Macroeconomic Market Disequilibria, Asymmetric and Non-linear Adjustments in Inflation Rates of Canada and Mexico

by

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Abstract

We consider monetary, foreign and labour disequilibriums in Canadian and Mexican economies to explain the behaviour of the inflation rate in these countries. Estimation of the disequilibriums is performed using multivariate cointegration techniques (Johansen, 1988, 1995). In both countries, we consider excess of money, excess demand, deviations from PPP, and wage inflation as the principal determinants of the inflation rate. We find important significance of the deviations from the PPP, and labour sector in explaining the behaviour of inflation rate both in the long run as well as in the short term. Disequilibrium in the monetary sector seems to be relevant in the case of Mexico. For Canada the efficient system of inflation targeting seems to indicate that the monetary disequilibrium is not significant. The presence of asymmetries and non-linearities is also analyzed. In the former case, we analyze the significance of positive and negative values of the different cointegrating vectors following Granger and Engle (1989) approach. In order to test for non-linearities we estimate a model using as explanatory variables different powers (square and cube values) of the disequilibrium terms as suggested by Escribano and Granger (1998), and Escribano and Aparicio (1999). Clear evidence of asymmetries and nonlinearities are found.

Keywords: Inflation, Money, Output, PPP, Wages, Asymmetries, Non-linearities, cointegration, VECM.
JEL Classification: C32, C51, E31

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Contents

1 Introduction

Throughout the course of history, economists have postulated that the inflation rate can be affected by various economic variables. Some economists believe that the inflation rate is higher because last period's money growth was in excess relative to the real activity growth. Hence, there exists an implicit idea that the cause of inflation is a disequilibrium between money supply and real activity. Other economists believe that the cause of higher (or lower) inflation rates is the foreign prices. Knowledge of these disequilibria and their impact on the inflation rate is valuable information for policy makers facing the task of achieving a stable macroeconomic environment.

As was briefly mentioned above, economic theory suggests alternative views of the sources and behaviour of inflation. A first explanation is related to the monetarist school. According to this school of economic thought, the cause of inflation is an excess of money supply with respect to real activity growth. A second view argues that external factors are the main explanation for the behavior of inflation in an open economy. According to this perspective the inflation of import prices in foreign currency is transmitted to domestic inflation. Another channel of transmission is through the effect of the exchange rate on domestic prices when the domestic economy imports intermediate and final goods. Another view which explains the sources of inflation is related to internal factors either from the labour market or from any domestic excess of demand. In the first case, the role of wages as an important component of producers' costs is highlighted. In the second case, for example, excess fiscal spending is considered a source of inflation.

The goal of this paper is to analyze the determinants of the inflation rate in Canada and Mexico in terms of the three macroeconomic explanations mentioned above for the period ranging from 1980-2002 using quarterly data. In other words, the main idea of the paper is to explain the inflation rate in terms of disequilibria found in the monetary, foreign and labour sectors. To our knowledge there have not been any other papers written in Canada nor in Mexico using the same perspective. The existenting studies of the determinants of inflation in Canada and Mexico have been more focused on only one of the three macroeconomic explanations.

In terms of the methodology, we follow closely Otero (2002) who analyzed the inflation rate in Colombia in terms of different macroeconomic disequilibria. The methodology is divided as follows. In the first step, the identification of the macroeconomic disequilibria is done using cointegration analysis (Johansen 1988, 1995). Different structural hypotheses are verified in order to identify cointegrating vectors which have interesting economic interpretations. In the second step, estimations of the $VECM$ are performed. However, in this step we are more interested in estimating an equation of inflation where the main explanatory variables are the macroeconomic disequilibria obtained in the preliminary step. This allows us to observe the relative importance of these disequilibria in explaining the behaviour of the inflation rate in the two selected countries. The third step consists of studying the presence of asymmetric and non-linear behaviour using positive and negative values for the former case and squared and cubed values of the disequilibrium vectors for the latter case.

The results can be summarized as follows. First, we found an important number of macroeconomic disequilibria in Canada and Mexico. The monetary factor seems to be more important in Mexico than in Canada possibly reflecting the fact that the Canadian system of inflation targeting achieves its main goal. Foreign factors are also more important in Mexico. Labour market disequilibria are shown to be important in both countries. Second, the analysis of asymmetries and nonlinearities reveals interesting effects of the disequilibria on the inflation rate.

In terms of the economic theory, we can affirm that the inflation rate in Canada is explained by internal factors represented by the labour sector. The effects from the disequilibria in the money market are small possibly indicating the good performance of the inflation targeting system. In the case of the Mexican economy, we found that disequilibrium in the foreign sector is the main determinants of the inflation rate. On the other hand, the impact of disequilibria in the labour sector clearly indicates that the role of wages through its relationship with unemployment rate (a Phillips' curve) and the domestic price level (through indexation contracts) is important.

This paper is organized as follows. Section 2 provides a brief summary of the literature done related to inflation rate determinants. This review is not exhaustive and it offers a brief description of the main research done on this paper's topic. Next, Section 3 presents a historical revision of the evolution of each country's main macroeconomic variables. Section 4 develops theoretical and methodological issues. The main results are summarized in Section 5, that is, the empirical evidence of the determinants of the inflation rate in Canada and Mexico. This section also includes a discussion about the evidence of asymmetries and nonlinearities in the adjustments of inflation in both countries. Finally, Section 6 concludes. Variable definitions as well as date sources are included as an appendix. At the end of the document Tables and Figures are included.

2 Review of Literature

This section presents a brief summary of previous work done using cointegrating techniques to model inflation. This methodology was introduced in 1988 by Johansen.

Surrey (1989) models inflation in the United Kingdom and in the United States in terms of three macroeconomic explanations: 1) a pure monetarist theory, 2) internal theories such as labour markets and excess demand theories and 3) external factors such as inflation of import prices and depreciation of the exchange rate. The methodology consisted of analyzing the inflation effects of using the long run relationships of the variables. The author uses the variables in first difference instead of using the levels due to the nonstationary characteristics of the variables. His findings suggest that external influences are more significant than domestic influences in the analyzed economies.

Juselius (1992) investigated domestic and international transmission effects on prices in Denmark for the period 1974-1987, using three macroeconomic explanations of inflation. These explanations were 1) theories describing the relation between price and wage inflation, that is, internal labour market theories; 2) theories of the effect of excess money on the inflation rate, in other words a pure monetarist theory; and 3) external theories which explain the impact of foreign prices on a small open economy.

The empirical results of Juselius (1992) determined that foreign effects have a more powerful influence on inflation than domestic ones. The foreign sector supports evidence that both Purchasing Power Parity (PPP) and stationary interest rate parity hold. Excess money has an effect on Danish price determination, but only marginally compared with the other sectors. The constant term was highly significant (4%), supporting evidence of autonomous inflation. Juselius believes this is a result of the backward-looking adjustment behaviour observed. This explanation is opposed to Lucas' forward-looking expectations model. Notice that Juselius (1992) does not analyze non-linear adjustments in the inflation rate.

Hendry (2001) analyzes inflation as a function of excess demands from most areas of the economy. The areas were regrouped as follows: money, goods and services, foreign exchange, factors of production, financial assets, and government deficits. The methodology consists of constructing the long run equilibria of each group or sector separately in order to determine which one is empirically relevant. Thus, equilibrium correction terms are developed for each sector separately. Hendry assumed all data are I(0), given the large data set, and is therefore not able to make use of multivariate cointegrating techniques. Hendry's findings point to many potential determinants of inflation but he concluded that "there is no single-cause of inflation." Empirical evidence indicates that there are some determinants that do not even play a role in determining inflation. More specifically, the main determinants of inflation are the excess demand for goods and services (19%), which was the most important source of inflation along with world price inflation (19%). The other significant determinants were the short-long interest rate spread and the markup (which includes unit labour costs). Less important inflation determinants are nominal money growth, commodity price inflation and interest rates. Finally, variables that did not determine UK inflation from 1875 to 1991 were excess money, excess debt and excess labour demand. In other words inflation in the UK can be explained by internal and foreign sectors and not by monetary ones. The intercept was insignificant, because there was no evidence for "autonomous" inflation, which was some what surprising giving the long sample period.

