks will affect the Mexican economy, but because of the difference in sizes between the countries' economies, the Mexican variables don't have any effect on the U.S. variables.

Standard VAR models are estimated by OLS; however, in this thesis I am adding the block exogenity restrictions to the model. This model will include two equations, one for each economy.

The variables that I will use for the empirical analysis will follow the new Keynesian Model. The variables in the Mexican equation will be: Real output; the Mexican CPI (Consumer Price Index); CETES28 interest rate and the MXN/USD exchange rate. The equation of the U.S. economy will include the same variables as the Mexican equation expect for the exchange rate and the T-Bills as interest rate.

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Author **Supervisor**

1. Introduction

A bit more than two decades have passed since Mexico entered to the North America Free Trade Agreement (NAFTA) under the idea that this partnership with developed economies was going to boost the Latin American country's economy. The arguments around the idea of implementing this free trade agreement in Mexico were directed towards the benefits that an agreement of this magnitude would bring to Mexico as a developing country. Political and economical factors in Mexico, such as the country's permanence in the economic reform program helped NAFTA to move forward.

Kose, Meredith and Towe (2004) discussed that the whole process to settle the NAFTA in Mexico was one of the tools used to create credibility over Mexico's reform agenda and to bring important foreign investments inflows. They also described the agreement as a watershed for the global trade policy. This description is precise, because this agreement didn't just involved trade policies or comprehended a huge area, but also incorporated topics such as investment, labor market and environmental policies among its regulations.

Most of the past researches in this topic are related on whether the NAFTA has helped Mexico to boost and grow into a developed country or focus on the way that the business cycles between Mexico and the U.S. have been synchronized due to the increase in trade and financial flows that this relationship has brought.

A different scope including Mexico and the United States of America has been covered with another researches, focusing on how the northern neighbor affects Mexican variables through its monetary policy, answering specific questions such as: What is the influence of external shocks, specifically the variation of the U.S. the interest rates, on the fluctuations of macroeconomic variables in emerging markets (including Mexico)? How fast or how delayed is a shock in the U.S. transmitted to macroeconomic variables of these same emerging markets? All these researches have been done under the scope of an analytical and empirical point of view.

The main objective of this empirical research is to bring a broader and combined perspective by investigating how the Mexican and U.S. monetary policy affect the Mexican GDP and price level before and after the NAFTA was signed and entered into force. The data set comprised in this thesis includes a block of variables for both countries. These variables are real output, price level, interest rate and exchange rate, the last one just for the Mexican block. As a consequence of the availability for the data in a retrospective way, the timeline for this thesis starts in 1988. The interest rate for Mexico was only available since that date. The timeline ends in 2008, and this is mainly because of the financial crisis, which is out of the scope of this thesis.

Additionally this agreement as well has positioned Mexico as an attractive country for foreign direct and indirect investment through different channels that have boosted the financial liberalization and openness to the global economies through the increased amount of trade accounts and financial flows between the countries. This attractiveness of the country to bring foreign and local investment makes Mexico at the same time more vulnerable and sensitive to external shocks.

Building and estimating an econometric model is the approach that I used to obtain my results. Vector Autoregressive Regression (VAR) is the most used model for this kind of researches. A block restriction will be added to this methodology, assuming that Mexico, as a small open economy is incapable of affecting the U.S. macroeconomic variables, but the U.S. is capable to affect Mexican variables, at the end this is the main point of the thesis, analyze how Mexican economy has been influenced by the U.S. before and after the NAFTA.

The contribution of my work to the existing literature will be a research from a different point of view. Analyzing how the U.S. monetary policy affects Mexican GDP and prices will help us have a deeper understanding of the strong connections that both countries have and mainly how these connections strengthened with the NAFTA, which is considering for the purposes of this thesis as the breaking point in which Mexico started to face some changes on the control of its macroeconomic variables.

This sensitiveness and vulnerability explained in the previous paragraph brings me to the core body and line of investigation of my thesis. Specifically I will look for the answers to the following questions: To what extent does the U.S. monetary policy shocks affect the Mexican real output? Which monetary policy has a stronger impact on the Mexican GDP before and after the NAFTA? Which monetary policy affects more Mexican GDP in the long run and which one in the short run? Are these results the same before and after the NAFTA? For the purposes of this thesis I will define a shock as a contractionary monetary policy shock, meaning that the analysis will be held on how the Mexican macroeconomic variables react to increases on the U.S. and Mexican interest rates. It is called contractionary monetary policy shock because with the increase of the interest rates you slowdown the economy and reduce the circulating money in the economy.

According to the Federal Open Market Committee from the Federal Reserve of the United States, monetary policy specifies the actions that can be taken by a Central Bank or Monetary authority institution of any country to control the cost of the money and the availability of it. Understanding how your closest partners' monetary policy affects you, has to be also taken into consideration at the time of deciding your actions towards these topics. A good monetary policy can increase your growth in a temporarily basis, but mainly and most important is that it contributes to a greater macro stability.

This thesis will be organized in the following way: the second section will introduce the theoretical background, which means, how the Mexican and the U.S. monetary policies work and in which variables they focus the most. The third section will present the relevant literature. The fourth section will explain the description of the variables and the hypotheses. In the fifth section I will present the theoretical and empirical model. The sixth part includes all the results. Conclusions, main findings and further research will be shown in the seventh section.

2. Theoretical Background

The North America Free Trade Agreement (NAFTA) is a broad trade agreement that came into effect on January 1, 1994. This agreement was signed by Canada, the United States and Mexico. The main objectives of NAFTA were to eliminate all the tariff barriers between these three countries in topics such as trade and investment. It is important to point out that all these barriers were not going to be removed at once but over a period of ten to fifteen years.

After the NAFTA started working, the links and partnership between the three countries have strengthened in an important way and they did it in a short period of time. The total trade between Mexico and the U.S. has grown substantially from 1993 to 2007. Before NAFTA Mexico's trade with the U.S. accounted for US$90 billion dollars, in 2007 it was worth US$365 billion dollars.

Before starting with the relevant literature, I will briefly describe the Mexican Central Bank and the Federal Reresve of the United States, what are their main objectives and which tools do they use to reach them.

The Mexican Central Bank was founded in the year 1925 and by constitutional law is an autonomous institution regarding its functions and administration. The main objective of the Mexican National Bank is to maintain the stability of the purchasing power of the currency. Influencing the interest rates and the exchange rate is how the maintenance of the general price level is achieved.

Carstens and Werner (1999) discussed about the most recent monetary program that the Mexican Central Bank launched has three main elements in which to focus in order to achieve its objectives:

1. A yearly annual inflation objective, established together with the Federal Government. The Mexican Central Bank will contribute to this objective with its

monetary policy and the Federal Government's contribution will come through the fiscal policy, which at the end also determines the minimum wage.

2. Obligations regarding international reserves and fluctuation of net domestic credit, as well as rules on the management of the monetary base by committing to equalize the supply primary money with the demand for base money by regulating the first one, in order not to create monetary surplus.
3. The right to modify its point of view on monetary policy in case of emergencies.

The Mexican central bank reserves the right to modify its point of view in monetary policy for mainly three emergency cases: In case of detecting some inflationary pressures contradicting the inflation targeted for that specific period, in case it is needed to get back the exchange rate and money markets to stable and normal levels and in case the expectations on the inflation are not matching the inflation target.

The Federal Reserve of the United States was founded in the year 1913. They have implemented three key objectives, which are: highest level of employment, stable inflation level and a moderate long-term interest rates. These three goals are considered to be in most cases complementary with each other; when they are not, a balanced approach is followed. This balanced approached is set by analyzing the impacts of the deviations and how long will it take to bring this variables back to the levels they have set in the first instance.

The tools used by the Federal Reserve of the United States to manipulate the amount of reserves a private or commercial bank need to hold are the following ones:

1. Open market operations, this is the primary tool of the Federal Reserve of the U.S. for maintaining the inflation target at the time of deciding the monetary policy, and it consist of buying and selling the U.S. Treasury and Federal financial instruments.
2. Discount rate means the interest rate that the commercial bank needs to pay when the Federal Reserve acts as a lending institution.
3. A reserve requirement is the amount of money that a bank is required to hold for the deposits they have as liabilities in their balance sheet. According to the

requirements listed on the Federal Reserve's webpage they have two thresholds, from 14.5 – 103.6 millions is 3% of the liability and above 103.6 million is 10%.

Clarida, Gali, Gertler (1998) stated in their investigation that the Federal Reserve of the United States is one of the central banks who focuses on the forward looking, which means that they are reacting to anticipated inflation. I will point out that as it has been discussed before in the three elements that the Mexican Central Bank uses to achieve its objectives, both central banks from the countries analyzed in this thesis are following the same strategy.

3. Relevant Literature

Stated by (Sosa, 2008) after the NAFTA agreement came into force between Mexico and United States, the Mexican economy has gone though a process of trade and financial liberalization and integration. This agreement and the fact that Mexico has large financial links to the U.S., has made Mexico more sensitive to external shocks.

According to Sosa (2008), there is a dramatic expansion of trade between Mexico and the U.S. since NAFTA's inception and this may have lead to an increase in the importance of U.S. cycles driving output fluctuation in Mexico. More than 80% of exports are sent to the U.S. and more than a half of imports come from the same country, which makes the U.S. the largest trading partner for Mexico.

"In the 1970 and early 1980's, least developed countries had self-sufficient financial markets so that transmission, if any, occurred through the trade balance and real exchange rate adjustments. The last decade, however, has witnessed a remarkable process of financial liberalization in many least developed countries and a substantial increase in the financial interdependencies of Latin America with the U.S." (Canova, 2005)

Other researches that investigate about the impacts of monetary shocks in small open economies will be presented below. These researches will help me with all the theoretical background behind my model and will provide me with ideas of what to expect from my empirical exercise. I will focus mainly on researches that used VAR model with block exogeneity restriction and researches that studied the cases of Mexico and Latin America.

"Cushman and Zha (1997) argue that past empirical studies on the impacts of the monetary policy have provoked puzzling dynamic responses on the macroeconomic variables. According to them the past studies have identify monetary policy for these economies in an inappropriate way. They employ the VAR model with a block exogeneity restriction; which is a key feature of this type of models where the assumption states that foreign variables are totally exogenous to the domestic economy (Sosa, 2008).

They only focus on the evaluation of domestic monetary shocks, and leave the U.S. monetary shocks out of the analysis.

The analysis of the responses of a small open economy to the foreign shocks is done by Giordani (2004) and leaves the domestic shocks out of the analysis. He estimates two models, the structural theoretical model from the New Keynesian models and the Bayesian VAR; at the end he compares them. He utilizes U.S. – Canada pair for the empirical estimates and finds out that all the Canadian variables are largely influenced by U.S. shocks; these findings match the past findings from all the literature. He concludes that the optimal and actual monetary policy rules for Canada should undoubtedly take into consideration the foreign variables.

Kim (2001) investigates how the U.S. monetary policy shocks are internationally transmitted to countries with a flexible exchange rate regime. Two controversial questions are being addressed in this research: Does a monetary expansion in the U.S. lead to recession or booms in other countries? And, does a monetary expansion improves or worsens the current account of a country? (Kim, 2001) states that there exists ambiguity in the effects predicted by the models. "The traditional Mundell-Flemming-Dornbusch (MFD) model alone has ambiguous predictions on the effects" (Kim, 2001). The inter-temporal models results show a different perspective from the MDF model. This ambiguity given by different results from each model is faced and solved in this research by using empirical evidence. The main finding from this research is that U.S. monetary expansion has a positive spillover outcome on these countries' output. Furthermore, monetary expansion improves vigorously the trade balance in the medium and long run, but it drives it to degradation in the short run. (Kim, 2001) demonstrates that after controlling for inflationary or supple shocks, Canada is the only country, from the analyzed ones, that has a strong reaction to U.S. monetary policy; this finding is contrary from what previous literature has showed, that the monetary policy of flexible exchange rate regime countries is considerably tracking the U.S. monetary policy.

In addition, Canova (2005) studies the transmission of U.S. shocks to Latin America, he provides information on how important are the consequences of the U.S. monetary policy shocks in eight Latin American countries. The findings show that the influence of the American shocks into the Latin American macroeconomic variables barely changes between countries with a fixed and flexible exchange regime.

According to Mackowiak (2006) contrary to the previous studies mentioned above, decides to analyze Central Europe, but similar to all the other studies the investigation focus on the macroeconomic changes caused by external shocks. The countries that he takes into the consideration for his research are Czech Republic, Poland and Hungary, leaving Slovakia outside of the equation. The proxy variable for defining the external shocks Mackowiak (2006) utilizes Germany, and he estimates a model where he includes important macroeconomic variables from both Germany and the three Central Europe economies in question.

The main findings of the research demonstrate that the external shocks, in this case Germany, are considerably responsible for the sizeable amount of variation in these countries. The model delivers some results, which show that nearly 60-85% of the variance in the price level is due to the external shocks. In the case of the real output, the results show that nearly 25-50% of the variance is due to the external shocks. The estimates also reveal that the German interest rate shocks have a higher impact on the aggregate price level of the Czech Republic compared to the ones of Poland and Hungary; accounting for 50% of the variation in the Czech Republic, whereas for Poland and Hungary is 2/3 of that digit.

There has been an important focus on the Asian crisis and the main discussion asks, if it was provoked by the expansionary monetary policy shocks in Japan (Mackowiak, 2006) Stated by Mackowiak (2006) in his research about Japan, it has been argued in current monetary policy discussions that Japan's neighbors and Japan's real output can be increased by an expansionary monetary policy, while others warned that Japan is attempting to fix their own economic problems by mechanisms that tend to worsen the economic problems of other countries.

He employs a Bayesian VAR and finds out that the shocks of the Japanese monetary policy affect to their own macroeconomic variables in a modest amount. Afterwards he does the same in order to estimate the effect that the Japanese monetary policy shocks have on the macroeconomic variables of the neighbor countries and in accordance to Mackiowak (2006) the variation is even smaller. Specifically, he cannot confirm that the Asia crisis was mainly due to the Japanese monetary expansion; in order to support this, he also demonstrates that the effect of the Japan's monetary expansion was the decrease in net exports and this is inconsistent with the idea that states that Japan is attempting to fix their own economic problems by worsening other countries' economic situation.

Mackowiak (2007) investigates how big is the impact of external shocks on macroeconomic fluctuations in emerging markets. Specifically, the variable used for external shocks will be the United States. He calculates a Structural VAR for 8 different emerging markets. He assumes that the emerging markets are small open economies, which means that the U.S. cannot be influenced by the small open economies, this assumption is achieved by adding the block restriction to the VAR model. The variables that are included in the model are important macroeconomic variables for the U.S., important macroeconomic variables for the emerging markets, as well as world commodity prices. The research finds that the shocks from the U.S. play an important role on the fluctuations of macroeconomic variables in emerging markets. Moreover, the short-term interest rate and the exchange rate in a normal emerging market are quickly and strongly affected, according to (Mackiowak, 2007). Interestingly, they found that other kind of external shocks have a bigger impact in emerging markets compared with the U.S. monetary policy shocks (Mackiowak, 2007).

Parrado (2001) analyses in his research the Chilean economy by identifying how domestic and foreign shocks, mainly the ones from the monetary policy influences the macroeconomic variables. He utilizes a structural VAR to perform its empirical analysis.

His findings go in line with those that point out that the monetary policy influence on output is small due to the categorization as an industrial country. Other outstanding contribution to the literature is his finding that the innovations on the foreign monetary policy influence the domestic interest rates for a short period of time. By contrast, risk premium shocks explain in a big proportion the exchange and the interest rates in the country.

Del Negro and Obiols Hums (2001) estimated an identified vector autoregression (VAR) model for the Mexican economy using monthly data from 1976 to 1997. They did it with the small-open-economy VAR in order to take into consideration the foreign shocks on the Mexican macroeconomic variables. Their research addresses to main questions: How big has the impact of the exogenous to the monetary policy been on the economic activity, and did the endogenous answers or responses of the monetary policy helped to mitigate or intensify the impact of the variation elsewhere? The main findings of this paper say that there was no impact on output and prices made from the external shocks to the monetary policy, the variation deriving from the U.S. economy has been a larger source of fluctuations for Mexico than the shocks to oil prices, and that the response of the monetary policy to the external shocks played and important role in the 1994 crisis.