Otero (2002) is the most recent paper on the effects of disequilibria from several sectors of the economy on the behaviour of inflation rates. The paper investigates the inflation rate in Colombia between 1980 and 2000 in terms of the same three macroeconomic explanations mentioned in Juselius (1992). Hence, inflation is regressed on excess money, excess demand, deviations from PPP and wage inflation. The methodology has two main steps. The first step consists of using multivariate cointegrating techniques in order to test for long run equilibrium relations in the monetary, foreign and labour sectors. The second step uses the cointegrating vectors as determinants in an inflation model. Otero (2002) also examines nonlinear adjustment in the dynamics of inflation rate. This examination is done using two approaches. The first one deals with asymmetric effects, that is it involves dividing the long run equilibria into positive and negative values. The second consists of testing for non-linear behaviour by squaring and raising to the power of three the deviations from equilibrium. This is done in order to see the implications of small and large deviations from equilibrium. The conclusions point to domestic factors having a stronger influence on inflation than external factors. This is different from what was found in industrial countries. The exact results are as follows: excess money 14%, excess demand 11% and PPP 2%(only the weaker version of PPP holds). The constant term is approximately 3.5%, which implies that there is an autonomous component in the Colombian inflation determination. That is, evidence of non-linear price behaviour in response to excess demand and deviations from PPP and prices appear to respond symmetrically to excess money.

Non-linear adjustment of long run equilibrium economic relationships is an important part of our paper. The following papers present work done using this methodology. Granger and Lee (1989) wanted to test for symmetric price responses of the cointegrating vectors. To do that, they took the deviations of the cointegrating vectors from their mean values. These values were partitioned into positive and negative components and regressed on a short-run dynamic equation. Escribano and Granger (1998) and Escribano and Aparicio (1999) believed that the Granger and Lee paper was too restrictive since it imposed only one equilibrium point around zero. In order to relax this assumption they allowed the possibility of having more than one equilibrium point by squaring and cubing the error correction terms. Teräsvirta (1989) also used quadratic and cubic error correction terms in his paper. Finally, Escribano and Pfann (1998) test for symmetric adjustment between higher and lower target levels using cubic polynomials or rational polynomials in order to allow multiple equilibria to exist.

To our knowledge, there has not been any work done on inflation using multivariate cointegrating techniques that includes all three sectors in the economy in a single model for Canada and Mexico. Furthermore, for Canada we did not find any articles which model inflation using cointegrating techniques. On the other hand we did find some articles for Mexico, and these are presented below.

Economic theory suggests that there exist a narrow relationship between the exchange rate and the general price level. Santaella (2002) analyzed the inflationary mechanisms of the nominal exchange rate in Mexico for the period 1969 to 2000. He tried to find out whether or not the change to a floating the exchange rate regime in 1995 caused changes in the pass-through mechanism. The methodology consists of using cointegration techniques to test for a long run relationship between the domestic and foreign price levels and the exchange rate. PPP does not hold in the absolute sense; it only holds in the relative sense.[1]

[1]There have been a number of papers written on Mexico that use cointegration techniques

The inflationary transfer of the exchange rate is calculated and an inflation model for the short run is constructed using an error correction model (ECM). The ECM estimates are then analyzed. Santaella's (2002) findings indicate that the exchange rate variable fails to have one unit root; this variable is therefore stationary. Domestic and foreign prices constitute one cointegrating vector. The empirical evidence indicates that for the period after 1996, the inflationary exchange rate transfers in the short and medium term were smaller than those observed during a fixed exchange rate regime.

Garces' (2002) paper estimates an econometric model in order to explain the tendencies of inflation in Mexico from 1985 to 1998. He analyses how the inflation rate reacts to changes in wage levels, the exchange rate and foreign prices (measured in US$). More specifically, domestic prices are determined by a Cobb-Douglas function with wages and external prices as independent variables. Given that all the series were found to be non-stationary and one cointegrating vector was found, cointegration is used to estimate the univariate model. An error correction model is constructed to determine the dynamics of the short run adjustments. The inflation rate is regressed on domestic prices lagged once, the deviations from the steady state (error correction terms), changes in the wage level, minimum wages, external prices, prices of public goods, and changes in the productivity level. Garces (2002) concluded that in the short run the changes in wages adjust more quickly than changes in the exchange rate. The velocity of convergence of inflation is more significant when changes occur in wages rather than in the exchange rate.

The analysis of PPP has been carried out for a group of countries. For example Roger and Smith (2001) studied relative prices in major cities in Mexico, U.S. and Canada and found that PPP fails to hold given the distance between these cities. On the other hand, Alexius (1996) tested PPP on 16 OECD countries using data from 1960 to 1994. PPP was rejected for some countries (Canada, Japan, Switzerland, Austria, Italy and Spain) and not rejected for others (Sweden, France, Holland and the United Kingdom). The method used was Johansen's maximum likelihood approach.

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in order to determine whether or not Purchasing Power Parity holds. Various papers written on the subject found proof in favor of PPP. McLeod and Welch (1992) found a cointegrating vector in domestic prices, foreign prices and the exchange rate using the Johansen methodology. Mejia and Gonzales (1996) find a linear relationship between the exchange rate, the Mexican consumer price index and the American consumer price index. As for Noriega and Medina (2000), they found the exchange rate to be stationary for the period 1925 to 1994 using structural dummies. Although many papers found evidence of a cointegrating vector, some of the studies done on the subject found something which was completely different. For example, Avalos and Hernandez (1995) found the exchange rate to be non-stationary for the period 1961-1994 but do not find evidence of a cointegrating vector and Perez Lopez (1996) uses domestic prices, foreign prices and wages.

3 Economic History of Inflation (1980-2002)

3.1 Canada

The data period covered in this paper ranges from 1980 to 2002. In order to understand, in a better way, the economic situation of this period we will start by presenting a brief history of the Canadian economy from the late 1970's.

In the 1970's the structure of the labour market experienced changes in terms of its industrial composition. The labour market modified the required skills of employees, and began to allow the entrance of woman and younger workers into the labour force, while more generous unemployment insurance benefits became available. These changes, along with slow economic growing, fueled an upward trend in the unemployment rate. In 1974 the unemployment rate was 5.3%, in 1975 it rose to 6.9% and by 1979 it had reached a high of 8%. The government reacted to this structural change through expansionary monetary and fiscal policies in 1973-1974. These policies had a very negative impact on the inflation rate. Hence the inflation rate for this period was as high as 11%. The rise in prices made Canadian exports decrease since Canadian products were no longer competitive in foreign markets. Canada experienced real GDP growth reaching 7.7% in 1973 and 6.2% in 1976, but real GDP growth for the following years started to slowdown. The exchange rate of the Canadian dollar during the mid-1970s was near parity with the U.S. dollar.

In 1975, the Bank of Canada adopted a monetarist approach to monetary policy. The Bank of Canada's Governor, Gerald Bouey, said in his "Saskatoon Monetary Manifesto" speech "that control of inflation required control of the money supply and in particular, that the rate of growth of money has to be slowed if inflation were to be lowered." Monetary targets were introduced but they were not very successful because the M1 target was very difficult to attain. In the same year, the government established the Anti-Inflation Act in order to control the rapid increase in both prices and wages. This was the first time in history that Canada had introduced such a control during peace time. Ceilings were imposed on to prices and wages of large firms and the public sector. This approach was successful, as it was able to bring down wage levels, while reducing the inflation rate to 7.5%. Unfortunately, the unemployment rate still remained high.

In the 1980's and the 90's Canada experienced clear evidence of business cycles. During the 1980's the economy slumped into a severe recession known as "The Great Recession." This was followed by some years of economic slowdown and then by a period of prosperity from 1985 to 1988. In the early 1990 the economy fell back in to a severe recession, known as the first "made in Canada recession," since it started before the one in the US. The economic recovery was slow but prosperity was seen between 1995 and 1996. The economy stayed strong till the end of the century (during the US boom of President Clinton's time). From the year 2000 to the present day the economy has experienced slow growth. This slow growth started some months before the September 11 terrorist attacks in New York City and Washington, which made the economic situation even worse.

In the early 1980's Canadian real GDP growth fell to negative numbers. The recession affected the already high levels of unemployment rate. In 1982 the unemployment rate reached a high of 11%. The average quarterly unemployment rate remained at 11% until 1985. These levels were the highest levels seen in the economic history of Canada. Despite the high level of unemployment and economic slowdown prices did not fall. In the early 1980 inflation rose to double digits and in 1981 it was as high as 12.4%. Stagflation was the term used to describe the economic situation of this period; that is, the consumer price index was high during this period of recession .

Interest rates reached very high levels in the first years of the eighties. In 1981 the 90 day treasury bill rate reached 21% and demand deposits reached 18%. These rates were very high compared to the US interest rate. The exchange rate had to depreciate during the recession and in the 1980 it was $1.18 Canadian dollars per one U.S. dollar. The Canadian national accounts deficit increased from $10.7 billion in 1980 to $20.3 billion in 1982. The nominal stock of money fell to 14% in 1982.

The years immediately following the 1982 recession were years of recovery. It was not until the period between 1985 and 1988 that Canada enjoyed a relative prosperity. After 1982, Canada observed real GDP growth averaging an annual rate of 5%. The unemployment rate as mentioned above remained at high levels from 1982 to 1985. The exchange rate depreciated to $1.40 per US dollar at the end of 1985. The inflation rate declined to 5.7% in 1983, and down to 4% in 1984. Inflation remained at this level until 1987, when it started to increase, but it never again reached double-digit figures. Interest rates were high by today's standards, but lower than during the recession period. The average return on demand deposits from 1983 to 1988 was 8.5%. The national accounts deficit fell from $31 billion in 1985 to $26 billion in 1992. The dollar appreciated at the end of the 1980's to $1.16 per US dollar.

The Governor of the Bank of Canada, John Crow, implemented a new monetary policy in 1988. He believed the goal of monetary policy should be price stability. In other words, the economy had to experience an inflation rate of zero percent. This monetary policy coupled with an inflation-control target tends to act as a growth stabilizer. The consequences of this monetary policy were the following: 1) Interest rates started to increase, reaching 12% and 13% in 1989 and 1990 respectively. 2) The Canadian Looney appreciated with respect to the U.S. dollar. In November 1991 the exchange rate was $1.16 Canadian dollars per one U.S. dollar, and it began to depreciate sharply thereafter. 3) Real GDP growth in 1989 was low at 2.4% and in 1990-1991 the economy went into another recession. In 1992, the growth rate was equal to 1%. 4) The national accounts deficit increased to $30 billion dollars in 1991. Canada's current account balance of payments was negative for most of the 1990's. 5) The unemployment rate increased from 7.5% in 1989 to 11.3% in 1992. Finally 6) the monetary policy implemented was able to bring down the inflation rate from 5.6% in 1991 to 1.5% in 1992. In conclusion, Governor Crow was able to bring inflation down but at the cost of a severe recession.

The 1990's started with a very successful solution to maintain low inflation. In February 1991, the federal government and the Bank of Canada introduced targets to reduce inflation to the midpoint range of 1% to 3%. Inflation control targets assisted the Bank in determining what monetary policy actions were needed in the short and medium-terms to maintain a relatively stable price environment, even if regulations on interest rates took between 18 and 24 months to work. The Bank of Canada used interest rates as an instrument to maintain the desired level of inflation by raising or lowering them. After these targets were introduced, inflation registered some of the lowest levels in decades. In 1993 and 1994 Canada had a budgetary balance deficit of 5.8 per cent of GDP ($42 billion).

This decade was also very significant for trade. During the 1990 Canada signed two trade agreements. The first one came into effect on January 1st, 1989, a trade agreement known as the Canada-US Free Trade Agreement (CUS-FTA). And five years later, on January 1st, 1994, the North American Free Trade Agreement (NAFTA) between Canada, the United States and Mexico was signed.

The period of the second half of the nineties has been considered a very prosperous one with stable economic growth, low inflation and high investments in technology. Employment growth was remarkably high starting in 1995. Interest rates on demand deposits decreased considerably, in response to the interest rate offered in the U.S. In 1990, the interest rate was around 13%. It decreased to 8.5% in 1995 and then down to 5% by the end of the nineties. The exchange rate in these years continued to depreciate, $1.40 at the end of 1994, $1.53 at the end of 1998. The Canadian economic fundamentals at the time were much better that those experienced in the 1980's. Inflation was now lower, productivity-enhacing technology had become a key part of the economy and annual government deficits were very low, and the economy was much more competitive. Lastly, from 1997 to 2002 Canada had five consecutive years of government budget surpluses.[2]

At the turn of the century Canada experienced a decline in economic growth. In the first half of 2001 Canada as well as other economies experienced a sharp slow down. This was due to higher interest rates, higher energy prices and a significant decrease in global high technology investment. The terrorist attacks of September 11 introduced a further shock in Canada and the rest of the world. Canadian economic growth decreased from 4.5% in 2000 to 1.5% in 2001. Canada's low and stable inflation rate, low interest rates and low net foreign debt kept Canada from experiencing a recession. Canadian GDP growth remained at very low levels when the US experienced a recession in the first half of 2002. From 2001 to 2002 the government budget surplus was equal to 0.8 per cent of GDP ($8.9).

[2] Most countries around the world expericenced deficits in these years.

3.2 Mexico

Over the last three decades, Mexico has put into practice different economic policies to try to solve short-term economic problems. The implementation of these economic policies has shaped the Mexican economy. The business cycles observed in Mexico are closely related to the presidential term periods that last for six years. Mexico, since the 1970's, has gone through a crisis at the end of each presidential term, with the exception of President Zedillo's term, which ended in December 2000. This section will try to highlight the main economic policies from 1970 to the turn of the century, thus helping us understand their impact on inflation, GDP growth, the external sector and other economic indicators. As the crises are due to the monetary and fiscal policies imposed by each government in turn, the history of inflation is presented below by presidential term.

President Luis Echeveria's (1970 to 1976) economic policy was called "Stabilizing development." The objectives of this policy were to ensure low inflation rates (similar to those in the rest of the world), a stable fixed exchange rate and positive interest rates. In the foreign sector, an import substitution policy was implemented. i.e. trying to produce at home the goods that were imported, disregarding the high costs that this involved. In order to achieve the stabilizing goals, the government imposed price controls on public goods and services, as well as on agricultural products. There were also public deficit controls to ensure a low and stable governmental domestic and external debt with respect to the gross domestic product. The Mexican economy at the time was a closed economy, in favor of domestic production. Mexico had high import tariffs and in most cases, import permits were required. Maintaining prices fixed at nominal price, made the economy very inflexible, neither productive nor competitive. These macroeconomic disequilibria made the Mexican economy very vulnerable to any exogenous shock.

In 1973, there was a worldwide oil crisis and for the first time in history, inflation in Mexico reached double digits. Inflation was 21%, a large increase from the five year average inflation rate of 5%. The government was no longer able to maintain prices at artificial levels. Public spending was increased and foreign loans were requested to finance the deficit. By the end of Echeverria's presidency, in 1976, all the problems in the economy added up and there was a crisis causing the Mexican nominal peso to devalued 70%. The exchange rate parity regime of peso-dollar ($12.50 pesos per one US dollar) implemented in 1954 ended in 1976. The crisis caused inflation to reach 41%, external debt increased five-fold to more than 20% of GDP and international reserves decreased by 1 billion US dollars. GDP growth averaged 6% during this presidential term.

José López Portillo's (1976-1982) presidency started with an agreement with the International Monetary Fund (IMF) to implement the policies needed after the devaluation. In this agreement the government included the request for new loans. A couple of years later, the external sector rescued Mexican economy, as crude oil prices set by OPEC[3] reached record figures. Mexican oil exports

[3] Organization of Petroleum Exporting Countries (OPEC).

increased and were essential in the economic recovery. These exports were even the base for high GDP growth during the late seventies. From 1978 to 1981 Mexican GDP growth was as high as 9%. In 1980, President López Portillo declined the opportunity to join the General Agreement on Tariffs and Trade, GATT. Mexico became a mono-exporter country; oil represented 80% of Mexican exports. Under López Portillo's administration there were very high levels of public spending financed by both oil income and external debt.