Mojon and Peersman, (2001) presented some results in order to describe the effects of the monetary policy in 10 different European countries. The period that they chose to analyze was the pre-EMU, which is before the European Monetary Union came into force. Depending on its monetary integration with Germany, they implemented one of three identification schemes for each one of the 10 countries. The first identification scheme was for was used for Germany, the second one to some other countries that are part of the Monetary Union System (Austria, Belgium and the Netherlands) and finally the third identification scheme was applied to all the other countries. “An unexpected rise in the short-term interest rate leads to a decrease in GDP, (with investment and exports falling more than consumption) and a gradual decrease in prices for all countries.” (Mojon and Peersman, 2001). They also demonstrated that they couldn’t reject that the monetary policy has similar effects in the GDP and prices in each individual countries, which integrate the euro area.

Sosa (2008), differently from what I will do in this thesis, he analyzes the business cycles in Mexico and how these are related to the U.S. shocks, mainly before and after the NAFTA period. He utilizes a VAR with a block exogeneity restriction in order to estimate the impacts. He finds out that after the NAFTA agreement came into force in 1994, Mexico's macroeconomic fluctuations were explained in a larger proportion by the U.S. shocks.

Following the research line from Sosa (2008), Chiquiar and Ramos Francia (2005) studied the connections that exist between Mexico and the U.S. in the production-manufactuing industry. Findings from this investigation demonstrate that the links between the U.S. and Mexico in the manufacturing sector have become stronger in the post NAFTA period, leading to a more exact synchronization of the business cycles of these two countries.

Torres (2000) analyzed the behavior of the Mexican business cycles in the period 1940 to 1997. This study contributes with an interesting point of view; he argues that the Mexican economy present a particular feature, in one side there exists an important relationship with the U.S. and in the other side the economy is still in the developing countries of Latin America. The research demonstrates that the Mexican economy was affected by the U.S. fluctuations and that the Mexican business cycle follows the U.S. counterpart with two lagged periods.

Torres and Vela (2003) continue in the same research line and study the link that Mexico and the U.S. have regarding their business cycles, under the statement that these two economies have been more connected in the 10 years after the NAFTA agreement was signed. The findings of this study state that the business cycles between the U.S. and Mexico are more coordinated after the NAFTA period. These results are harmonized with past investigations done by Sosa (2008) and Chiquiar and Ramos (2005).

4. Description of the variables and hypotheses

In this section I will describe the variables that I am going to use in order to realize my empirical exercise.

All variables included in the data are available from January 1988 to December 2008 (252 observations). The data was collected from the IMF International Financial Statistics Database, Banco de México (Mexican Central Bank) and the Federal Reserve of the U.S. St. Louis. The reason why I chose this timeline for the analysis is because we have a breaking point in 1994 when the NAFTA was signed, the analysis is based on the impacts before and after the NAFTA. 6 years before gives us a wide overview of time for doing the empirical exercise, and 15 years after in order to avoid the world financial crisis of 2008, which is outside of our investigation topic for this thesis (2008 was still selected for the empirical exercise since the crises hit Mexico at the beginning of 2009).

The first variable of my model is the real output. This time series is only available in a quarterly basis; the proper transformation of the variable is to interpolate it by using a quadratic match procedure in order to convert the quarterly data into monthly data. This transformation can be easily achieved with statistical software. The data for this variable is available since January 1988 to December 2008. This data was gathered from the IMF International Financial Statistics Database.

The second variable of the model is aggregate price level. This variable is composed by the data of the consumer price index for both countries. This data was collected from the IMF International Financial Statistics Database.

The third variable of the model is the interest rate. For Mexico two data sets were collected. The CETES28 interest rate and the TIIE28 interest rate. According to the Mexican Central Bank, the definition of both interest rates will be the following:

- CETES28 is a negotiable instrument issued by the Federal Government since 1978, which obliges it to pay the nominal value at the maturity. This financial instrument was created to finance productive investment, influence the regulation of monetary basis and foster the healthy development of the stock market.

- TIIE28 is the Interbank Equilibrium Interest Rate, which represents the rate for credit operations between banks. This rate is calculated in a daily basis according to the biddings made by the banks to reflect the money market conditions in local currency.

The behavior between these two variables is quite similar across the years. Nevertheless, since the TIIE28 was calculated in January 1997 for the first time, we decided to use CETES28 as our main variable for the model. For the U.S. the Treasury bill interest rate 28 days was collected, which is the U.S. counterpart of the CETES28.

Finally, the fourth variable of the model is the exchange rate. This variable is the monthly average of the MXN/USD exchange rate. This series was also collected from the IMF International Financial Statistics Database.

After the literature review of all these studies, three main hypotheses will be tested during the empirical exercise of the thesis:

1. GDP and Mexican prices are better explained by the domestic shocks even though to the large link between countries.
2. The U.S. monetary policy influence on Mexican GDP and prices is bigger than the Mexican counterpart before and after the NAFTA period.
3. Foreign monetary policy has long-lived effects on the Mexican GDP and prices after the NAFTA and short-lived effects before the NAFTA.

5. Theoretical model

In this section of the thesis I will present the New Keynesian model, which can be considered as the theoretical model behind the empirical research, performed in this work. Svensson (2000) and Gali and Gretler (2007) used this same theory to perform their respective investigations.

The New Keynesian model is comprised by a Phillips curve, an IS curve and a monetary policy rule for setting the interest rate in the short term, for this thesis we will assume a Taylor rule. I will describe each of these equations from the model in the following points:

- The Phillips curve is used to describe the partially forward-looking pricing rule, in other words, it helps to describe the determinants that set the inflation in the next period.
- The IS/AD curve helps to describe the determinants that set the output or GDP of a country for the next period.
- And lastly the Taylor rule. Orphanides (2007) discusses the Taylor rules and argues that the developments of the inflation and the macroeconomic stability should be a key point in the decision of how the central bank should influence its interest rate policy.

After the new Keynesian model has been described in the previous paragraph, I will continue to fit these concepts into equations for the Mexican economy. The only additional concept that will be added is the exchange rate representing the uncovered interest parity. In the following paragraphs I will describe how the Mexican economy will look like.

Firstly, the New Keynesian models include a Phillips curve, this equation describes the partially forward-looking pricing rule, and it is written in the following way.

$$\pi_{t+1} = \alpha_\pi \pi_t + (1-\alpha_\pi)E_t\pi_{t+2} + \alpha_x x_{t+1} + \alpha_q(q_t - q_{t-1}) + \varepsilon_{t+1}^{CP} \qquad (1)$$

x_t is the real output for the specific case of this work; q_t represents the real exchange rate; π_t denotes the inflation; E_t is an expectation operator; ε_t^{CP} is a cost push shock and it follows the next distribution $\varepsilon_t^{CP} \sim nid\ (0, \sigma_{CP}^2)$. $E_t\pi_{t+2}$ is the operator used to bring in the lags of the monetary policy. All the variables mentioned in these sections will be transformed to the first difference of the logarithms for my empirical exercise.

The second equation of the New Keynesian will be the IS/AD equation. IS/AD equation is written in the following way:

$$x_{t+1} = \beta_x x_t (1 - \beta_x) E_t x_{t+2} - \beta_i (i_t - E_t \pi_{t+1}) + \beta_x \cdot x_{t+1}^* + \beta_q E_t q_{t+1} + \varepsilon_{t+1}^{AD} \tag{2}$$

Where x_{t+1}^* is the foreign real output, which I will include as I want to know the reaction of the Mexican variables to the fluctuations in the foreign ones, and i_t is the monetary policy instrument used by the domestic economy, which in my empirical exercise will be the CETES28 interest rate. ε_t^{AD} represents an aggregate demand shock, and this shocks will be distributed in the following way: $\varepsilon_t^{AD} \sim nid\ (0, \sigma_{AD}^2)$. In Equation (2) the output is affected by the interest rate with a lag.

The exchange rate equation will include uncovered interest rate parity, so it will look as follows:

$$(i_t - E_t \pi_{t+1}) - (i_t^* - E_t \pi_{t+1}^*) = q_{t+1|t} - q_t \tag{3}$$

Where the foreign inflation rate is denoted by π_t^*. The Taylor-type policy rule is described in this monetary policy and it can be modeled as the following.

$$i_{t+1} = \rho_i i_t + (1 - \rho_i)(\gamma_x x_{t+1} + \gamma_\pi \overline{\pi_{t+1}} + \gamma_{i*} i_{t+1}^* + \gamma_x^* x_{t+1}^* + \gamma_{\pi*} \overline{\pi_{t+1}^*} + \varepsilon_{t+1}^{MP} \tag{4}$$

As it is observable in the four last equations, a set of foreign variables have been included into the Mexican economy, this has been done to show that Mexico is considered to be an open economy and hence, it is influenced by foreign variables too.

The United States economy will be also described with the New Keynesian models, including the Phillips curve, IS curve and Taylor rule. These equations from the foreign block will contain fewer equations as it is assumed to be a closed economy.

$$\pi_{t+1}^{*} = \alpha_{\pi}^{*}\pi_{t}^{*} + (1-\alpha_{\pi}^{*})E_{t}\pi_{t+2}^{*} + \alpha_{x}^{*}x_{t+1}^{*} + \varepsilon_{t+1}^{CP*} \tag{5}$$

$$x_{t+1}^{*} = \beta_{x}^{*}x_{t}^{*} + (1-\beta_{x}^{*})E_{t}x_{t+2}^{*} - \beta_{i}^{*}(i_{t}^{*} - E_{t}\pi_{t+1}^{*}) + \varepsilon_{t+1}^{AD*} \tag{6}$$

$$i_{t+1}^{*} = \rho_{i}^{*}i_{t}^{*} + (1-\rho_{i}^{*})(\gamma_{x}^{*}x_{t+1}^{*} + \gamma_{\pi}^{*}\pi_{t+1}^{*}) + \varepsilon_{t+1}^{MP*} \tag{7}$$

The block restriction characteristic set for this thesis presumes that Mexico is incapable to affect the foreign economy. This characteristic has been set and is the main reason why these equations from the foreign block contain fewer equations as it is assumed to be a closed economy; hence the Mexican variables are not included in the foreign block.

5.1 EMPIRICAL MODEL

In the following paragraphs I will present a seven variable VAR model to explain the relationship between Mexico and the United States. From these seven variables, four of them are describing the Mexican economy and the three remaining ones are describing the American economy.

These 7 last equations are called the structural form of the model, which represents all the economical background behind it. The structural form it assumed to be linear and has a stochastic dynamic form. The constant and other deterministic terms will be omitted. The system can look in the following way:

$$A(L)y(t) = \varepsilon(t)$$

In the previous equation $A(L)$ is a $m*m$ matrix polynomial in the lag operator which doesn't have negative powers, $y(t)$ represents a $m*1$ vector of observations and $\varepsilon(t)$ is a $m*1$ vector with the structural disturbances or shocks. The $\varepsilon(t)$ is serially uncorrelated and the variance $var(\varepsilon(t)) = \Lambda\, and\, \Lambda$ is a diagonal matrix in which the diagonal elements are the variances of the structural disturbances. Expressed in a more formal way it will look like this: $E[\varepsilon(t)\varepsilon(t)'|y(t-s), s > 0 = I, E[\varepsilon(t)|y(t-s), s > 0] = 0$.

This thesis will comprise two groups of variables. The domestic block represented by the Mexican macroeconomic variables, and the foreign block represented by the American variables. Accordingly, we will have:

$$A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix}, y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix}, \varepsilon(t) = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}.$$

The model consists of m_1 domestic variables in the small open economy vector $y_1(t)$, these variables are the ones describing Mexican economy and m_2 variables, which are exogenous to the small open economy in the vector $y_2(t)$, these variables are describing the U.S. economy. The dimension of A_{ij} will be $m_i * m_j$. In the other side $y_i(t) and\ \varepsilon_i(t)$ have a dimension of $m_i * 1$.

The Mexican block comprises the following variables:

- A measure of economic activity (Real output) represented by (x_t^{MXN}),
- A measure of aggregate price level (Consumer price index) represented by (p_t^{MXN}),
- The short-term interest rate (CETES 28) represented by (i_t^{MXN}),
- The exchange rate represented by $\left(e_t^{\frac{MXN}{USD}}\right)$.

The U.S. block comprises the following variables:

- A measure of economic activity (Real output) represented by ($x_t^{U.S.}$),
- A measure of aggregate price level (Consumer price index) represented by ($p_t^{U.S.}$),
- The short-term interest rate (T-BILLS28) represented by ($i_t^{U.S.}$).

All the variables will be transformed to the first differences of the logarithms in order to fit the model and fulfill the requirements of the stability of the system. The stability of the system will be checked with the root of the characteristic polynomial.

Zha (1999) stated that ignoring the fact that you need to establish a block exogeneity restriction is not only economically unattractive but is also could drive to inaccurate conclusions. This assumption has been used by Cushman and Zha (1997) and Mackiowak (2006) in their past researches. As I have mentioned before, this assumption states that Mexico is a small economy and that its shocks or fluctuations in their macroeconomic variables will not affect the U.S. economy.

The inclusion of some independent variables into other equations as explanatory variables makes the structural form to face correlation of the error terms. Due to this problem the structural form cannot be estimated directly as it will bring biased and inconsistent results.

After arranging and multiplying the structural form, we get to the reduced form. This reduced form makes the estimation to be feasible. The reduced form is represented in the following equation.

$$y(t) = B(L)y(t_{-1}) + u_t$$

In this equation, $B(L)$ is defined as a polynomial matrix and $var\big(u(t)\big) = \Sigma$. All the structural innovations will be restored in the following way. I will reformulate $A(L) = A_0 + A^0(L)$, where A_0 represents a coefficient matrix on L^0 in $A(L)$, which means that is the contemporaneous coefficient matrix in the structural form. A_0 can be called as an impact matrix. $A_0(L)$ is the coefficient matrix in $A(L)$ without the contemporaneous coefficient A_0. After all these, I can reformulate the structural equation as $A_0y(t) + A^0\,(L)y(t) = \varepsilon(t)$. After the reformulation it will follow a rearrangement of the equation and pre-multiplying it by A_0^{-1} we get that:

$$y(t) = -A_0^{-1}A_0(L)y(t) + A_0^{-1}\varepsilon(t)$$

The reduced form residuals and the structural shocks have a relationship that can be modeled in the following way:

$$u(t) = A_0^{-1}\varepsilon(t)$$

The identification problem in this kind of models is when you have fewer parameters to be estimated in the reduced form VAR than in the structural form of the model. Evidently, I will face this problem. The Choleski recursive scheme is the best path to identify the system. The process to get a just identified system is to establish the $n(n-1)/2$ restrictions. Sims (1980) states that the reduced formed errors are orthagonalized by the Choleski decomposition.

The Choleski scheme suggests a way to order the variables in the system and Sosa (2008) makes reference that the Choleski scheme helps us to implement the restriction were we assume that the contemporaneous variables of the Mexican economy won't affect the U.S. economy. In order to state the complete exogeneity restriction in the model we need to establish the block exogeneity restriction, which makes that the lagged values of the Mexican variables won't affect the U.S. variables either. To achieve this, the model is estimated in two blocks, one block is the domestic equation, and the other block is the foreign equation, where the domestic variables are completely excluded.

For the Choleski scheme I will follow Mojon and Peersman (2001) and chose the order of the variables as follows: The real output will be in the first place, the aggregate price level will follow, the third variable will be the interest rate and the last variable will be the exchange rate. Note that the exchange rate will only be present in the domestic equation. It is important to mention that a different ordering of the variables will bring different results.

6. Empirical Methodology

In the following section of this thesis, the complete empirical of the methodology that was performed to arrive to the results will be presented. This section will be divided into three parts. First the steps followed for fitting the whole time period into the correct specifications of the model. In the second part the same steps followed for the specifications of the model with the data before the NAFTA, and lastly the specifications of the model with the data after the NAFTA.

6.1 WHOLE TIME PERIOD 1988 – 2008

In this part of the thesis I will analyze the whole series from 1988 to 2008 in order to define the most accurate specifications for my model according to the type of time series I have and how they interact among them.