In 1981, oil prices dropped, forcing Mexico to finance its public spending with external debt. The government, instead of making a drastic change in public spending, continued spending at the same pace. This situation made Mexican investors worried and fearing a new peso devaluation. This caused a major capital drain which was estimated at 3 billion US dollars, being the reason for the 1982 crisis. The Mexican peso devalued six-fold and inflation rates reached levels of almost 100%. Interest rates increased from 20% in early 1980 to 50% in 1982. The President accused bank owners of promoting the capital drain and decided to nationalize the banks in September of that year, three months before he left office. In an attempt to cure inflation and to stabilize exchange rates comprehensive price controls were established. The complex situation presented above made it impossible for the Mexican government to pay for the external debt servicing and in 1982 it declared the country insolvent.

In the period ranging from 1982 to 1988, Miguel de la Madrid became the new Mexican President. At the beginning of this six-year period Mexico remained a closed economy so it was not able to benefit from the low prices of its products. That is, even if Mexican products were cheaper, making them more competitive internationally, Mexico did not export many goods besides oil. Under the de la Madrid presidency the public deficit was cut in half, as suggested by the IMF, the inflation rate decreased to 50% and an exchange rate control was introduced. The control system consisted of dual parity: a controlled rate (lower, for enterprises with foreign commitments) and a free rate (higher, for the general population). The central bank, Banco de Mexico, in order to maintain the stability of the currency allowed exporters to import goods without import permits. This initiative to open the economy was a great success. In 1985, Mexico became a member of the GATT, now the World Trade Organization (WTO), and new horizons opened for the Mexican economy. Furthermore in 1985, the economy went into a recession and the international monetary reserves declined by 2 billion US dollars. At the end of this Presidential term Mexico was yet again in a big crisis. Mexico lost the privilege to external credit. So in order to pay for the debt servicing Mexico had to generate a surplus on the balance of payments. To achieve this surplus the Mexican peso was subjected to a series of devaluations during the next few years. The peso went from 150 pesos for one US dollar in 1983 to 3,200 pesos for one US dollar in 1987. This dramatic devaluation put enormous pressure on the inflation rate, reaching hyperinflation levels of nearly 160% per year in 1987. As real interest rates were negative (nominal interest rates were 100%), investors looked for alternatives to invest their money and the stock market appeared to be a good option. Unfortunately, after a year of striking increases in the Mexican stock index, the stock market collapsed in October 1987. All these events caused speculative attacks against the central bank reserves. In 1988, 7 billion dollars left the country causing a new devaluation, of approximately 20%, at the end of that year.

As dramatic as things were, the Mexican government introduced a very creative stabilizing program in order to deal with all these problems. The plan, known as Pacto (pact), consisted of a negotiated agreement among the government, representatives of unions (workers) and representative of entrepreneurs (chambers and business organizations). The areas covered in this plan were: reinforce the financial sector, have a restrictive monetary policy and to have price, wage and exchange rate controls in order to eliminate speculative inflationary pressures. All the participants in the Pacto agreed to limit their demands for price (public and private) and to set wage increases to a certain percentage (lower than what had been in the previous month). At the beginning, the Pacto was revised on a monthly basis. As inflation decreased significantly, the revisions were done every three months. Once the economic agents had regained confidence in government actions it was revised every six months. This plan had great results; the inflation rate displayed a considerable downward tend.

Starting in 1989, the economic policy of Carlos Salinas de Gortari [4] consisted of stabilizing the economy and maintaining the low inflation rate. The public debt decreased considerably, in relative terms and therefore monetary policy was mainly used to maintain a stable exchange rate. On January 1st 1993, Mexican currency changed from pesos to new pesos "nuevos pesos". The latter was equivalent to the pesos without three zeros, that is, 50,000 pesos became 50 new pesos. In 1993 a Constitutional reform declared the Central Bank independent (autonomous). The main goal of this important change was to introduce a protective environment to prevent fluctuations in the inflation rate. The Central Bank became the sole entity to have control over purchasing power.

In 1990, Mexico, Canada and the United States started negotiations for a free trade agreement. In December of 1992, the North American Free Trade Agreement (NAFTA) was signed and in January 1994 entered into force.

At the beginning of the nineties, the Mexican economy started to grow (4.46%) but it remained vulnerable. In 1994, political events [5] put special pressure on the economy. President Salinas de Gortari refused to devalue the peso, despite the fact that more than 10 billion US dollars fled the country after PRI presidential candidate Luis Donaldo Colosio was assassinated. Instead, he introduced what was called Tesobonos, a government deposit that was nominated in US dollars. With this instrument the Mexican government issued around 29 billion US dollars in debt. At the end of 1994, when investors realized that the short-term commitments of the Mexican Government in foreign currency exceeded Mexican international reserves, they tried to secure their money by changing pesos into US dollars in huge amounts; which caused a devaluation.

[4] Presidential term from 1988 to 1994.

[5] The PRI presidential candidate, Luis Donaldo Colosio, was murdered in March 1994 and the Secretary General of the same political party, José Francisco Ruiz Massieu, was killed in September of that year, after the presidential elections (August) when Ernesto Zedillo was elected.

In 1994, Mexico was forced to adopt a floating exchange rate regime. At the beginning of 1995, the economy went into a recession. Mexico fell into one of the deepest crises in the history of the country. The Mexican peso depreciated more than 150%. In 1994 the exchange rate was 3.2 pesos per US dollar, but after the devaluation it was more than 8 pesos per one US dollar and international reserves fell by the highest amount in the history of Mexico, about 18 billion US dollars.

President Ernesto Zedillo's six year period (1994-2000) started with one of the toughest crisis in modern Mexico. Just 29 days after his inauguration, the President had to take key decisions regarding the national economy. As a result, a terrible devaluation affected not only the pockets of the Mexican people but also the confidence of the international community in the Mexican economy, just months after NAFTA entered into force. Billions of dollars left the country and the expectations created by NAFTA seemed to go down the drain. Nevertheless, the Government made it clear that fiscal and monetary discipline would guide the recovery. With the financial support of the US government, a package of 50 billion dollars was offered to Mexico. Although not all the funds available were used, the confidence in the Mexican economy shown by the Clinton Administration, as well as the NAFTA itself made it possible to shorten the financial crisis.

It is fair to say that the heaviest burden was on the Mexican workers who saw their real income reduced. Exports grew dramatically during the first years of NAFTA. From 60.8 billion US$ in 1994, exports went to 79.6 in 1995; 96.0 in 1996; 110.2 in 1997; 117.5 in 1998; and exports reached 166.5 billion US$ in the last year of Zedillo's administration (2000). In short, during Zedillo's presidential period exports more than doubled. As well, foreign direct investment (FDI) experienced a huge increase (65 billion US dollars). It is difficult to deny that the external sector played an important role in Mexico's recovery. Zedillo's administration took a special interest in curing inflation. Given the drastic devaluation and the openness of the Mexican economy it seemed to be a hard task. Nonetheless, the administration was very successful and managed to reduce inflation from 52% in 1995 to 9% in 2000. The economic stability and fiscal and monetary policy observed during the last years of this administration generated confidence in the Mexican economy. Monetary reserves attained record levels during those years. From 6 billion US$ at the end of 1995 the reserves increased to 36 billion.[6] In fact, the economic situation of Mexico was in one of the best states ever at the time of the transition to the next administration.

The new century started with a new political party (Partido Action Nacional, PAN) leader, President Vicente Fox. The year 2000 ended with low inflation(9%), high international reserves, growing exports, stable FDI,[7] low interest rates(2%-3%)[8] like those offered in the US. and sound GDP growth

[6] The Central bank independence in 1993 was successful in reducing inflation and in increasing international reserves.

[7] Mexico has been the second destiny of FDI to developing countries, just after China.

[8] Interest rates started a downward trend starting in 1997.

(6.64%). The last two years have been a typical, not only for the Mexican economy but for many other countries. As Mexico is one of the more open economies of the world (Mexico has 11 free trade agreements and several bilateral investment agreements, preferential trade with a total of 32 countries) the tragic events of September 11, 2001 had a huge impact on the Mexican economy. The expectations of high GDP growth were hampered by the international environment. The Mexican economy went into a recession in 2001 and it has remained at practically zero growth. The international environment (conflict in Iraq) and internal situation do not give hope for a positive change in the short term. Inflation has kept its decreasing trend. In 2002 the inflation rate was 5.7% and down to 1% in 2003.

4 Methodological Issues

4.1 Stationarity

Let $\{y_t\}$ denote a time series for $t = 0, 1, 2, ..., T$. This time series is said to be weakly stationary when the mean, variance and the autocovariances of the series are all independent of time. In formal terms, when 1) $E(X_t) = \mu$, 2) $V(X_t) = \sigma^2$ and 3) $E[(X_t - \mu)(X_{t+h} - \mu)] = \gamma_h$ where h is the horizon. A stationary time series is frequently denoted by $I(0)$. When a time series does not satisfy any of these conditions, we say that it is nonstationary. In this case the series is time-dependent meaning that there is no long run mean to which the series returns to and the variance tends to infinity. A current example of this case is a random walk.

In general a time series is said to be integrated of order d, denoted by $I(d)$ if d differences are needed to obtain a stationary time series. In most cases, we are interested in distinguishing between an $I(0)$ and $I(1)$ processes. One current test statistic used to determine the order of integration of the series is the so-called augmented Dickey - Fuller test statistic (Dickey and Fuller, 1979; Said and Dickey, 1984) which is based on the following equation estimated by OLS:

$$\Delta y_t = d_t + \rho y_{t-1} + \sum_{i=1}^{k} b_i \Delta y_{t-i} + \epsilon_t \tag{1}$$

where ρ is the parameter of interest, ϵ_t is *i.i.d.* $(0, \sigma_\epsilon^2)$ and $d_t = \psi' z_t$ where z_t is a set of deterministic components such as $\{0\}$, $\{1\}$ or $\{1, t\}$. The null hypothesis is $H_0 : \rho = 1$ and the alternative hypothesis is $H_1 : |\rho| < 1$. Under the null hypothesis the time series has one unit root, that is, it is nonstationary, denoted by $I(1)$. The alternative hypothesis indicates stationarity, no unit root and or with a deterministic trend, denoted by $I(0)$. Critical values are different according to the deterministic components considered in (1). Notice that a lag length (k) is needed in (1) to obtain non-autocorrelated residuals. In selecting the lag length we use the recursive data-dependent rule suggested by Campbell and Perron (1991). This rule works as follows. We start assuming a maximum lag, say $kmax$. We test for the statistical significance (at 10% using a standard Normal distribution) of the coefficient of the lag associated with $kmax$. If this coefficient is significant then $k^* = kmax$. If not, we run the regression using $kmax - 1$. The procedure continues until a "no rejection" is obtained. If no rejection is obtained and $k = 0$, then $k^* = 0$. For details of the size and power properties of the ADF using this rule, see Ng and Perron (1995).

4.2 Cointegration Analysis

In order to test for cointegration, assume a VAR in the error correction model representation ($VECM$). Using similar notation as in Johansen (1988, 1995):

$$\Delta X_t = \mu + \Pi X_{t-1} + \Gamma_j(L)\Delta X_{t-1} + \varepsilon_t \tag{2}$$

where X_t is a $n \times 1$ vector of endogenous variables, $\Gamma_j = -\sum_{l=j+1}^{k} \Phi_l$, $\Pi = \sum_{j=1}^{k} \Phi_j - I_n = \Phi(1) - I_n$ and

$$\begin{aligned} E(\varepsilon_t) &= 0 \\ E(\varepsilon_t'\varepsilon_t) &= \left\{ \begin{array}{ll} \Omega & t = \tau \\ 0 & otherwise \end{array} \right\}. \end{aligned} \tag{3}$$

The equation (2) offers three possible cases according to the rank of the matrix Π. First, the matrix Π can be the zero matrix, which implies that the rank of Π equals 0. Second, the matrix Π can have full rank n. Third, the matrix Π can have rank deficiency, that is $0 < rank(\Pi) < n$, in which case Π can be decomposed as $\Pi = \alpha\beta'$ where α and β are $n \times r$ matrices of full rank r. In the same sense, X_t has r cointegrating vectors, which are the columns of β, and has $k = n - r$ unit roots, while the matrix α contains the adjustment parameters.

The Johansen maximum likelihood cointegration testing method aims to test the rank of the matrix Π, using the reduced rank regression technique based on canonical correlations. See Franses (1999) or Johansen (1995) for a more complete description of this approach. Assuming that the intercepts are not restricted, the procedure consists of obtaining an $n \times 1$ vector of residuals r_{0t} and r_{1t} from the so called auxiliary regressions (regressions of ΔX_t and X_{t-1} on a constant and the lagged ΔX_{t-1} through ΔX_{t-k+1}). These residuals are used to obtain the $(n \times n)$ residual product matrices:

$$S_{ij} = (1/T)\sum_{t=1}^{T} r_{it}r_{it}', \tag{4}$$

for $i, j = 0, 1$. The next step is to solve the following eigenvalue problem

$$|\lambda S_{11} - S_{10}S_{00}^{-1}S_{01}| = 0 \tag{5}$$

which gives the eigenvalues $\widehat{\lambda}_1 \geqslant ... \geqslant \widehat{\lambda}_n$ and the corresponding eigenvectors $\widehat{\beta}_1$ through $\widehat{\beta}_n$, which are the cointegrating vectors. A test for the rank of the matrix Π can now be performed by testing how many eigenvalues λ equal unity. The first test statistic for the resulting number of cointegration relations is the so-called Trace statistic (see Johansen, 1988), which is a likelihood ratio test defined by

$$Trace = -T \sum_{i=r+1}^{n} log(1 - \widehat{\lambda}_i) \tag{6}$$

where the null hypothesis is that there are at most r cointegrating relations. We begin by testing whether there is no cointegration ($r = 0$) versus least one such relation. If this is rejected, we test whether there is at most one cointegration relation and so on.

Another useful test is given by testing the significance of the estimated eigenvalues themselves

$$\lambda_{\max} = -Tlog(1 - \widehat{\lambda}_i) \tag{7}$$

which can be used to test the null hypothesis of $r - 1$ against r cointegrating relations.

Critical values for these tests have been tabulated by Osterwald-Lenum (1992). The limiting distributions depend on the set of deterministic components considered in the equation and depend also on the set of deterministic components allowed in the cointegrating relations. Given the nature of our series, we always consider an intercept in the estimation of the $VECMs$.

Another important issue in the application of the Johansen test is the specification of the lag length. Many suggestions appear in the literature. One suggestion is to use informational criteria such as Akaike criterion(AIC) or Schwarz criterion (SIC).[9]

4.3 Asymmetric and Non-Linear Adjustments

Another goal of this paper is to investigate the presence of asymmetric and non-linear adjustments in the equation of inflation. In testing for asymmetries, we follow the approach of Granger and Lee (1989), which consists of calculating the deviations from the cointegrating vectors with respect to their means and hence obtaining positive and negative values. An inflation model is estimated using these variables as regressors. The coefficients of these variables are used to calculate a linear equation for each sector in the economy. A scatter graph is plotted using the calculated linear equations, in the horizontal axis, and the related error correction terms, in the vertical axis. This will allow us to identify asymmetric adjustments with respect to inflation.

[9] The AIC and the SIC are respectively, defined as $AIC = -\frac{2l}{n} + \frac{2k}{n}$ and $SIC = -\frac{2l}{n} + \frac{k \log n}{n}$; where T is the number of observations, k is the number of estimated parameter and l is the value of the log likelihood function.