In the Vector Autoregressive Analysis is more important the stability of the whole system, according to Sims et al. (1990) which implies that a stationary system is better than the stationarity of the individual variables. Following this, not all the time series in the model need to be stationary, if the model is stable as a whole, it is sufficient to proceed with the proper tests of the model and the structural analysis of impulse responses and variance decomposition.

First I will run the VAR model with the variables without transformation and 2 lags for the endogenous variables according to the Schwarz, Hanna-Quinn Criterions. This test is telling that the VAR system does not satisfy the stability condition when the variables are without transformation because at least one unit root is outside the unit circle. (See table 6.1.1)

Table 6.1.1 *Roots of the characteristic polynomial without transformed variables. Time period 1988-2008*

Root	Modulus
1.000475	1.000475
0.983029 - 0.023759i	0.983316
0.983029 + 0.023759i	0.983316
0.934268 - 0.014569i	0.934382
0.934268 + 0.014569i	0.934382
0.713586 - 0.300178i	0.774153
0.713586 + 0.300178i	0.774153
0.644676 - 0.030517i	0.645398
0.644676 + 0.030517i	0.645398
0.500310 - 0.220251i	0.546645
0.500310 + 0.220251i	0.546645
0.497783	0.497783
0.217736 - 0.120889i	0.249045
0.217736 + 0.120889i	0.249045

Source: Author's computations. System estimated with 2 lags according to Schwarz and Hanna-Quinn Criterions. At least one root lies outside the unit circle. The VAR does not satisfy the stability condition.

In order to correct this I will run the Augmented Dickey Fuller (ADF) test and KPSS test for each variable in order to test the stationary of the single variables and get the first differences of the logarithms when necessary. A variable is consider to be stationary when the series fluctuates a constant long run mean, has a finite variance which is no dependant on time and the covariance between two values of the series depends only in the difference apart in time.

I will start by analyzing the GDPUS. As shown in the figure depicted in Appendices, I can observe that the series is not stationary because it doesn't have a constant long run mean. For that I run the ADF and the KPSS test (table 6.1.2)

Table 6.1.2. *Stationarity tests for GDPUS. Time period 1988 – 2008.*

Test	Variable	t-statistics	Stationary
ADF	GDPUS		No
KPSS	GDPUS	1.2843	No

Source: Author's computations. 95% confidence level.

The Augemented Dickey Fuller test is a left-handed test. From this test it is observable that the null hypothesis of presence of unit root at a 95% confidence level cannot reject since the t-statistics is positive and the critical value for this test is -1.94.

In order to confirm the results from the previous test, I present here the results from the KPSS test and I reject the null hypothesis of stationarity at a 95% confidence level and assume that our variable is non-stationary. As I have a non-stationary variable I will transform the variable to the first differences of the logarithms.

Now I will analyze the GDPMX in order to test its stationarity. As shown in the figures in Appendices, it is appreciable that the series is not stationary as it doesn't satisfy our three conditions described before. I will run the ADF and KPSS test (Table 6.1.3) and the results are shown below.

Test 6.1.3 *Stationarity tests for GDPMX. Time period 1988 - 2008*

Test	Variable	t-statistics	Stationary
ADF	GDPMX	4.3262	No
KPSS	GDPMX	1.2863	No

Source: Author's computations. 95% confidence level.

The null hypothesis of presence of unit root cannot be rejected at a 95% confidence level since the t-statistics is positive and the critical value is -1.94, so the GDPMX is a non-stationary time series. The KPSS test is confirming the results from the previous test as the null hypothesis of stationarity is rejected at a 95% confidence level and assumes that the variable is non-stationary. In the following step I will perform the same procedure as I did for the GDPUS variable. I will transform the GDPMX into the first differences of the logarithms.

I will proceed with the analysis of the CPIUS. As it is depicted in the figure in the Appendices section, we can observe that the series is non-stationary. For providing stronger evidence I ran the ADF and KPSS test (6.1.4) and the results are shown below.

***Table 6.1.4** Stationarity tests for CPIUS. Time period 1988 – 2008.*

Test	Variable	t-statistics	Stationary
ADF	CPIUS	4.7149	No
KPSS	CPIUS	1.3004	No

Source: Author's computations. 95% confidence level.

The null hypothesis of presence of unit root cannot be rejected at a 95% level since the t-statistics is a positive number and the critical value is -1.94, so the CPIUS is non-stationary time series. To confirm this result the KPSS test its telling us that the null hypothesis of stationarity is rejected at a 95% level and assumes that the variable is non-stationary.Following these results I will treat the variable as non-stationary and transform it into the first differences of the logarithm.

The next variable to analyze is the CPIMX. As well as before, I ran the ADF and the KPSS test (Table 6.1.5) and the results are shown in the next table.

***Table 6.1.5** Stationarity tests for CPIMX. Time period 1988 – 2008.*

Test	Variable	t-statistics	Stationary
ADF	CPIMX	3.4075	No
KPSS	CPIMX	1.2929	No

Source: Author's computation. 95% confidence level.

The null hypothesis of presence of unit root cannot be rejected at a 95% confidence level since the critical value is -1.94 and our t-statistics is a positive number, this suggests that the series is non-stationary. The KPSS test if confirming our past results; the null hypothesis of stationarity is rejected at a 95% confidence level. According to the KPSS test the series is non-stationary. Following these I will transform the variable into the first difference of the logarithms.

The following variable to be analyzed is the Interest Rate U.S. The figure depicted in Appendices shows the interest rate US for the period 1988 to 2008. From graph is hard to analyze if it is stationary or not, following this, I ran the correspondent tests to analyze the variable. The results from both tests (table 6.1.6) are shown below.

Table 6.1.6 *Stationarity tests for IRUS. Time Period 1988 – 2008*

Test	Variable	t-statistics	Stationary
ADF	IRUS	-1.3113	No
KPSS	IRUS	0.6083	No

Source: Author's computations. 95% confidence level.

The null hypothesis of presence of unit root cannot be rejected at a 95% percentage level, and the variable is non-stationary according to this test. The KPSS test is helping to provide stronger evidence on the previous test; the null hypothesis of stationarity is rejected at a 95% confidence level. From both test we got that the variable is non-stationary, this variable will be transformed to the first differences of the logarithms.

The Interest Rate MX is shown in the figure at the Appendices section. I ran the same tests as for all the other variables in order to check for stationarity. The results for the ADF and KPSS tests (table 6.1.7) are shown below.

Table 6.1.7 *Stationarity tests for IRMX. Time period 1988 – 2008*

Test	Variable	t-statistics	Stationary
ADF	IRMX	-2.7764	Yes
KPSS	IRMX	0.8689	No
Schimdt Phillips	IRMX	-1.7398	No

Source: Author's computations. 95% confidence level.

The null hypothesis of presence of unit root is rejected at a 95% confidence level, which means that the variable is stationary. The KPSS test in this occasion is giving different results; the null hypothesis of stationarity is rejected at a 95%, and the variable is non-stationary. Because of the ambiguity of results from these two tests, I ran the Schmidt Phillips test; the null hypothesis of presence of unit root cannot be rejected at a 95% confidence level since the critical value is -3.02. This third test gives me more evidence on the non-stationarity of the variable. This variable will be transformed to the first differences of the logarithm.

Lastly, I will perform the same test for the exchange rate MXN for USD depicted in the figure shown in Appendices. The results from the ADF and KPSS (shown in table 6.1.8) test showed the same results.

Table 6.1.8 *Stationarity tests for ERMX. Time period 1988 – 2008*

Test	Variable	t-statistics	Stationary
ADF	ERMX	1.7766	No
KPSS	ERMX	1.2186	No

Source: Author's computations. 95% confidence level.

The null hypothesis of presence of unit root cannot be rejected at a 95% confidence level, since the t-statistics is positive and the critical value is -1.94. According to this test the variable is non-stationary. The KPSS test provides stronger evidence on the non-stationarity of the variable; the null hypothesis of stationarity is rejected at a 95% confidence level. This test is confirming the results from the previous test. This variable will be transformed into the first differences of the logarithms.

After transforming all the variables to the first differences of the logarithms and running the VAR model with all the variables and 1 lag for the endogenous variables as suggested by the Hannan Quinn and Schwarz Criterion and performing the stability test (See table 6.1.9), the root for the characteristic polynomial is telling us that the VAR model satisfies the stability condition since no root lies outside the unit circle.

Table 6.1.9 *Roots of characteristic polynomial with transformed variables. Time period 1988 – 2008.*

Root	Modulus
0.888321	0.888321
0.678205 - 0.056447i	0.680550
0.678205 + 0.056447i	0.680550
0.451104 - 0.134423i	0.470706
0.451104 + 0.134423i	0.470706
0.201560 - 0.186343i	0.274500
0.201560 + 0.186343i	0.274500

Source: Author's computations. System estimated with 1 lag according to Schwarz and Hanna-Quinn Criterions. No root lies outside the unit circle and the VAR satisfies the stability condition.

Following all the previous work, finding the optimal number of lags and having the stability of the system, I can continue with the analysis of residuals. The autocorrelation of residuals needs to be tested. This can be tested with the Portmanteau test (table in Appendices) which null hypothesis states that there is no more autocorrelation on the residuals.

The null hypothesis is rejected at a 95% confidence level since the p-value is 0.0000, confirming the presence of autocorrelation of residuals. The LM-type test for autocorrelation confirms the results from the previous test, concluding that residuals from the model have the presence of autocorrelation.

The autocorrelation mentioned before is due to the trend and fluctuations from the Mexican interest rate variable because of the crisis suffered in 1995. Also some other variables present some trend changes trough out the series.

One of the procedures to get rid of this autocorrelation is increasing the lags. Akaike criteria suggest 10 lags, after increasing the lags and checking for the remaining autocorrelation, Portmanteau test (table in Appendices) says that there is still autocorrelation. The next step will be to add a dummy variable to the Mexican interest rate for the period of 1995. This variable presents a substantial increase on that year due to the crisis; the dummy variable will cancel this effect of increasing.

After running the corresponding test for autocorrelation (table in Appendices) to the model which already includes the dummy variable for the trend shift, we observe that we reject the null hypothesis of no remaining autocorrelation at a 95% confidence level, since the p-value for the test is 0.000.

The autocorrelation could not be solved with increasing of lags or with the dummy variables for the series that presented a trend shift so I would use one lag as suggested from the Hannan-Quinn and Schwarz information criteria.

6.2PERIOD BEFORE NAFTA 1988-1993

In January 1994 the NAFTA treatment was signed between Mexico, Canada and the U.S. In this part I will analyze the period before the NAFTA was signed.

To be able to compare this period before the NAFTA and the period after the NAFTA was signed, I will need to work with the variables transformed in the same way. Hannan-Quinn information criterion (table in Appendices) suggests 1 lag for the model with the variables transformed to the first differences of the logarithms. The stability test is telling that the VAR satisfies the stability condition with the variables without transformation because no root lies outside the unit circle as shown in the following table (table 6.2.1).

Table 6.2.1 *Roots of the characteristic polynomial with transformed variables. Before NAFTA.*

Root	Modulus
0.643297	0.643297
0.440586 - 0.203620i	0.485363
0.440586 + 0.203620i	0.485363
0.483274	0.483274
0.341997 - 0.046622i	0.345160
0.341997 + 0.046622i	0.345160
0.097059	0.097059

Source: Author's computations. System estimated with 1 lag according to Schwarz and Hanna-Quinn Criterions. No root lies outside the unit circle and the VAR satisfies the stability condition.

After performing the last test and proving evidence that the VAR model satisfies the stability condition. I need to check for the autocorrelation. For this I ran the Portmanteau test (table in Appendices). The null hypothesis tests that there is no remaining autocorrelation in the model. The p-value from the test is 0.7871 and I cannot reject the null hypothesis. This means that there is no leftover autocorrelation in the model.

6.3 PERIOD AFTER NAFTA 1994 – 2008

As I mentioned it before, for the comparison of the different time periods I will keep working with the variables transformed to the first differences of the logarithms. Hannan-

Quinn and Schwarz criterion (table in Appendices) suggest 1 lag for the period after the NAFTA with the transformed variables to the first differences of the logarithms.

The stability test confirms that the after NAFTA period VAR model satisfies the stability condition since no root lies outside the unit circle. (See table 6.3.1)

Table 6.3.1 *Roots of characteristic polynomial with transformed variables. After NAFTA.*

Root	Modulus
0.899504	0.899504
0.823216	0.823216
0.495315 - 0.213639i	0.539424
0.495315 + 0.213639i	0.539424
0.518871	0.518871
0.150883 - 0.161804i	0.221238
0.150883 + 0.161804i	0.221238

Source: Author's computations. System estimated with 1 lag according to Schwarz and Hanna-Quinn Criterions. No root lies outside the unit circle and the VAR satisfies the stability condition.

After contributing with the evidence that the stability of the model is satisfied, the residual analysis comes into place. The autocorrelation will be tested with the Portmanteau test (table Appendices). The null hypothesis of no remaining autocorrelation can be rejected at 95% confidence level, since the p-value for the test is 0.0011.

For correcting this I will increase the amount of lags to 10 as suggested with the Akaike info criterion. I ran the model and after that the Portmanteau test (table in Appendices) for testing remaining autocorrelation. The null hypothesis of no remaining autocorrelation can be rejected at a 95% confidence level since the p-value is 0.0003.

In 1995 Mexico suffered a crisis where the interest rate suffered an important increase. I added a dummy variable to cancel the effect of that period where the trend of the variable shifted and also dummies to other variables, which also presented an important trend shift during the series. Following this I ran the model with the dummy and performed the autocorrelation test (table in Appendices). The null hypothesis of no remaining autocorrelation can be rejected at a 95% confidence level since the p-value is 0.0078.

The autocorrelation of residuals was not solved with the dummy variable for any of the trend shifts of the original variables or with the increase of lags in the endogenous variables. For this reason I will use the model just with 1 lag as suggested by Hannan-Quinn and Schwarz information criteria.

7. Results

In this section of the thesis I will present the empirical results from the impulse responses and the variance decomposition of the Mexican macroeconomic variables to contractionary monetary policy shocks, which means that I will look after the increase in the interest rates.

7.1 IMPULSE RESPONSES

The impulse responses analysis is a tool that helps to investigate the influential behavior between the endogenous variables in a VAR (p) model. Specifically it addresses the magnitude and length of the influence that a variable will suffer attributable to a shock in another variable. In this analysis it is assumed that the deterministic and exogenous variables don't affect the endogenous ones. The conditional mean of the endogenous variables that is due to the exogenous variables is deleted. The formula for the impulse responses is as follows.

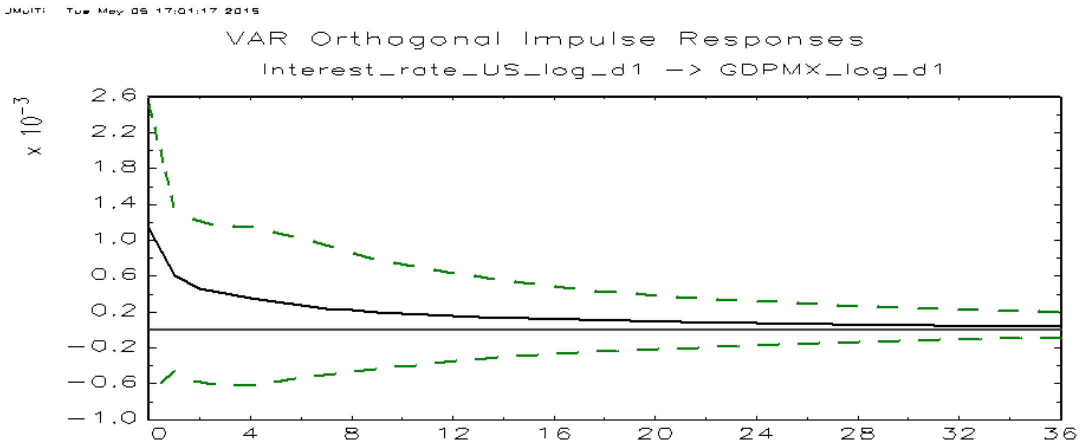
$$\Phi_s = \sum_{j=1}^{s} \Phi_{s-j} A_j, \quad s = 1,2,3 \ldots$$

The confidence intervals for the impulse responses will be bootstrapped using 250 replications; this bootstrapping technique is called Efron and Hall Bootstrap Percentile CI.