In testing for nonlinearities, we follow Escribano and Granger (1998), and Escribano and Aparicio (1999). We will first estimate a model using the original error correction terms and their squared values. The second model will model the original error correction terms, the squared and cubic values of the cointegrating vectors. Scatter Graphs are also used to identify non-linear behaviour of the error correction terms.

5 The Model

The main goal of this paper is to investigate if the deviations (or disequilibria) from long-run economic relationships are able to explain inflation rates both in Canada and in Mexico. Three economic sectors, which frequently provide macroeconomic explanations about the behaviour of the inflation rate, are used. They are the monetary, foreign and labour sectors. We follow closely Otero (2002) in dividing the study into two major phases. In the first phase, the analysis of cointegration is performed allowing us to find the number of cointegrating vectors, the identification of these vectors and the calculation of the disequilibria in each macroeconomic sector. In the second phase, the estimation of a single equation for the inflation rate is performed using the disequilibria as the principle determinants of its behaviour. Evaluations of the equation using a set of diagnostic tests is also performed. In this phase, we test for asymmetries and nonlinearities. A brief description of each macroeconomic sector considered in the study follows.

5.1 The Monetary Sector

According to the Monetarist perspective, the main cause of inflation depends on the level of money supply in the economy. Hence, inflation occurs when the money supply exceeds real productivity growth, i.e when there is excessive monetary growth. It can be summarized using the words of Friedman and Schwartz (1963): "money is the sole and only cause of inflation."

Under the assumption that money markets are competitive, money supply equals money demand. Therefore, we are going to use the money demand equation to analyze the existence of long run equilibrium relationships in the monetary sector. Overall, the demand for money depends on three economic variables: 1) the level of income as a measure of the number of transactions in the economy; 2) the price level; and 3) the interest rate which represents the opportunity cost of holding money.

In a log-linear specification, the equation for the demand for money can be specified as follows:

$$m_t^d = a_1 y_t + a_2 p_t - a_3 R_t + \epsilon_t^m \tag{8}$$

where m^d is frequently the $M1$ definition of money, that is, currency plus demand deposits; y_t is the real output of the economy; p_t is the consumption price index; and R_t is the interest rate. Series denoted in capital letters are original series while lower case letters denote series in logarithms. Hence, our set of variables is $X_t' = [m_t, y_t, p_t, R_t]$.

5.2 The Foreign Sector

In small open economies such as Canada and Mexico it is assumed that external factors affect the economy via the balance of payments. Therefore, this sector focuses on the international or external side of the sources of inflation rate. In fact, domestic prices levels can be affected by external factors either through inflation of imported prices in foreign currency or inflation may be caused by depreciations of the exchange rate.

In this context, testing whether the Purchasing Power Parity (denoted PPP) theory holds in the long run is a common approach. Absolute PPP holds when the exchange rates of two countries are equal to the difference between the two countries national price levels. This idea comes from the "law of one price" which states that in the absence of natural or government trade barriers, a commodity should sell for the same price everywhere. On the other hand, relative PPP refers to rates of change of price levels, that is, inflation rates.

Deviations of PPP are due to trade barriers, transportation costs, taxes imposed, lack of competitiveness, tariffs and non competitive markets. PPP allows us to determine if domestic and foreign price levels evolve in similar ways. Define,

$$ER_t = \frac{P_t^{US}}{P_t E_t} \tag{9}$$

where ER_t is the real exchange rate, E_t is the nominal exchange rate, P_t^{US} is the US price index, and P_t is the domestic price. In logarithmic notation we have

$$e_t = p_t^{us} - p_t - e_t \tag{10}$$

which indicates that our set of variables is given by $X_t' = [e_t, p_t, p_t^{us}]$.

5.3 The Labour Sector

The Labour sector involves the analysis of other internal aspects in explaining the behaviour of the inflation rate. In this case variables such as the consumer price index, wages, unemployment rate and productivity rate are considered as possible determinants. We expect, for example, that inflation and wages are positively correlated; and on other hand, inflation and unemployment are negatively correlated.

Broadly speaking, macro economists believe that prices can be either flexible or sticky. Under flexible prices it is postulated that both prices and wages adjust rapidly to changes in demand and supply. Under flexible prices, it is assumed that there is full employment and output is at its potential level. On other hand, models with fixed prices assume that it takes time for wages and prices to adjust to changes in the economy.

The set of used variables in this sector are $X_t' = [w_t, p_t, U_t, prod_t]$, where w_t is the wages rate, p_t is the consumer price index, U_t is the unemployment rate, and $prod_t$ is the rate of productivity.

6 Empirical Results

6.1 Data Series

The empirical models are estimated using unadjusted quarterly data for Canada and Mexico over the sample period ranging from 1980:1 to 2002:2. The series used in our models are the $M1$ definition of money (denoted by m_t), the constant-price (1995=100 for Canada and 1993=100 for Mexico) gross domestic product (y_t), the interest rate for deposits (R_t), the consumer price index (p_t^{can}, p_t^{mex} and p_t^{us} for Canada, Mexico and the US respectively), the nominal exchange rate (e_t), wages (w_t), the unemployment rate (U_t) and productivity rate ($prod_t$). Series denoted in capital letters are original series while lower case letters denote series in logarithms. The specific definitions of the series and their sources are found in the Appendix.

6.2 Stationarity Analysis

Figure 1 and Figure 2 present the evolution of the Canadian series in levels and in first differences respectively. All the series in levels display trends. Demand deposits and the unemployment rate have downward trends and the rest of the series have upward trends. The visual analysis suggests that all the series should be considered with both a constant term and a time trend. On the other hand, the series in first difference show no evidence of trends.

The results of the ADF unit root tests are presented in Table 1[10] for series in levels and in Table 2 for series in first differences. These tables contain the lag length considered (denoted k), the values of the test statistics, the deterministic components included in the autoregression ADF ($\{0\}$, $\{1\}$ or $\{1, t\}$). The last column of these tables presents the decision taken about the series: $I(1)$ denotes a time series which is nonstationary and $I(0)$ denotes a time series that is stationary. The results indicate that all the series in levels are nonstationary while the series in first differences are stationary.

The graphs of the Mexican series in levels and in first differences are shown respectively in Figure 3 and Figure 4. We can clearly see that the series in levels display trends where most of them are upward sloping. The demand deposits and the unemployment rate each have two peaks in early 80's and mid 90's, periods of economic crisis. As in the case of Canada, the results from the

[10] Estimations of the ADF test were performed in Eviews. Cointegration analysis, identification of the cointegrating vectors and estimations of the inflation equations were performed in Pc Give 10.0 of Doornik and Hendry (2001).

ADF statistics indicate that all series are nonstationary in levels (Table 3) and stationary in first differences (Table 4).

6.3 Cointegration Analysis

6.3.1 Canada

An unrestricted VAR was estimated for each one of the macroeconomic sectors considered in the analysis (monetary, foreign and labour). All these VARs include the series in levels, a constant term and centered seasonal dummies. The sample period ranges from 1982:1 until 2002:1 and the AIC and the SIC were used to select the lag length. In order to obtain more parsimonious results, we selected the lag length which corresponds to the minimum value of SIC that is: $k = 2, 3$ and 2 for the monetary sector, foreign sector and labour sector, respectively.

Therefore, the Johansen cointegration test is applied to the selected VAR model and the results are presented in Table 5. This table includes the eigenvalues denoted by λ_i, the null and alternative hypotheses, denoted by H_0 and H_1 respectively, and the $\lambda - Trace$ and the $\lambda - Max$ statistics. Notice that the $\lambda - Trace^*$, and the $\lambda - Max^*$ statistics are also included in this table. These statistics are the $\lambda - Trace$ and the $\lambda - Max$ statistics corrected by the degrees of freedom (Reimers, 1992). In general these latter values are the ones used in the selection of the cointegration rank. From the results of Table 5, we can conclude that there exist two long run relationships in each of the three sectors.

We now focus on the identification of the cointegrating relationships. We start with the monetary sector which has two cointegrating vectors. It is useful to remember that the specification of the $VECM$ includes the series m_t, y_t, p_t^{can} and R_t, a constant, centered seasonal dummies while the matrix Π included an intercept and a time trend. The lag length selected was equal to 2. Firstly, the first cointegrating vector (denoted by $cv_{1t}^{mon-can}$) was normalized with respect to m_t and the second cointegrating vector ($cv_{2t}^{mon-can}$) was normalized with respect to y_t. Performing a Likelihood Ratio (LR) statistic on the significance of the time trend,that is it trend equal zero. This hypothesis was not rejected. For the vector $cv_{1t}^{mon-can}$, we tested for homogeneity in both y_t and p_t^{can}. In the second vector we tested the joint null hypothesis that the coefficient of m_t is zero and the coefficient of p_t^{can} is -1. We obtained a $\chi^2 = 5.902$ with a p-value of 0.117 indicating a non rejection of the null hypothesis. Notice that no restrictions were imposed on the coefficient associated with the interest rate (R_t).[11] The first cointegrating vector may be interpreted as a demand for money while the second vector may be interpreted as a aggregate demand. These vector are given by

[11] Additional restrictions about the short-term behavior were also verified, specially related to the weakly exogeneity of the variables p_t^{can} and R_t.

$$cv_{1t}^{mon-can} = m_t - y_t - p_t^{can} + 0.131R_t \quad (11)$$
$$cv_{2t}^{mon-can} = y_t - p_t^{can} + 0.025R_t \; . \quad (12)$$

In the foreign sector the same set of deterministic components were considered but using $k = 1$. Lag length determine in PcGive. As the first step, we normalized both vectors with respect to the exchange rate variable. One of the imposed restrictions was to verify that the coefficient associated with the domestic price (p_t^{can}) is equal to -1. This same variable was verified for weakly exogeneity in the first vector. In the second cointegrating vector ($cv_{2t}^{for-can}$), we imposed the restrictions that the coefficient associated with the foreign price level (p_t^{us}) is zero. None of these restrictions were rejected with a $\chi^2 = 0.099$ (0.754), where the p-value is indicated in parenthesis. Notice that imposing the restriction that the coefficient of the domestic price is -1 in $cv_{2t}^{for-can}$ was strongly rejected with a $\chi^2 = 51.079$ (0.000). This result implies that the second cointegrating relation should have another economic interpretation. Another set of restrictions was that the coefficient of the exchange rate is equal to zero and that in both countries the coefficients associated with the price levels are equal. But, all of these restrictions were strongly rejected. However, the restriction imposing that the coefficient associated with the foreign price is zero and the fact that the coefficients associated with the exchange rate and domestic price have unity coefficients with opposite signs was not rejected with a $\chi^2 = 0.09$ (0.754). Finally, we test for the existence of PPP in the first cointegrating vector ($cv_{1t}^{for-can}$). The second vector includes only the exchange rate and the domestic price establishing a relationship between both variables. This final set of restrictions was not rejected with a $\chi^2 = 4.995$ (0.288). The results imply that PPP holds for Canada. Hence, the final cointegrating vectors are given by

$$cv_{1t}^{for-can} = e_t - p_t^{can} + p_t^{us} - 0.0075trend \quad (13)$$
$$cv_{2t}^{for-can} = e_t + 2.122p_t^{can} - 0.0139trend \quad (14)$$

For the labour sector, the set of imposed restrictions with $k = 1$ was such that we found the following identified cointegrating vectors:

$$cv_{1t}^{lab-can} = w_t - p_t^{can} - 0.027U_t - 1.65prod_t + 0.002trend \quad (15)$$
$$cv_{2t}^{lab-can} = p_t^{can} - 1.589w_t + 0.0044trend \quad (16)$$

with a $\chi^2 = 0.838$ (0.36). The first vector may be interpreted as a relationship between salaries and unemployment (a Phillips' curve) while the second vector establishes a relationship between prices and salaries.

All six long run linear relationships are presented in Figure 5.

6.3.2 Mexico

An unrestricted VAR was estimated for each of the three sectors; the monetary sector, foreign sector and the labour sector. The three VARs include the Mexican series in level, a constant term and centered seasonal dummies. The minimum values of the SIC corresponded to $k = 2$ for all three sectors.

Table 6 presents the results from the multivariate cointegration tests. Specifications similar to those for Canada were considered for the $VECM$ and the long run structure in the case of Mexico. The results (Table 6) indicate that there exists one cointegrating vector in the monetary and foreign sectors. In the labour sector, we cannot reject the null hypothesis that there are two cointegrating relationships.

In the identification process, the lag length selected was $k = 2, k = 1$ *and* $k = 1$ for the monetary, foreign and labour sectors. Staring with the monetary sector we considered that the cointegrating vector is associated with money demand equation. In consequence a set of restrictions were imposed corresponding to unit elasticity in output and prices. And the time trend to equal zero. The result was a statistic of $\chi^2 = 5.32$ (0.26), where the p-value is in parenthesis indicates non-rejection of the null hypothesis. Hence, the long run money demand equation is given by

$$cv_{1t}^{mon-mex} = m_t - y_t - p_t^{mex} + 0.073R_t. \tag{17}$$

A similar approach was followed in the case of the identification of the cointegrating vector in the foreign sector. The starting point was to verify if PPP holds for Mexico. Finally the set of restrictions that was not rejected considered that the coefficients of time trend is zero, and that the coefficient of the domestic prices and foreign prices enter in the long run relationship with opposite signs. This set of restrictions was not rejected with a $\chi^2 = 5.067$ (0.167), where the p-value is indicated in parenthesis. Hence, the identified cointegrated vector is given by

$$cv_{1t}^{for-mex} = e_t - 1.073p_t^{mex} + 1.073p_t^{us}. \tag{18}$$

For the labour sector, a set of restrictions on the two cointegrating vectors were tested. The set of restrictions that was not rejected is given by the following two identified cointegrating vectors:

$$cv_{1t}^{lab-mex} = w_t - p_t^{mex} - U_t \tag{19}$$

$$cv_{2t}^{lab-mex} = p_t^{mex} - w_t - 0.0075trend, \tag{20}$$

where they have similar interpretations as in the case of Canada.

Figure 6 presents the four cointegrating vectors.

In the following sections estimates of the inflation rates in Canada and Mexico are presented. All equations are evaluated using a set of diagnostic tests frequently used in the literature. The null hypothesis of non-autocorrelated residuals is evaluated using a Pormanteau statistic $Q(i)$ for $i = 2, 4, 8$. The possible existence of autocorrelation in the square of the residuals is also analyzed and it is denoted by $Q(i)\ r^2$ for $i = 2, 4, 8$. Another statistic used to test for autocorrelation is the $LM(i)$ for $i = 1, 2, 3, 4$. The null hypothesis of normality in the residuals is verified using the Jarque-Bera statistic. We also test for the existence of $ARCH(i)$ effects for $i = 1, 2, 4$. The test of White for heteroskedasticity is also performed. Finally, the $RESET$ test of Ramsey is used to verify misspecification issues. For details about these statistics, see Doornik and Hendry (2001).

6.4 Estimates of the VECM

Tables 7-9 present the estimates of the $VECM$ for the monetary, foreign and labour sectors of Canada, respectively. The bottom panel of these tables include a set of diagnostic tests to evaluate the quality of each equation of the system. A dummy variable (denote by $D91_t$) is included in order to take into account the recession period experienced in Canada.

The results for the monetary sector are presented in Table 7. The cointegrating vectors appear totally significant coefficients but not in all equations. The diagnostic tests indicate that the equations for money and inflation are the most satisfactory of the four equations of the system. However, notice that the equation of money presents problems related to the no normality of the residuals. And the equation of inflation seems to present problems of heteroskedasticity in the estimated residuals.

The equations for exchange rates and inflation of the foreign sector appear more robust to the diagnostic tests (see Table 8). On the other hand, the equation for foreign price inflation indicates no normality of the residuals and heteroskedasticity. Both cointegrating vectors enter significantly in almost all three equations, the exception being that the first cointegrating vector does not enter significantly to the inflation equation.

In the case of the labour sector (Table 9) the residuals show evidence of no normality in all equations except the equation of unemployment. Overall there is significance of the coefficients of both cointegrating vectors in the four equations.