7.1.1 IMPULSE RESPONSES WHOLE TIME PERIOD 1988 – 2008.

I will start first by analyzing the full sample, which means, analyzing the magnitude and length of the influence that the Mexican GDP and CPI will suffer attributable to a shock on the US interest rate and Mexican interest rate.

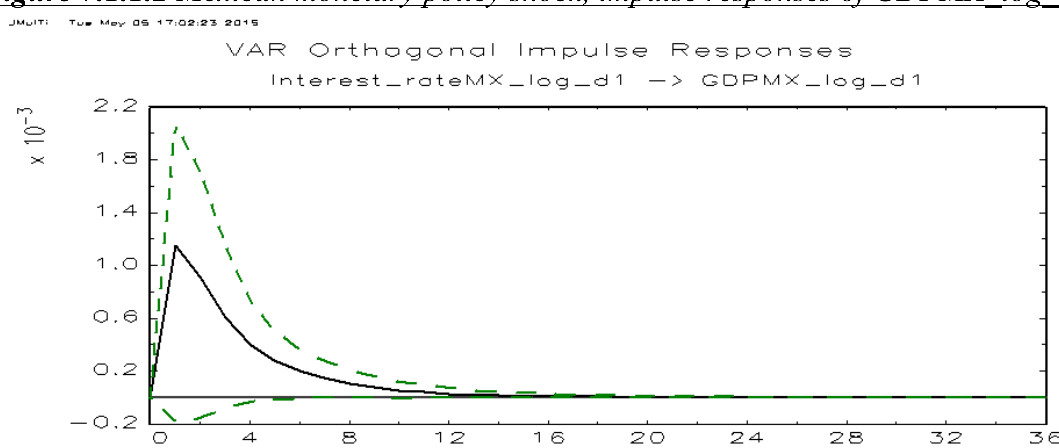
***Figure 7.1.1.1** U.S. monetary policy shock, impulse responses of GDPMX_log_d1*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

Depicted in figure 7.1.1.1 it is observable that a shock of one standard deviation (5.83%) on the U.S. monetary policy has an immediate response of 0.11% on the Mexican GDP. And it declines during the first month to 0.06%. After the 30th month the impulse disappears as it reaches the 0% on the graph. The impulse responses are not significant; this can be explained, as the sample is small, only with 252 observations.

***Figure 7.1.1.2** Mexican monetary policy shock, impulse responses of GDPMX_log_d1*

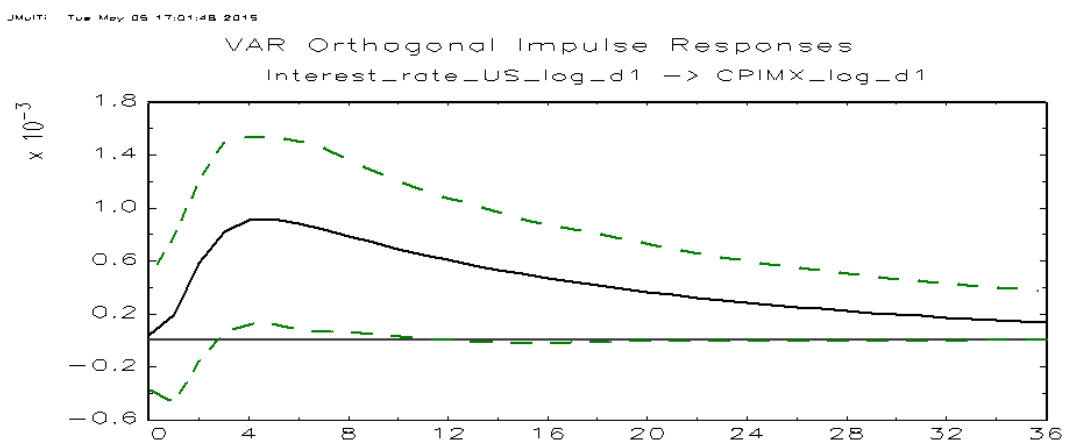


Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The impact of a shock of one standard deviation (11.27%) on the Mexican monetary policy causes an impulse of 0.12% on the Mexican GDP from the moment of the shock to 1 month after. This is the biggest magnitude of impact on the Mexican GDP caused by the Mexican interest rate shocks.

Through the period of our sample Mexican GDP has a more immediate response to its own monetary policy shocks. Also on the short-term the magnitude of the response is stronger than the one presented for the U.S., but the impulse response remains a longer period of time for the U.S. monetary policy shock, as it declines to zero after 30 months, whereas the response to the Mexican monetary policy disappears before one year has passed.

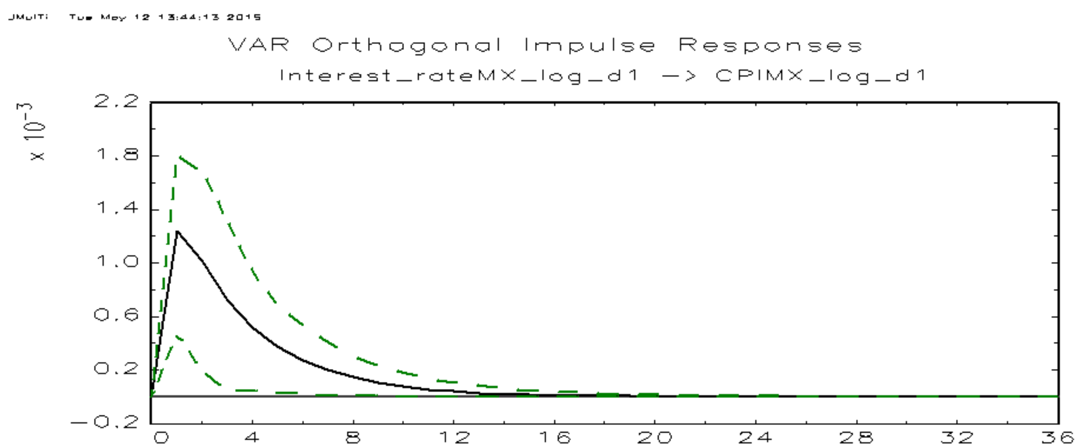
Figure 7.1.1.3 *U.S. monetary policy shock, impulse responses of CPIMX_log_d1*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

Depicted in figure 7.1.1.3 is the impulse response of the Mexican CPI due to a U.S. monetary policy shock of one standard deviation (5.83%). It is observable that the impulse is significant from the second to the ninth month; during this significant period is when the impulse reaches its maximum in the fourth month after the shock, influencing in a positive way the Mexican CPI by 0.09%. The impulse does not converge to zero during the first 36 month after the shock, which means U.S. monetary policy still influence the Mexican CPI in the long run. Canova (2005) found out that a shock on the U.S. monetary policy produces a significant increase in the interest rates of Latin American countries, followed by an increase in prices. The results shown in figure 10.0 go in line with these findings and demonstrate the increase in prices attributable to a U.S. monetary policy shock.

Figure 7.1.1.4 *Mexican monetary policy shock, impulse responses CPIMX_log_d1*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The impulse response of the first differences of the logarithms Mexican CPI attributable to a shock of one standard deviation (11.27%) on the Mexican monetary policy is significant for the first thirteen months after the shock. A shock on the Mexican monetary policy influences positively in the Mexican CPI, reaching its maximum point on the first month after the shock with a 0.12%. The impulse response disappears on the 12^{th} month after the shock as it converges to zero.

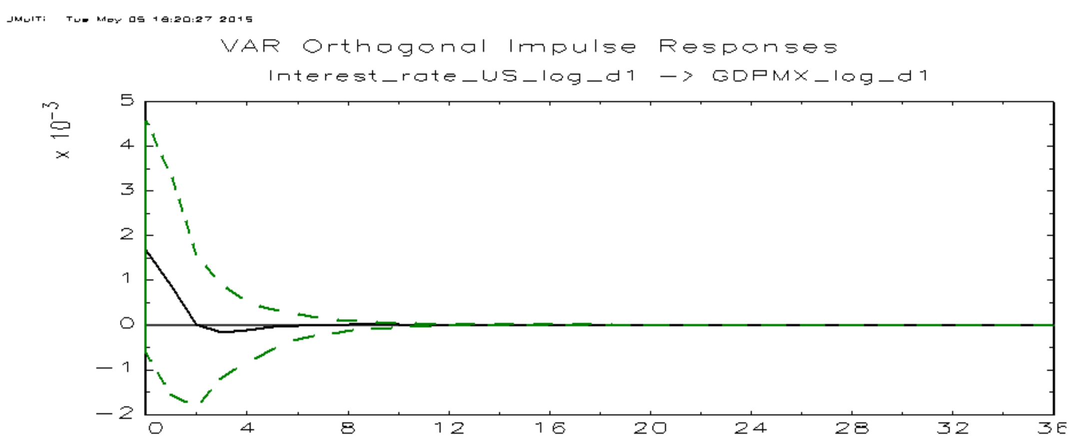
In the last two figures shown above it is observable that the Mexican monetary policy plays a bigger and more immediate role for the Mexican prices, nevertheless the U.S. monetary policy influence in Mexican prices remains for a longer period as the impulse does not converge to zero during the 36 months after the shock.

7.1.2 IMPULSE RESPONSES BEFORE NAFTA 1988 – 1993.

In the following section I will analyze the period before the NAFTA was signed and entered into force. This section will show the magnitude and length of the influence that the Mexican GDP and CPI will suffer attributable to the shocks on the U.S. interest rate and Mexican interest rate.

Due to the smaller amount of trade and financial links between Mexico and the United States before the NAFTA entered into force, the intuition says that Mexican monetary policy affected more Mexican macroeconomic variables than what the U.S. monetary policy could affect. It is important to mention that the results will be affected in this part of the thesis as a consequence on the availability of retrospective data and the restrictions made due to the small sample.

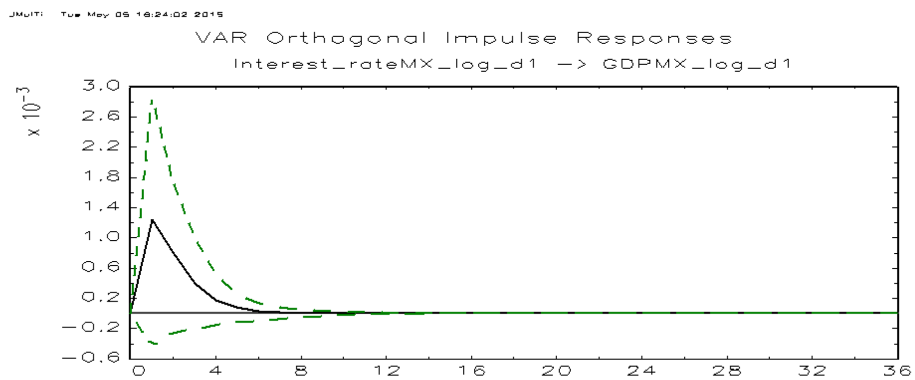
Figure 7.1.2.1 *U.S. monetary policy shock, impulse responses of GDPMX_log_d1 before NAFTA*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The figure 7.1.2.1 shows how the U.S. monetary policy influenced the Mexican GDP before the NAFTA period. The impact seems to be insignificant but this can be explained due to the size of the sample. There is an immediate response from the first differences of the logarithms of the Mexican GDP to a shock of one standard deviation (3.34%) in the U.S. monetary policy. However this effect disappears two months after the shock. For the third month it declines below zero and converges to zero again on the fifth month after the shock. The peak is immediately after the shock with 0.17% impact. From the moment of the shock to the first month, the first differences of the logarithms of the Mexican GDP declined 0.08%, reaching a point of 0.09%.

Figure 7.1.2.2 *Mexican monetary policy shock, impulse responses of GDPMX_log_d1 before NAFTA*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

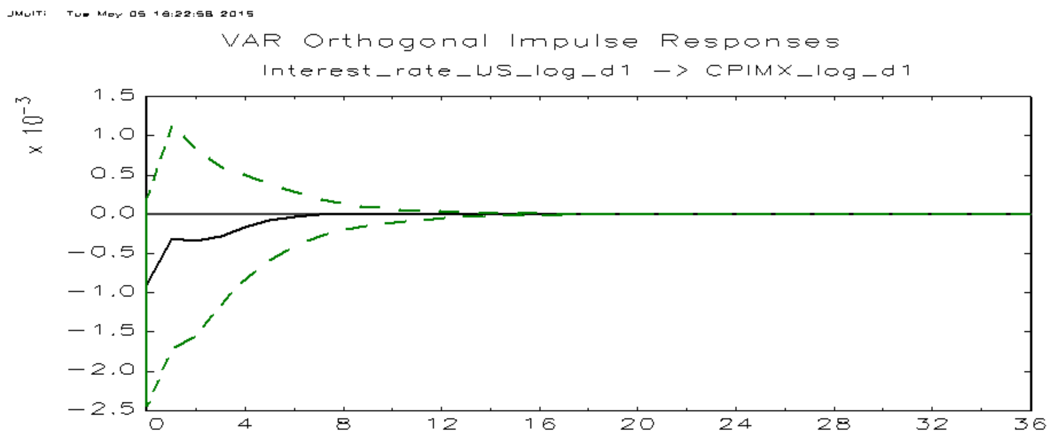
The impulse responses depicted in the figure 7.1.2.2 appeared to be insignificant due to the small sample where the first observation start in January 1988 and the last observation is in December 1993. The responses are attributable to a shock of one standard deviation of 8.54%

Before the NAFTA, the response of the first differences of the logarithms of the Mexican GDP reached it maximum point after the first month with 0.12%. After 6 months the reaction disappears definitely as it converges to zero in the graph.

Following the previous analysis I can determine that the response on the first differences of the logarithms of the Mexican GDP to shocks on the Mexican monetary policy appears to be stronger in the short run than the response to the shocks on the U.S. monetary policy, since the impulse response represented 0.12% after one month for the Mexican monetary policy and from 0.17% to 0.09%, 0.08% difference, for the U.S.

monetary policy in the same period. Additionally the length of the impact is longer for the Mexican monetary policy, converging to zero after 6 months; while for the U.S. monetary policy converges to zero on the second month after the shock and then on the fifth month.

Figure 7.1.2.3: *U.S. monetary policy shock, impulse responses CPIMX_log_d1 before NAFTA*

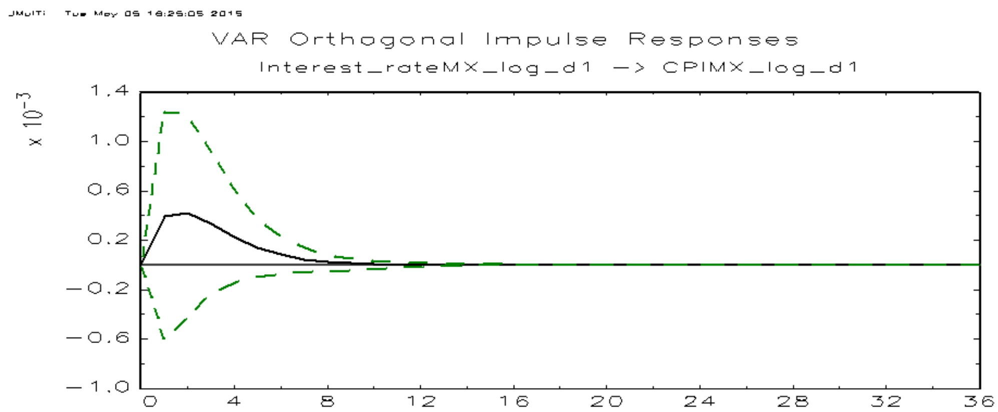


Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The U.S. monetary policy has an immediate influence on the first differences of the logarithms of the Mexican CPI as it is shown on the figure above. Promptly after the shock of one standard deviation of 3.34% in the foreign monetary policy, the first differences of the logarithms have a negative response of -0.09%, after the first month the first differences of the logarithms of the Mexican price levels increase to a level of -0.03%.

The impulse response disappears completely on the 6th month after the shock. All the impulse responses appeared to be insignificant, as mentioned before; this can be explained by the small size of the sample.

***Figure 7.1.2.4** Mexican monetary policy shock, impulse responses of CPIMX_log_d1 before NAFTA*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The figure above illustrates how the first differences of the logarithms of the Mexican price level respond to a shock of one standard deviation of 8.54% on the Mexican monetary policy. Shocks on the Mexican monetary policy have a positive influence on our Mexican macroeconomic variable. After the first month of the shock the impulse response reaches its peak at 0.04% and it maintains in that level for the next month. After the second month it starts to decline until it absolutely disappears on the 7th month after the shock.

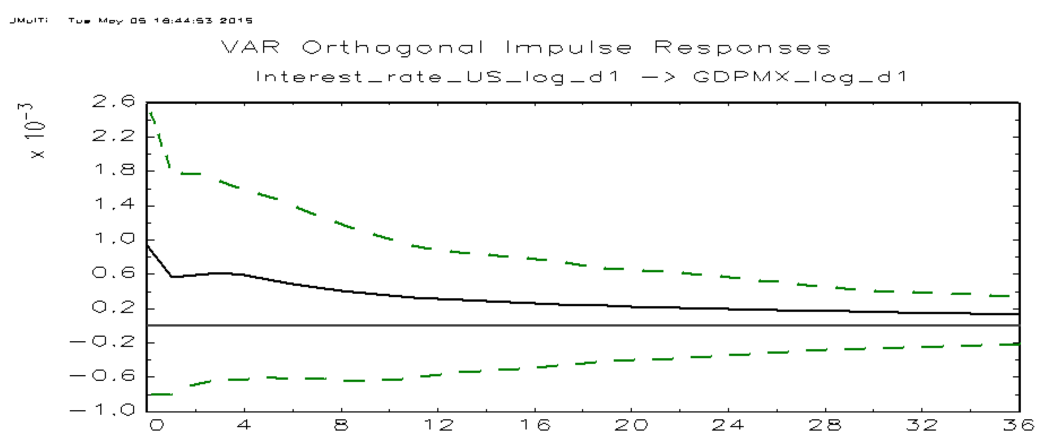
Oppositely from what I expected from the theory, in the case of the impulse responses of the first differences of the logarithms attributable to shocks on the Mexican and U.S. monetary policy, the responses appeared to be stronger for the shock on the U.S. rather than in Mexico before the NAFTA entered into force. However, as expected, the response lasted longer for the shock on the Mexican monetary policy demonstrating that before the linkages between Mexico and United States strengthened, Mexican monetary policy played a bigger role that the U.S. counterpart making Mexico less vulnerable to foreign shocks in the long run.

7.1.3 IMPULSE RESPONSES AFTER NAFTA 1994 – 2008.

In this section of the thesis I will analyze the period after the NAFTA treatment was signed and entered into force. The impulse responses will show the same as in the past sections, the magnitude and length of the impulse on the Mexican GDP and on the Mexican price level. Both macroeconomic variables are transformed to the first differences of the logarithms in order to achieve the stability of the VAR system.

According to the theory and due to the strength that the linkages between Mexico and the United States got after the NAFTA came into force, the expectations are that the U.S. monetary policy will play a bigger and more important role on the domestic macroeconomic variables than what it did in the period before the NAFTA was on board.

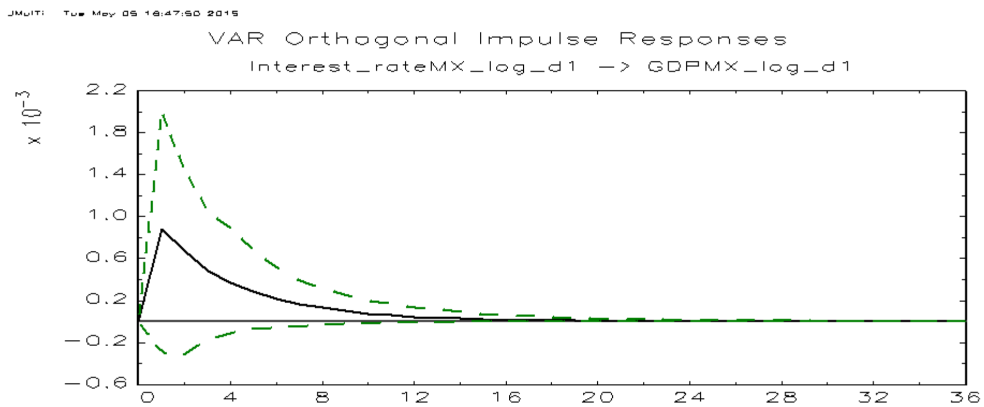
Figure 7.1.3.1 *U.S. monetary policy shock, impulse responses of GDPMX_log_d1after NAFTA*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

I will start by analyzing how the disturbances or shocks on the U.S. monetary policy affect the first differences of the logarithms of the Mexican GDP. The response appears to be insignificant throughout the period of time after the NAFTA. The response is positive and it occurs immediately after the shock of one standard deviation of 6.47% by a 0.09%. It declines immediately after one month and remains on the same level until the fourth month. The impulse does not converge to zero in the first 36 months after the shock.

Figure 7.1.3.2 *Mexican monetary policy shock, impulse responses of GDPMX_log_d1after NAFTA*

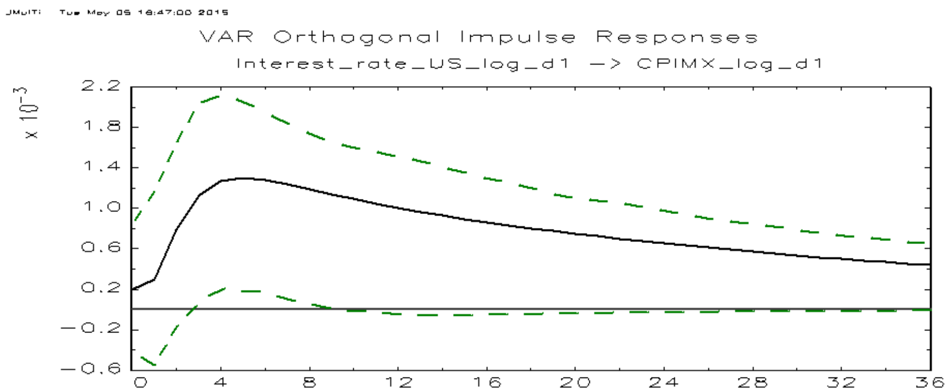


Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The responses of the first differences of the logarithms correspond to a shock of one standard deviation of 11.47% on the Mexican monetary policy. The Mexican variable responds positively and immediately to the shocks on its own monetary policy reaching its peak at 0.09%. After that the response starts to decrease and it disappears by the 12th month when it converges to zero.

As expected from the theory, after the NAFTA the response of the first differences of the logarithms of the Mexican GDP to a shock of the foreign monetary policy stays for a longer period of time than the response to a shock on the domestic monetary policy. This result can be briefly explained by the increase of commercial links and financial liberalization that Mexico has been facing on the last years and specially after the NAFTA started functioning.

Figure 7.1.3.3 *U.S. monetary policy shock, impulse responses of CPIMX_log_d1after NAFTA*

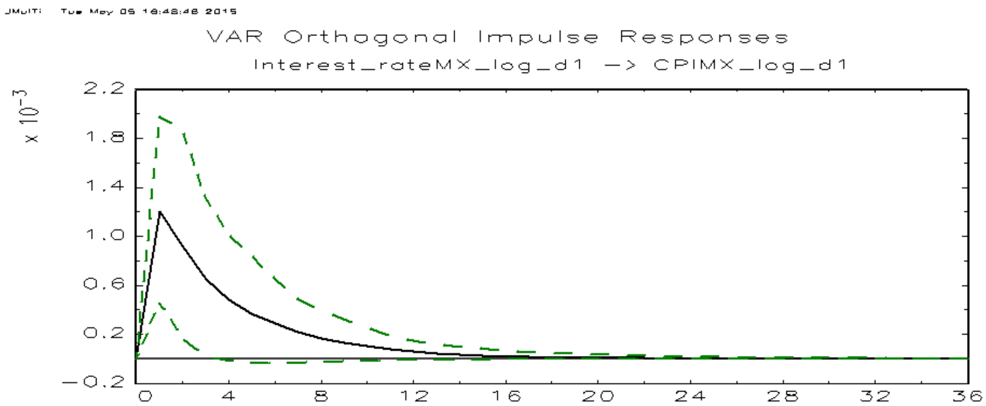


Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The figure shown above depicts the impulse response of the first differences of the logarithms of the Mexican price level to a shock of one standard deviation of 6.47% on the foreign monetary policy.

The response is positive and occurs immediately after the shock happened by 0.02%. It is only significant from the 3rd to the 7th month after the shock, where it reaches its maximum point of 0.13% on the 4th month. After the 6th month the impulse start to be weaker, nevertheless it does not converge to zero on the first thirty-six months after the shock took place.

Figure 7.1.3.4 *Mexican monetary policy shock, impulse responses of CPMX_log_d1 after NAFTA*



Note: Time period in months in the horizontal axis and one standard deviation shock in the vertical axis. 95% confidence intervals by Efron and Hall Bootstrap Percentile

The figure above represents the impulse responses of the first difference of the logarithms of the Mexican price level to a shock of one standard deviation of 11.47% on the domestic monetary policy.

The positive impulse response is significant for the first two months after the disturbance occurred on the Mexican monetary policy. The impulse appeared to be strong and immediate, reaching its maximum point after one month after the shock by 0.12%. After it reaches its peak, it starts to decline until it converges to zero on the 13th month after the shock.

Concluding the analysis of the responses of the Mexican price level to a shock of both monetary policies, my results are as expected. One shock of the U.S. monetary policy influences more strongly than a shock to the domestic monetary policy. Additionally after the NAFTA was signed the response to the U.S. shock remains longer in the Mexican variable as it does not disappear on the first thirty-six months after the shock.

7.2 VARIANCE DECOMPOSITION.

In this section of the thesis I will assess the importance that the external shocks have on the Mexican GDP and price level via Forecast Error Variance Decomposition (FEVD). This is a useful technique used in the Vector Autoregressive models to investigate the part of the variance of Mexican GDP and CPI that it is attributable to shocks on the foreign and domestic monetary policy.

This technique represents the i^{th}, j^{th} element of the orthogonal impulse responses coefficient matrix Ψ_n by $\psi_{ij,n}$. The variance of the forecast error is represented in the following formula:

$$\sigma_k^2(h) = \sum_{n=0}^{h-1} (\psi_{k1,n}^2 + \cdots + \psi_{kK,n}^2) = \sum_{j=1}^{K} (\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2)$$

In the previous formula, the term $\left(\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2\right)$ represents how much the variable "j" contributes to the h-step forecast error variance of variable "k". If I divide the formula above by $\sigma_k^2(h)$ I will get the contribution of the variable "j" to the h-step forecast error variance of variable "k" in percentage terms. Represented in a formula it looks as the following:

$$\omega_{kj}(h) = (\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2)/\sigma_k^2(h)$$

7.2.1 VARIANCE DECOMPOSITION WHOLE TIME PERIOD 1988 – 2008.

I will first start by analyzing the variance decomposition during the complete series of the sample in order to investigate how much does external shocks, domestic shocks, Mexican monetary policy and foreign monetary policy account in the Mexican GDP and price level.

Table 7.2.1.1 GDPMX_log_d1 – Domestic and external shocks, variance decomposition, complete period.

Horizon	External shock	U.S. I.R. policy shock	Domestic shock	Mex. I.R. policy shock	Exchange rate shock
6	0.08	0.01	0.92	0.02	0.03
12	0.09	0.02	0.91	0.02	0.03
18	0.09	0.02	0.91	0.02	0.03
24	0.09	0.02	0.91	0.02	0.03
30	0.09	0.02	0.91	0.02	0.03
36	0.09	0.02	0.91	0.02	0.03

Source: Author's computations. Horizon is in months and the external shock plus the domestic shock equal one.

From this table is it visible that the majority of the variance of the first difference of the logarithms of the GDPMX is due to the domestic shocks as it accounts for 92% during the first 6 months, then decreases to 91% and remains like that until the end of the 36 month from the analysis. The other 9% is due to external shocks in the long run.

The variance of the first difference of the logarithms of the GDPMX due to the monetary policy of both countries is small; this means that the U.S. and the Mexican monetary policy don't affect strongly the GDPMX. These results go in line with Sebastian Sosa (2008) who found out that the role-play of U.S. real interest rate in explaining GDPMX fluctuations is small. Additionally, the influence is in the same proportion in the long run, as both accounts for 2%. The 3% of the variance of the first differences of the logarithms of the GDPMX is due to the exchange rate, this might be because of the direct relation both variables can have. An increase or decrease on the exchange rate will affect directly your imports or exports and this will have a repercussion on the GDP of the country.

Table 7.2.1.2 CPI_log_d1 – Domestic and external shocks, variance decomposition, complete period.

Horizon	External shocks	U.S. I.R. policy shock	Domestic shocks	Mex. I.R. policy shock	Exchange rate shock
6	0.05	0.03	0.95	0.04	0.08
12	0.09	0.07	0.91	0.04	0.08

18	0.11	0.09	0.89	0.04	0.08
24	0.12	0.10	0.88	0.04	0.08
30	0.13	0.10	0.87	0.04	0.08
36	0.13	0.10	0.87	0.04	0.08

Source: Author's computation. Horizon is in months and the external shocks plus the domestic shocks equal one.

Through the horizon of time, the strength of the U.S. affecting Mexico's price level is bigger as time goes by. It starts with the 5% of the variance is due to external shocks, in this case the U.S. and the 95% of the variance is due to domestic shocks. In the 36th month we can see that Mexico is responsible for the 87% of the variance of its price level and the 13% left corresponds to the U.S. However the foreign monetary policy plays a stronger role on the variance of the Mexican price level; after 18 months a shock in the U.S. interest rates influences more than two times compared with the influence caused by a shock on the domestic or Mexican monetary policy. These results go in line with Mackowiak (2007) who found out that the U.S. shocks influence in an important amount the fluctuations on the emerging markets macroeconomic variables.

7.2.2 VARIANCE DECOMPOSITION BEFORE NAFTA 1988 – 1993.

Following, in this section I will analyze the period before the NAFTA agreement entered into force. This period comprises from 1988 to 1993 in my database.

Table 7.2.2.1 GDP_log_d1 – Domestic and external shocks, variance decomposition, before NAFTA.

Horizon	External Shocks	U.S. I.R. policy shock	Domestic Shocks	Mex. I.R. policy shock	Exchange rate shock
6	0.09	0.03	0.91	0.02	0.00
12	0.09	0.03	0.91	0.02	0.00
18	0.09	0.03	0.91	0.02	0.00
24	0.09	0.03	0.91	0.02	0.00
30	0.09	0.03	0.91	0.02	0.00
36	0.09	0.03	0.91	0.02	0.00

Source: Author's computations. Horizon is in months and the external shocks plus the domestic shocks equal to one.

The variance of the Mexican GDP before the NAFTA agreement came into effect, was strongly due to the domestic shocks, accounting to 91%, whereas the external shocks accounted just for the 9% of the variance. Mexico can be considered as an industrial country and therefore the monetary policy doesn't influence in a big proportion the Mexican GDP, in this same line Parrado (2001) discussed about Chilean characteristics as an industrial country and that the monetary policy explains a small part of Chilean GDP fluctuations.

The U.S. monetary policy had a bigger influence on variance of the first differences of the logarithms of the Mexican GDP than the influence caused by the shocks to the domestic monetary policy. Before the NAFTA agreement the exchange rate had no role on explaining the variance of the Mexican GDP during the first 36 months.

Table 7.2.2.2 CPIMX_log_d1- Domestic and external shocks, variance decomposition, before NAFTA.

Horizon	External shocks	U.S. I.R. policy shock	Domestic shocks	Mex. I.R. policy shock	Exchange rate shock
6	0.06	0.03	0.94	0.01	0.06
12	0.06	0.03	0.94	0.01	0.06
18	0.06	0.03	0.94	0.01	0.06
24	0.06	0.03	0.94	0.01	0.06
30	0.06	0.03	0.94	0.01	0.06
36	0.06	0.03	0.94	0.01	0.06

Source: Author's computations. Horizon is in months and the external shocks plus the domestic shocks equal to one.

The domestic shocks explain a bigger part of the fluctuation of the CPIMX before the NAFTA agreement, as they account for the 94% and the external shocks explain only 6% of the fluctuations. U.S. monetary policy affects in a bigger proportion. A bigger proportion of the variance of the Mexican price level is explained by the shocks of the foreign monetary policy rather than what the domestic monetary policy explains; these results are in line with the results from the impulse responses where I found out that the response to the U.S. monetary policy was stronger than the Mexican counterpart in the short run. The shocks on the exchange rate explain a bigger part of the fluctuations than what the monetary policies of both economies do. It is clear that the exchange rate has a substantially bigger impact on the Mexican price level before the NAFTA period than the impact caused by the monetary policy of both countries. This reason can be explained because of the direct and close relation that the exchange rate and the price level have considering the purchasing power parity, which explains the fluctuations in the exchange rate between two countries' currencies by variations in the countries' price levels.

7.2.3 VARIANCE DECOMPOSITION AFTER NAFTA 1994 – 2008.

Table 7.2.3.1 GDPMX_log_d1 – Domestic and external shocks, variance decomposition, after NAFTA

Horizon	External shocks	U.S. I.R. policy shock	Domestic shocks	Mex. I.R. policy shock	Exchange rate shock
6	0.11	0.02	0.89	0.01	0.03
12	0.12	0.02	0.88	0.01	0.03
18	0.12	0.02	0.88	0.01	0.03
24	0.12	0.02	0.88	0.01	0.03
30	0.13	0.03	0.87	0.01	0.03
36	0.13	0.03	0.87	0.01	0.03

Source: Author's computations. Horizon is in months and the external shocks plus the domestic shocks equal to one.

After the NAFTA the domestic shocks still explain most of the fluctuation of the Mexican Gross Domestic Product as they account for 87% after 36 months and the external shocks account for 13%. Interest rate is still responsible for a small part of the variation of the GDPMX although that the process of openness and financial liberalization had already started after the NAFTA. The Mexican interest rate policy shock explain less the fluctuation of the Mexican GDP in comparison with the period before the NAFTA and this is because with the signature of this trade agreement Mexico become more vulnerable to external shocks and the Mexican policy lost strength on affecting its own economy as it did before. Additionally it is observable that now the exchange rate plays a bigger role than what it did in the period before the trade agreement.

I have discussed before that the Mexican monetary policy doesn't influence in a big proportion the Mexican GDP because it is considered as an industrial country and this idea was strengthened with Parrado (2001) who made the same analysis for Chile; however on the other hand the GDPUS shocks explain 6% of the Mexican GDP fluctuations after the NAFTA compared with the 1% before it. This is in line with Sosa (2008) who found out that the fluctuations of the Mexican output due to U.S. shocks has increased since the inception of the trade agreements, as the total trade between the two countries increased from US$ 90 billion to US$ 365 billion from 1993 to the year 2007.

Table 7.2.3.2 CPIMX_log_d1 – Domestic and external shocks, variance decomposition, after NAFTA.

Horizon	External shocks	U.S. I.R. policy shock	Domestic shocks	Mex. I.R. policy shock	Exchange rate shock
6	0.08	0.06	0.92	0.03	0.09
12	0.14	0.12	0.86	0.03	0.08
18	0.20	0.16	0.80	0.03	0.08
24	0.22	0.18	0.78	0.03	0.08
30	0.24	0.19	0.76	0.03	0.07
36	0.25	0.20	0.75	0.03	0.07

Source: Author’s computations. Horizon is in months and the external shocks plus the domestic shocks equal to one.

Domestic shocks still explain in a bigger proportion the Mexican price levels after the NAFTA; nevertheless, it loses strength as time goes by. During the first six months, the domestic shocks are explaining 92% of the variation of the first differences of the logarithms of the Mexican price level, by the end of the 36th month, it just accounts for the 75%. External shocks gain strength, from 8% in the sixth month to 25% in the 36th month. From that percentage of explanation that the external shocks have towards the fluctuations of the Mexican macroeconomic variable, the majority part is explained by the U.S. monetary policy; as it explains the 20% out of 25% of the variation in the last month of the analysis.

Additionally, the influence of the U.S. monetary policy shock on the Mexican price level accounts for almost 7 times more than the influence from the Mexican monetary policy shock after the NAFTA on the 36th month of the analysis. Before 1994 the U.S. monetary policy was responsible for the 3% of the variation of the Mexican price levels, and after the 1994 this influence grew up to 20% on its highest level. These results are supported with the argument Kose, Meredith and Towe (2004) discussed in their research, where they stated that due to the low inflation and the increase on the policy credibility in Mexico, the exchange rate had an important role and permitted the external shocks to have a greater influence on Mexican prices.

These results are in line with my expectations that the foreign monetary policy will affect more the Mexican price level after the NAFTA compared with how much its counterpart affects it in the same period and with how much it affected before the NAFTA. This can be due to the financial liberalization and integration that Mexico has had with other global economies since the NAFTA agreement was signed, leading Mexico to a more open economy and hence more vulnerable to external shocks and influence; as Sosa (2008) mentions it in his investigation.

8. Conclusions

This thesis pointed out how the Mexican and the U.S. economies' links become stronger after the NAFTA agreement was signed in 1994 and how since then Mexico started to face a financial liberalization towards all the global economies and a more trade openness.

Many researchers have extensively discussed the tightening of the links between these two countries as a consequence of the increase in trade after the NAFTA was signed. Most of the questions answered in all these previous literature are related with how the Mexican business cycle has been synchronized with the U.S. business cycle. They analyze how the output in the U.S. affects the Mexican output, for this they use the industrial production or the output gap as proxies for economic activity. Some other researchers focus on how the U.S. monetary policy affects the Mexican output gap or economic activity.

The contribution of my work to all the previous literature is a different point of view and perspective since the investigation includes a combination of how the U.S. monetary policy and the Mexican counterpart affect the Mexican economic activity before and after the NAFTA through its different transmission channels, mainly focusing on the Mexican real output and the price levels in Mexico. This is going to give the reader a deeper understanding on the level of dependency of Mexico from the United States' economy.

In this work, a VAR model is estimated to identify how the monetary policies of both countries affect the Mexican output and price level. The equation in this model is including U.S. and Mexican variables. The block restriction is implemented in the model, assuming that the small open economy, in this case Mexico, cannot affect the U.S. economy.

The empirical method of this thesis and the interpretation of the results driven from the impulse responses and variance decomposition, in my humble opinion, lead to the following findings:

- Domestic shocks, in general, explain a bigger part of Mexico's macroeconomic variables fluctuation before and after the NAFTA, nevertheless external shocks gained strength after the NAFTA was signed and Mexico opened more its economy.
- U.S. and Mexican monetary policy don't play an important role in explaining the GDPMX fluctuations.
- The U.S. monetary policy plays an important role in explaining the Mexican price level fluctuation, as it explains the 10% of its variation throughout the complete period of the analysis.
- After the NAFTA, the U.S. monetary policy influence on the Mexican price level increased significantly, as it explains 20% of its variation, compared with the 3% before the NAFTA.
- The GDPMX and CPIMX response to Mexican monetary policy shocks lasted longer before the NAFTA than what the response to the U.S. monetary policy shocks lasted.
- The GDPMX and CPIMX response to U.S. monetary policy shocks lasted longer after the NAFTA than what the response to the Mexican monetary policy shocks lasted.
- The exchange rate influence on the Mexican price level after the NAFTA is bigger than the influence from the monetary policy.

As a consequence of all the previous results, I would say, in my humble opinion, that the NAFTA has made Mexico more vulnerable and sensitive to the external shocks. Additionally it was pictured in the results from the impulse responses that both monetary policies have an impact on Mexico's economy, the Mexican one having a stronger influence in the short run and the U.S. counterpart in the long run.

Additionally, apart from more sensitive and vulnerable, I also think that NAFTA has helped Mexico to grow in a faster pace since its inception. This growth has happened as a consequence of the increase of the trade links and the increase of foreign direct inflows.

All these variables need to be taken into consideration by the Mexican Central Bank at the moment of decision making towards the path that the monetary policy will follow in order to be able to lead the country to a stable economy. "When the U.S. catches a cold, emerging markets (Mexico), catch a cold" (Mackowiak, 2007).

8.1 FURTHER RESEARCH

This thesis is mainly focused on how the Mexican and the U.S. monetary policies affect and impact the Mexican real output and the Mexican price level. The signature of the NAFTA agreement strengthen the trade and financial links between Mexico and the U.S. and therefore it was taken into consideration as a breaking point for analyzing the period before it and after it.

The thesis can be extended in different paths. First of all, due to the lack of time period of information for the Interbank Equilibrium Interest Rate (TIIE) for Mexico, which was first calculated in 1997, I had to choose the CETES28 and the T-Bills28 interest rates for performing the analysis. CETES, as it was mentioned before, is a negotiable instrument issued by the Federal Government and the behavior across the years has been quite similar. Nevertheless, a sensitivity analysis using the TIIE and just for the period after the NAFTA would be interesting in order to see how this two different interest rates affect the domestic economy.

Moreover, I discussed that the financial crisis of 2008 was out of the scope of my thesis. A research including the financial crisis and answering the question on how big the influence of the U.S. monetary policy shocks on Mexico's economy slowdown was, and how differently this influence from the crisis is from the period without crisis.

More sensitivity analysis can be added by changing the output for industrial production as Sosa (2008) made it for the purpose of his analysis. The output gap can be considered another measure of the economic activity of any country. Horvath (2008) used this variable as the main one to measure economic activity in his research, and added industrial production and GDP as a sensitivity analysis. The output gap: is the difference between the seasonally adjusted GDP and the potential GDP. This is achieved estimating the Hodrick-Prescott filter with a smoothing parameter of 1600 and afterwards interpolating the data by using a quadratic match procedure in order to convert the quarterly data into monthly data. Analyzing how the fluctuations of the U.S. interest rate makes the seasonally adjusted GDP of Mexico move away from its potential, could be an interesting starting point for the monetary policy makers at the time of decision making.

A different path that can be taken into consideration for extending this research implies the members of this trade agreement. Three countries are inside and complying with all the rules and benefits from the NAFTA agreement: Mexico, United States and Canada. According to the Canadian Government, the Mexico – Canada relationship also became stronger after 1994; Canada's Direct Investment in Mexico as of 2014 accounts for $13,046 millions of dollars. Adding Canada to the equations in the model will show more robust research and results. An interesting approach will be to investigate how much Canada's monetary policy affects Mexican macroeconomic variables. As the U.S. is the biggest trade partner for Mexico according to Sosa (2008) I will expect a bigger influence from them, nevertheless Canada is also an important partner so I would also expect them to play an important role on the behavior of the Mexican economy.

On the other hand, as it was shown in the results from the empirical exercise of this thesis, the GDP is poorly influenced by the monetary policy, it was also mentioned that this can be due to the fact that Mexico can be considered as a industrial country and in this case other variables will be the ones that influence the GDP with a stronger impact. In this line I would suggest to extend my work by adding the oil prices to the equations of the model. According to the Central Intelligence Agency (CIA) Mexico ranks in the 8th place as a producer of crude oil with 2.8 million barrels per day and ranks in the 12th place as an exporter of crude oil with 1.3 million barrels per day and the oil rents represented in average 4.7% of the GDP during the time period analyzed. The expectation here will be to have a positive relationship between the oil prices and the Mexican GDP, meaning that an increase in oil prices should be reflected as a increase in the GDP, as long as Mexico keeps investing in technology for oil production and reaching efficiency in the industry, which will mean that it will stay competitive for the international markets.

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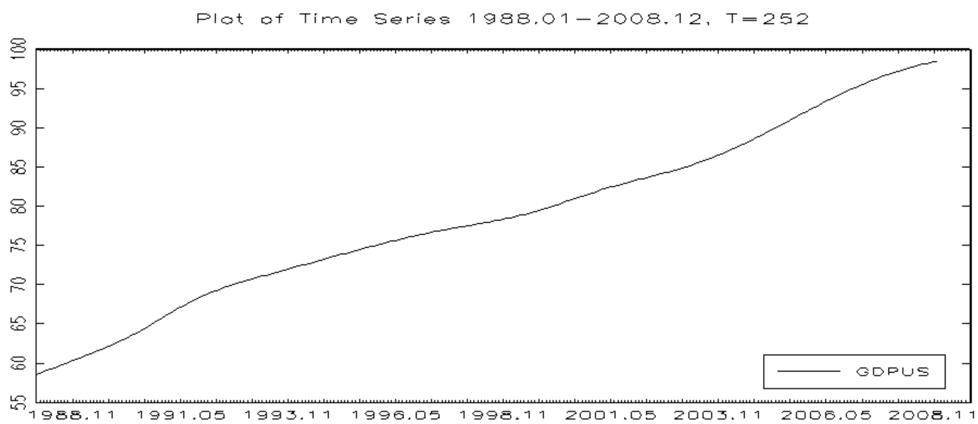
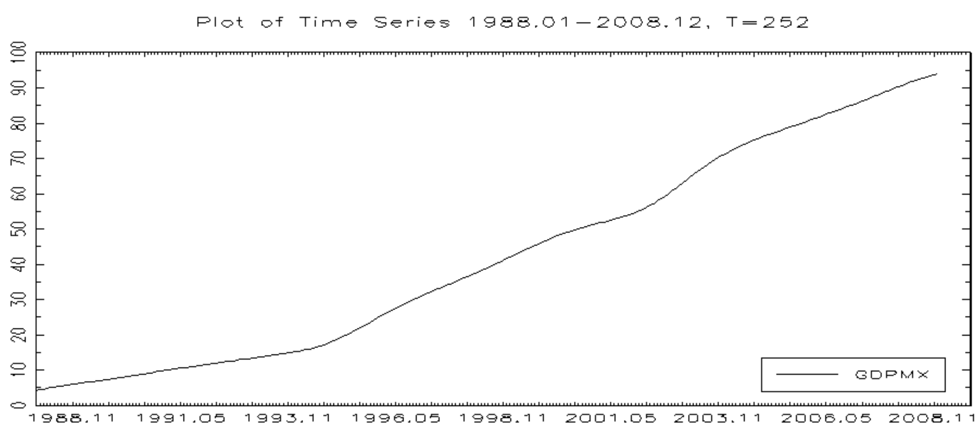
Appendix A: Graphs of the variables of my data without transformation.

Graph A.1 GDPUS for the time period 1988 - 2008



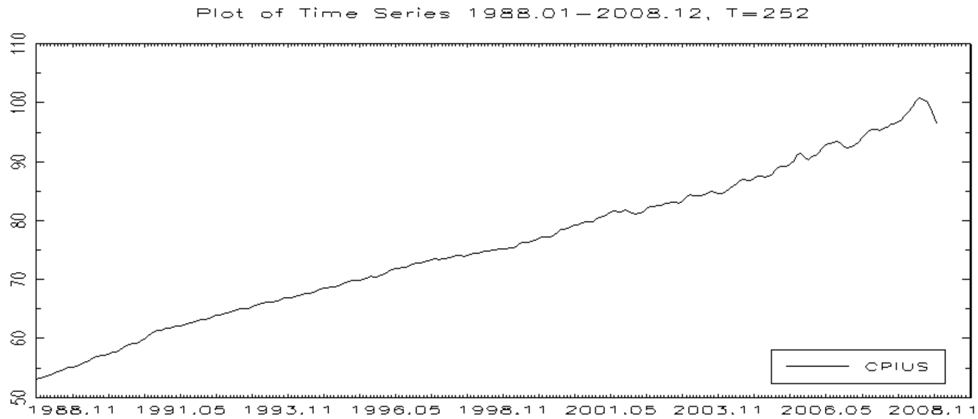
Source: JMulTi Software.

Graph A.2 GDPMX for the time period 1988 - 2008



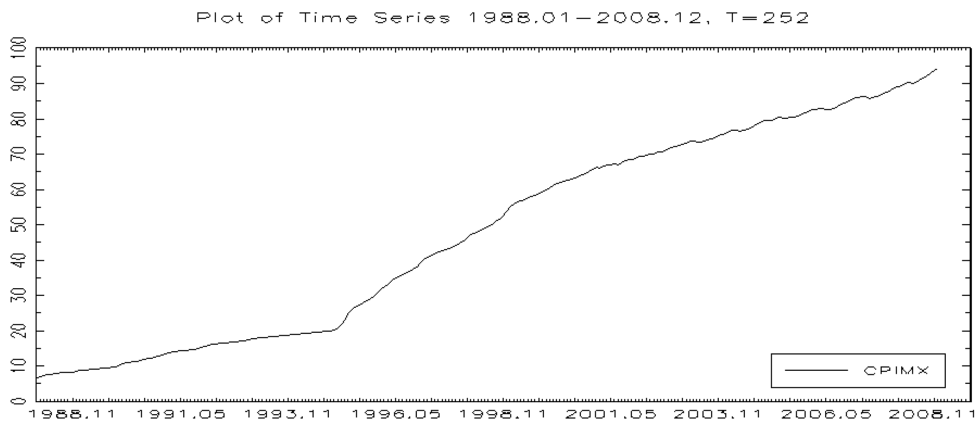
Source: JMulTi Software.

Graph A.3 CPIUS for the time period 1988 - 2008



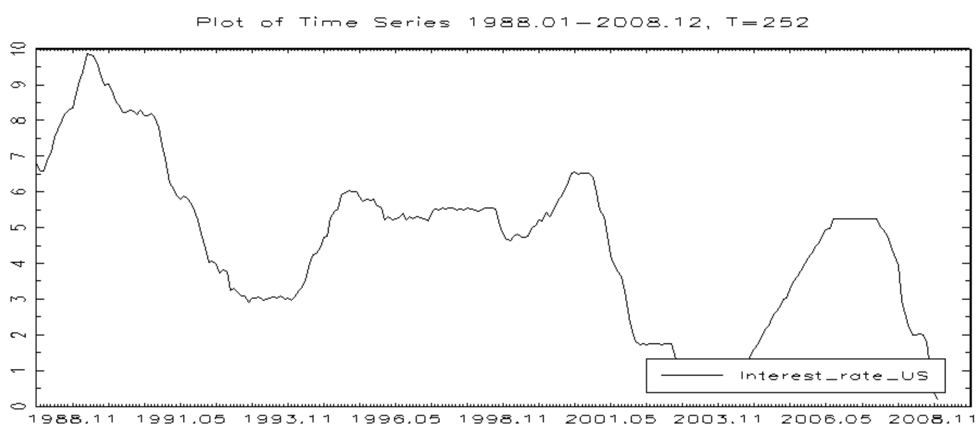
Source: JMulTi Software.

Graph A.4 CPIMX for the time period 1988 - 2008



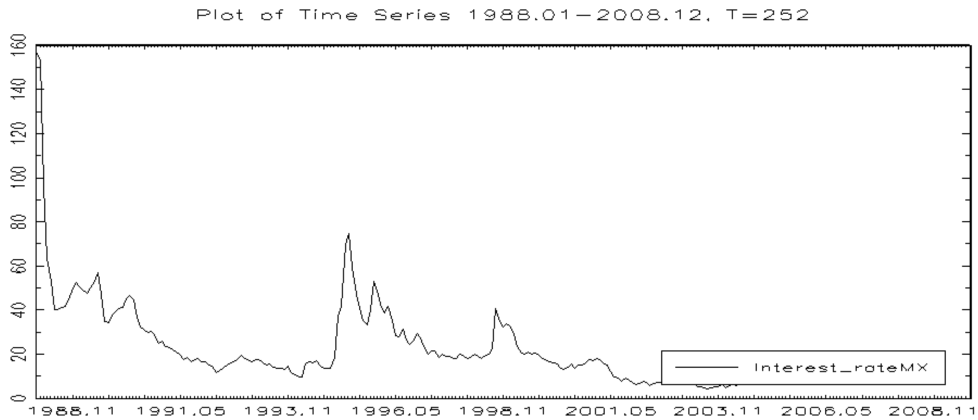
Source: JMulTi Software.

Graph A.5 Interest rate US for the time period 1988 - 2008



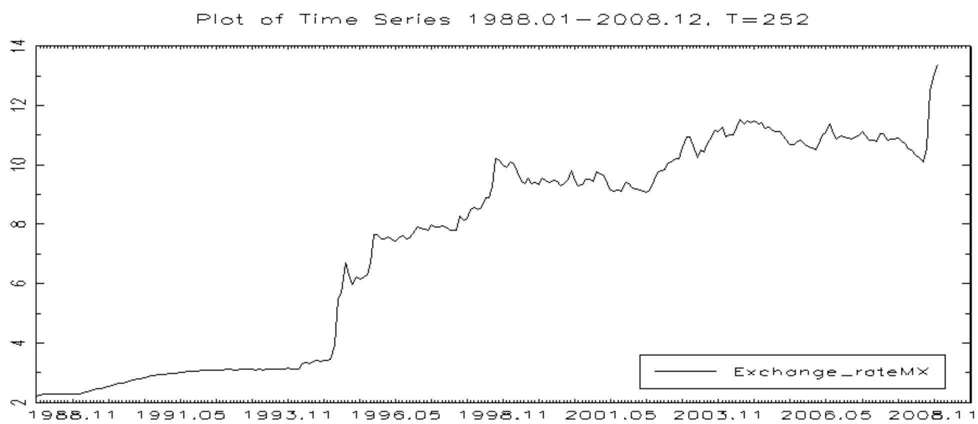
Source: JMulTi Software

Graph A.6 Interest rate MX for the time period 1988 - 2008



Source: JMulTi Software

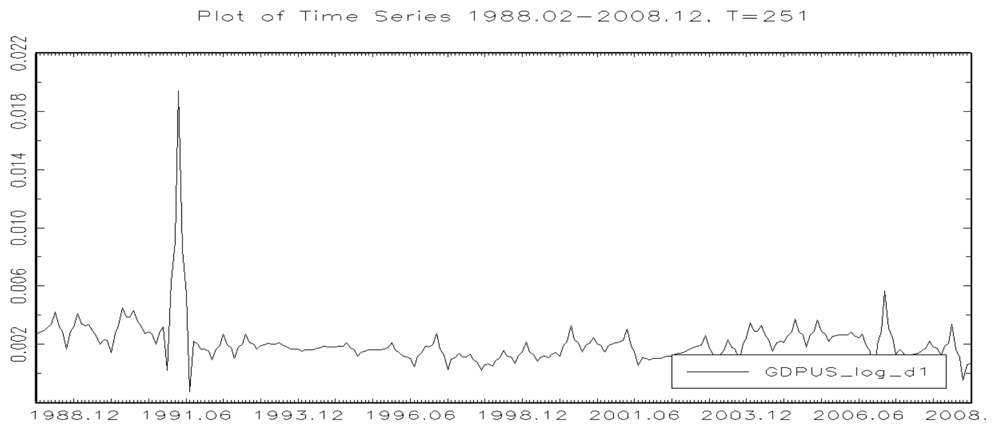
Graph A.7 Exchange rate MXN/USD for the time period 1988 - 2008



Source: JMulTi Software

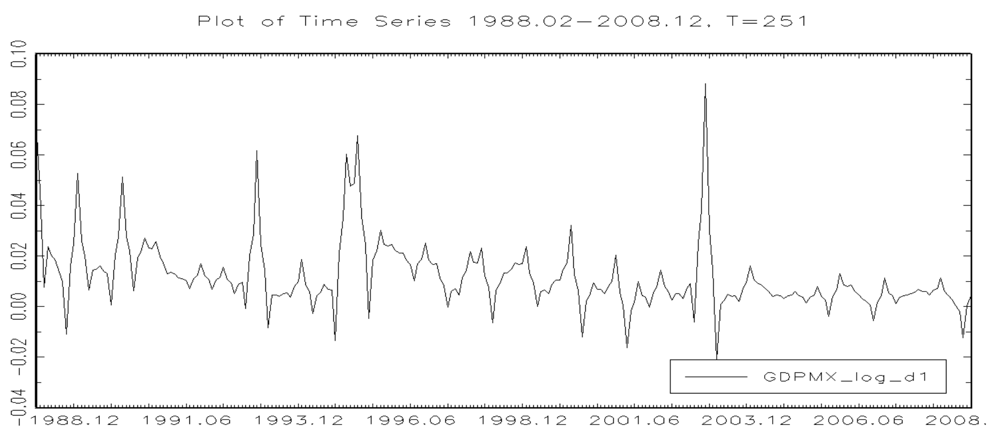
Appendix B: Graphs of the variables of my data with the transformation to the first differences of the logarithms

Graph B.1 First differences of the logarithms for the GDPUS for the time period 1988 – 2008.



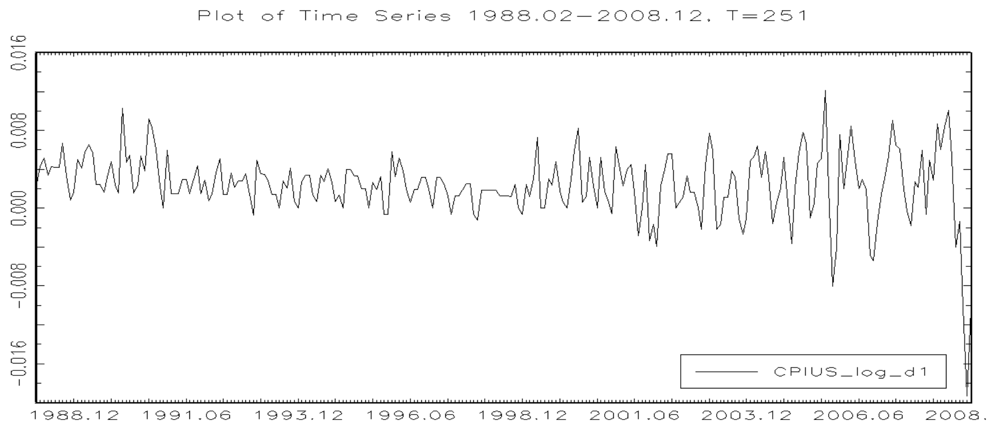
Source: JMulTi Software

Graph B.2 First differences of the logarithms for the GDPMX for the time period 1988 – 2008.



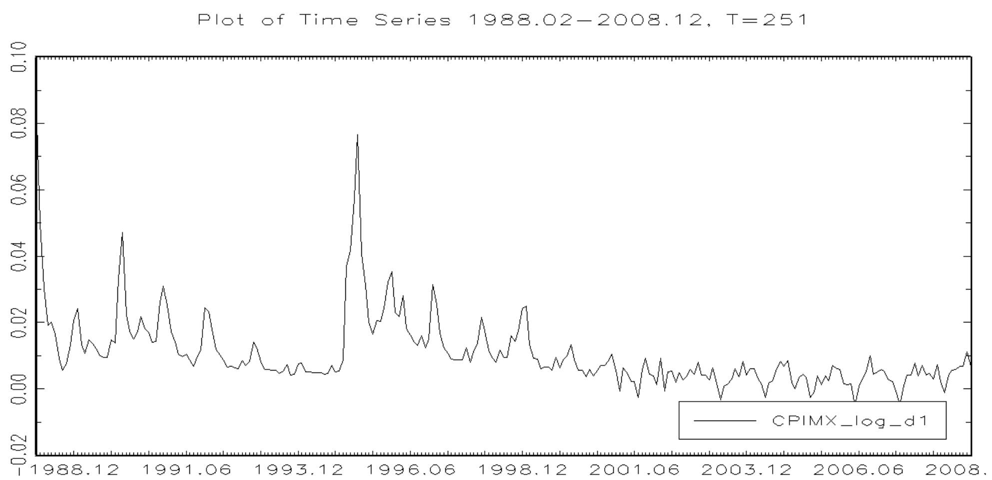
Source: JMulTi Software

Graph B.3 First differences of the logarithms for the CPIUS for the time period 1988 – 2008.



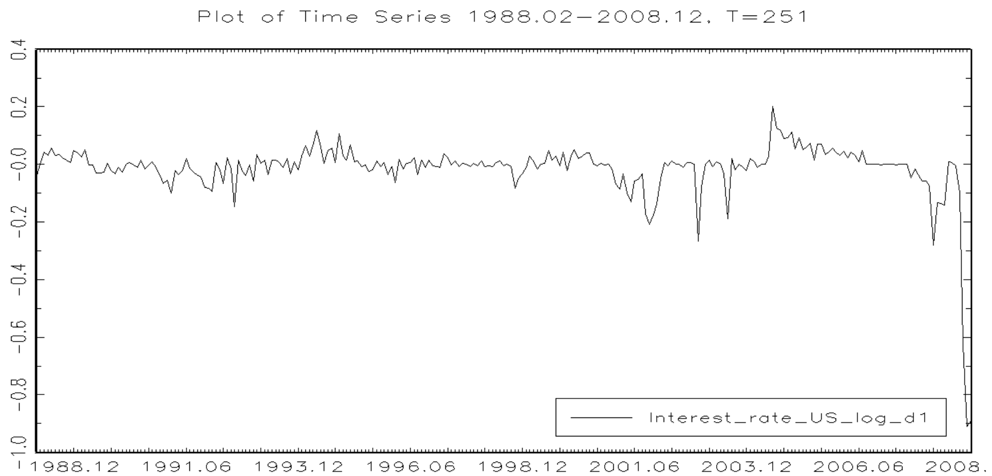
Source: JMulTi Software

Graph B.4 First differences of the logarithms for the CPIMX for the time period 1988 – 2008.



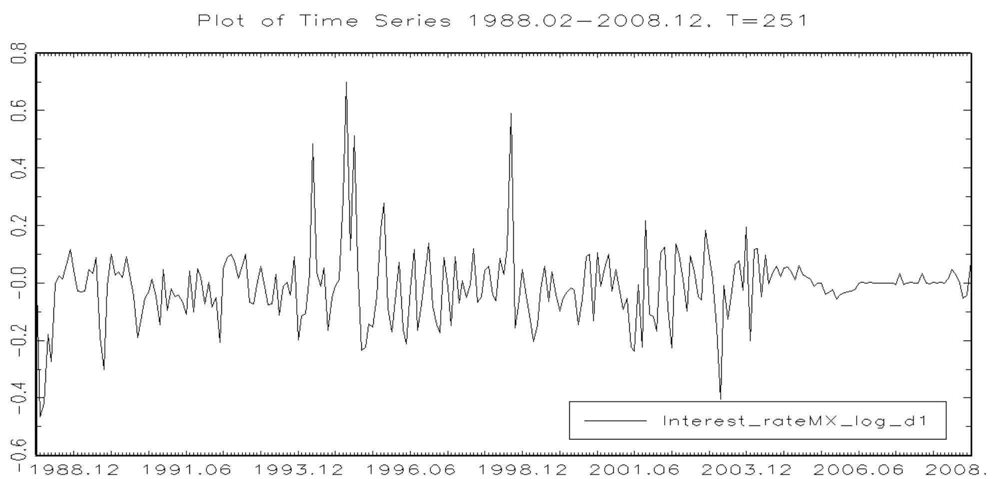
Source: JMulTi Software

Graph B.5 First differences of the logarithms for the interest rate US for the time period 1988 – 2008.



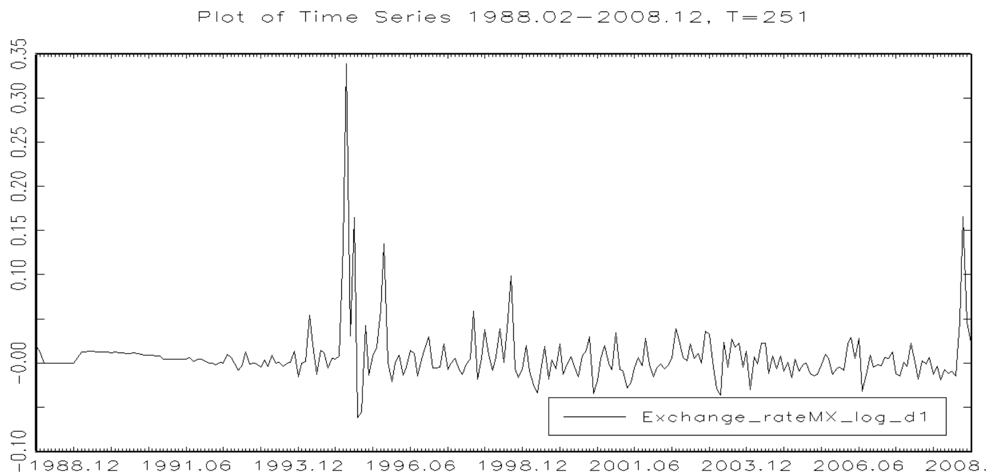
Source: JMulTi Software

Graph B.6 First differences of the logarithms for the interest rate MX for the time period 1988 – 2008.



Source: JMulTi Software

Graph B.7 First differences of the logarithms for the exchange rate MXN/USD for the time period 1988 – 2008.



Source: JMulTi Software

Appendix C: Autocorrelation tests

Test C.1 Autocorrelation test Period 1988 – 2008

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	964.96	0.0000	Yes

Source: Author's computations. 95% confidence level.

Test C.2 Autocorrelation test Period 1988 – 2008 with 10 lags

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	516.84	0.0004	Yes

Source: Author's computations. 95% confidence level.

Test C.3 Autocorrelation test Period 1988 – 2008 with dummy variable for crisis period.

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	967.21	0.0000	Yes

Source: Author's computations. 95% confidence level.

Test C.4 Autocorrelation test Period 1988 – 1993

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	715.99	0.7871	No

Source: Author's computations. 95% confidence level.

Test C.5 Autocorrelation test Period 1994 – 2008

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	871.18	0.0011	Yes

Source: Author's computations. 95% confidence level.

Test C.6 Autocorrelation test Period 1994 – 2008 with 10 lags

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	520.08	0.0003	Yes

Source: Author's computations. 95% confidence level.

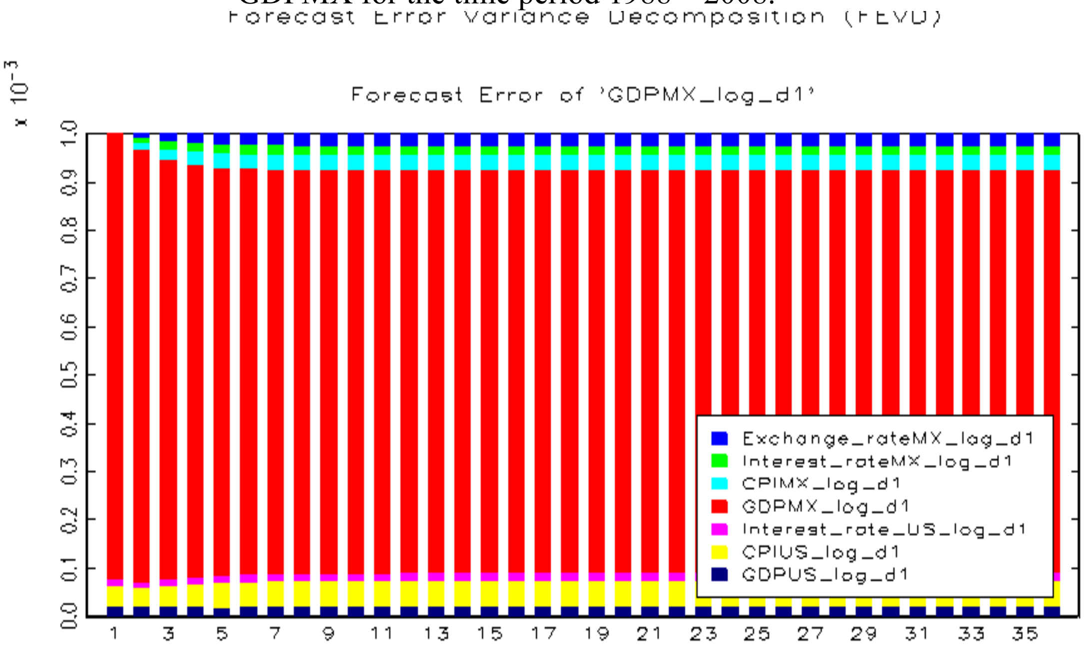
Test C.7 Autocorrelation test Period 1994 – 2008 with dummy variable for crisis period

Test	t-statistics	P-value	Autocorrelation
Portmanteau Test	843.68	0.0078	Yes

Source: Author's computations. 95% confidence level.

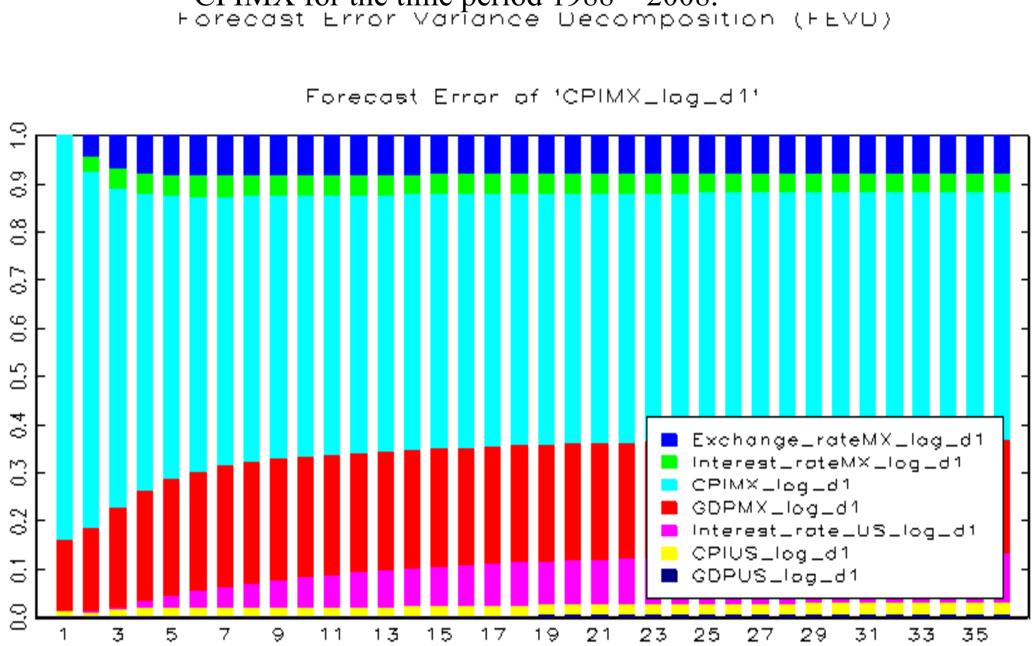
Appendix D: Variance Decomposition results.

Graph D.1 Variance decomposition for the first differences of the logarithms of the GDPMX for the time period 1988 – 2008.



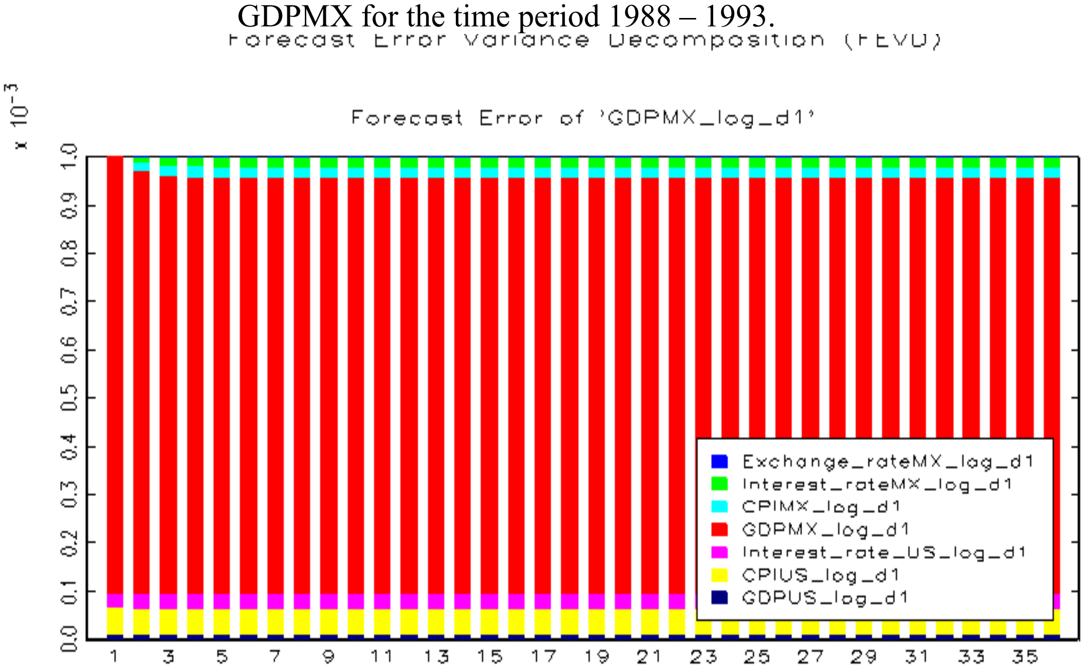
Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represents the change.

Graph D.2 Variance decomposition for the first differences of the logarithms of the CPIMX for the time period 1988 – 2008.



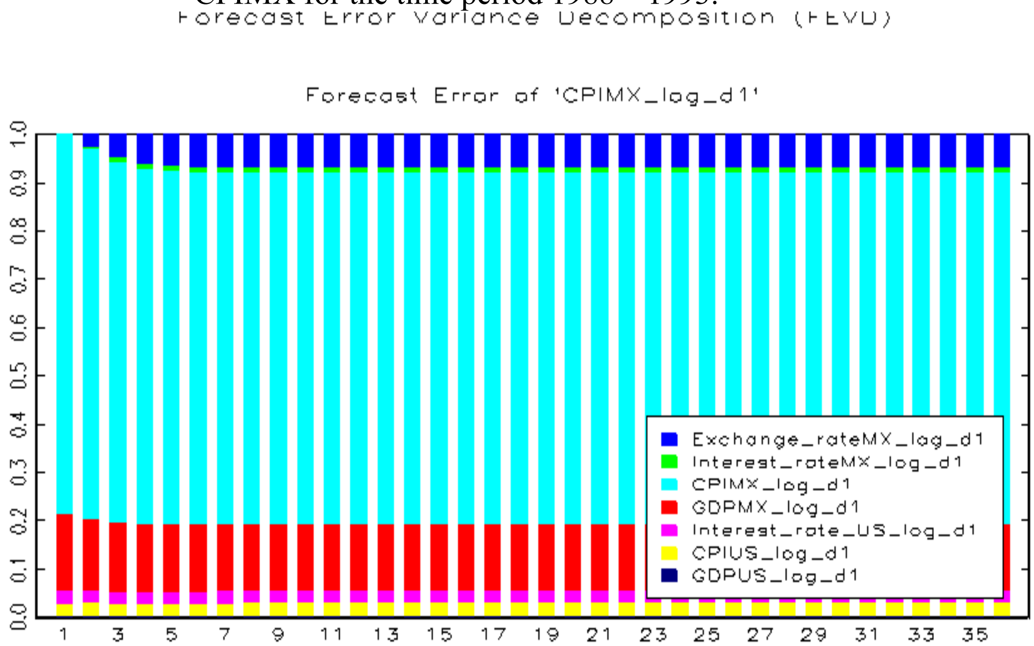
Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represent the change.

Graph D.4 Variance decompositions for the first differences of the logarithms of the GDPMX for the time period 1988 – 1993.



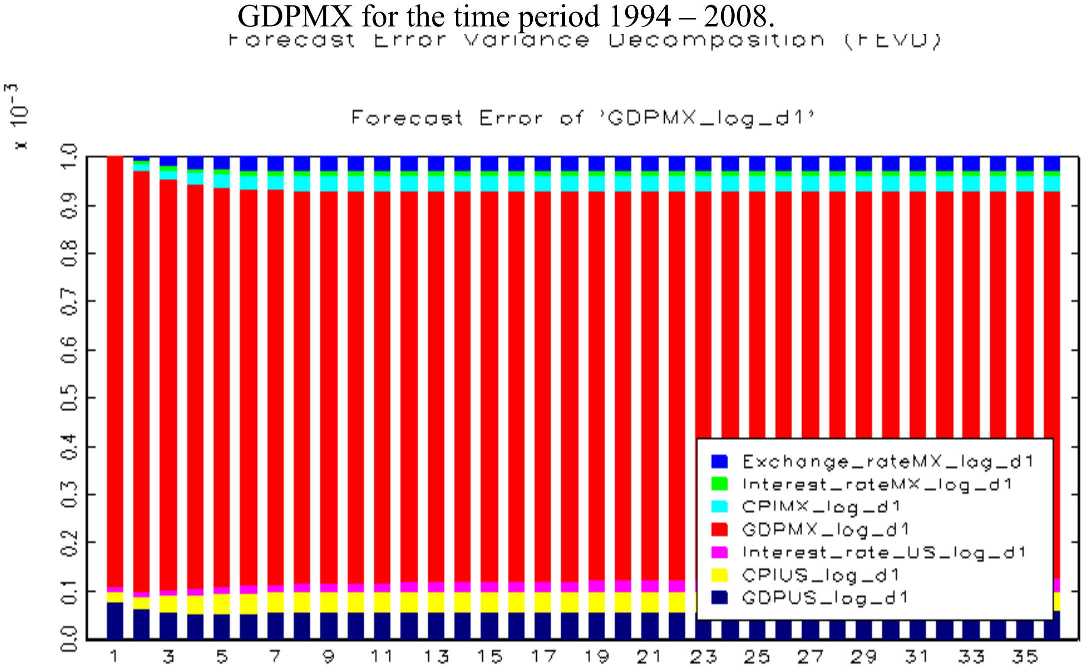
Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represents the changes

Graph D.5 Variance decomposition for the first differences of the logarithms of the CPIMX for the time period 1988 – 1993.



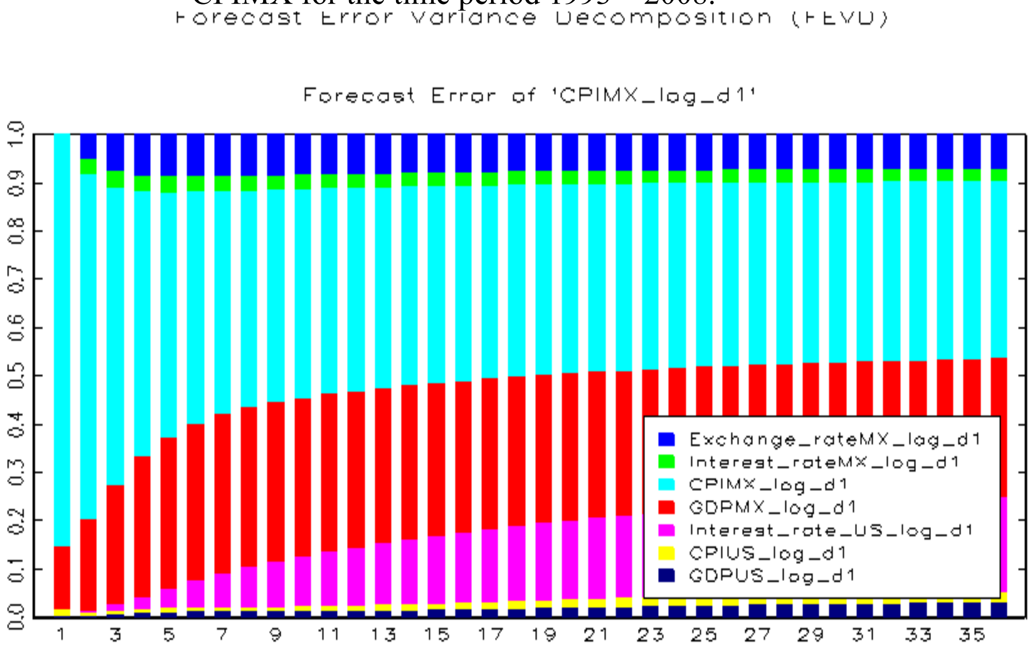
Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represents the change.

Graph D.5 Variance decomposition for the first differences of the logarithms of the GDPMX for the time period 1994 – 2008.



Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represents the change.

Graph D.6 Variance decomposition for the first differences of the logarithms of the CPIMX for the time period 1993 – 2008.



Source: JMulTi Software. The horizontal axis represents the months and the vertical axis represents the change.