Tables 10-12 present the estimates of the $VECM$ for the monetary, foreign and labour sectors of Mexico, respectively. A dummy variable[12] is included in order to take into account the great crisis experienced in 1987 (denoted $D87_t$), when Mexico reached hyperinflation figures of almost 160%. Given the magnitude of the inflation rate this dummy variable is included in all three $VECM$s. All the equations in all systems suffer some problems such as no normality and heteroskedasticity of the residuals.

[12] The VECM was originally estimated with three dummy variables: d83, d87 and d95. The dummy variable of 1987 was the only one with a significant coefficient in the VECM.

6.5 Inflation Rates, Asymmetries and Nonlinearities

6.5.1 Canada

In the case of Canada we found two long run equilibrium relationships in each of the macroeconomic sectors considered. These six cointegrating vectors were included as explanatory variables in the complete inflation model. However, only the first cointegrating vector of each sector had a significant coefficient and was therefore included in the selected model. Table 13 reports the results from the selected model, called Model 1.[13] The linear inflation equation was estimated using a constant term, central seasonal dummies, a dummy variable $D91_t$ and a MA(2) term to correct for autocorrelation.

We found that excess money has very little influence on inflation because monetary disequilibria only account for 0.2%. Deviations form PPP have an influence of less than 1% on inflation. And the labour sector has the largest influence on inflation, 9.5%. Model 1 has an autonomous component of 1.41%, which falls between the Central Banks inflation target band of 1% and 3%. The diagnostic tests of Model 1 are shown in Table 14. We can see that all the tests are satisfactory with only one exception: the RESET test of order one seems to indicate that there exists a misspecification problem.

Given the misspecification error and that excess money has very little influence on inflation we eliminated this variable and we estimated another inflation model, denoted Model 2. The deviations from PPP decreased their effects on inflation to 0.7% and the effects of the disequilibria in the labour sector increased to 11%, reinforcing the importance of this sector in determining the inflation rate in Canada. The autonomous component remains between the inflation target bands with a value of 1.64%. In terms of diagnostic test statistics, the estimated model performed satisfactorily. The results of these tests are shown in Table 14.

Table 13 also reports the results of the Canadian inflation model with asymmetric and non-linear adjustments. Table 14 shows the respective diagnostic test results for these models. Model 3 deals with asymmetric adjustments. It is estimated with a constant term, central seasonal dummies, the dummy variable $D91_t$, a MA(2) term and the six error correction terms divided into positive and negative components. All diagnostic test statistics perform satisfactorily. The asymmetric adjustments are plotted in Figure 7. The graphs indicate that inflation responds asymmetrically to all six disequilibria terms since the slope of the line graphs are different in the positive and negative side. The cointegrating vectors $cv_{1t-1}^{mon-can+}$ and $cv_{2t-1}^{for-can+}$ seem to have more influence on the inflation rate than the corresponding vectors with negative values. The difference in slope is represented in the graph by having a steeper slope in the positive side. And vectors such as $cv_{2t-1}^{mon-can}$, $cv_{1t-1}^{for-can}$ and $cv_{1t-1}^{lab-can}$ behave in the opposite way, that is, it is the negative side of the error correction terms which has more influence on the inflation rate. Notice that the coefficients of the $cv_{2t-1}^{lab-can}$ have

[13]Notice that in most cases, to save space, the tables don't show the central seasonal dummies.

opposite signs clearly indicating the presence of asymmetries.

Model 4 presents non-linear adjustments of inflation rates using all six error correction terms and their squared values. The same specification used in Model 3 is applied in this model with one exception: the constant term is not included since it was not significant at the 95% significance level. All diagnostic test statistics perform satisfactorily. Figure 8 plots the results of the non-linear (square) adjustments. The graphs of $cv_{1t-1}^{for-can}$, $cv_{1t-1}^{lab-can}$ and $cv_{2t-1}^{lab-can}$ do not present evidence of nonlinearities. On the other hand the evidence of nonlinearities in the first monetary cointegrating vector is very clear. The remaining two graphs present very little evidence of non-linear behaviour.

The last model estimated for Canada is the Model 5, which is same as Model 4 augmented by the cube values of the error correction terms.[14] All diagnostic test statistics perform satisfactorily. Figure 9 plots the results of the non-linear (square and cube) adjustments. When both squared and cubic values of the cointegrating vectors are included in the model there is more evidence of non-linearities. For example, the inflation rate responds now in a non-linear way to movements in $cv_{1t-1}^{for-can}$ and $cv_{2t-1}^{lab-can}$. The response to the second error correction term in the foreign sector present a more significant non-linear behaviour on the inflation rate. However, the response of inflation rate to the term $cv_{1t-1}^{mon-can}$ is yet non-linear but is not as significant. The inclusion of cubic values into the model does not effect the $cv_{2t-1}^{mon-can}$, that is, the graph is exactly the same as the one in Figure 8.

6.5.2 Mexico

In the case of Mexico we found one cointegrating vector in the monetary and foreign sectors and two cointegrating vectors in the labour sector. All four were included in the complete inflation model. Because Mexico has experienced several crises during the selected sample period, we include some dummy variables to account for the corresponding periods. The selected model, Model 1, includes dummies for the following years: 1983, 1988 and 1995. The linear model also includes a constant term and Δp_{t-3}^{mex}. Table 15 reports the estimates of Model 1. We can see that excess money and both labour error correction terms have a very small influence on the inflation rate, equalling 1.5%, 0.5% and -7.2%, respectively. The deviation from PPP (weak version) has a very significant influence on inflation, almost 20%, implying that the foreign sector is the most significant determinant of the inflation rate in Mexico. Table 16 shows the diagnostic tests which indicate the presence of heteroskedasticity. The rest of the diagnostic tests suggest appropriate model selection.

Mexico's inflation model with asymmetric adjustments is denoted as Model 2 and is reported in Table 15. The model includes the four error correction terms divided into positive and negative components, a constant term, Δp_{t-2}^{mex} and data camouflages dummy variables $D83_t$ and $D88_t$. All diagnostic test statistics

[14] It is important to mention that $(cv_{1t-1}^{lab-can})^3$ was not included in the model since it produced a near singular matrix.

(Table 16) perform satisfactorily. If we look at the equations of the cointegrating vectors $cv_{1t-1}^{mon-mex}$ and $cv_{1t-1}^{lab-mex}$ we might think that these two vectors respond symmetrically to prices given that the coefficients for positive and negative values are very similar in magnitude. But if we look at the plots of these variables (Figure 10) we can see that the slope changes slightly when crossing the zero vertical line. On the other hand the remaining two vectors have very clear asymmetric effects on inflation. More specifically, the error correction term $cv_{1t-1}^{for-mex+}$ has more influence on inflation than negative values and the term $cv_{2t-1}^{lab-mex}$ has completely different effects using positive and negative values. By completely different we mean that the responds of inflation is opposite in sign.

Table 15 reports the non-linear adjustment models. Model 3 contains the error terms and their squared values and an MA(2) term. All diagnostic test statistics perform in a satisfactory way except for some minor problems of normality and misspecification of the model. Figure 11 shows the non-linear (squared) adjustments. The first error correction term from the labour sector shows significant evidence of non-linearity in the response of the inflation rate. On the other hand, the inflation rate responds in a non-linear way to the terms $cv_{1t-1}^{for-mex}$ and $cv_{2t-1}^{lab-mex}$ but in smaller proportion. There was no evidence of non-linear behaviour in the inflation rate in response to the term $cv_{1t-1}^{mon-mex}$.

Model 4 is estimated with the four cointegrating vectors, their squared and cube values. This model does not have a constant term nor lagged values of prices because neither were significant. According to the diagnostic tests (Table 16), this model has autocorrelation in the residuals squared and the model has an $ARCH$ effect. To fix this issue, Model 5 was estimated using the same variables as in Model 4 but using a correction for $ARCH$ effects. The diagnostic tests (Table 16) indicates that this procedure has indeed solve both problems of Model 4. Figure 12 presents the non-linear (square and cube) adjustments. We can conclude that in the Mexican case, as in the case of Canada, when both squared and cubic values are included in the model there is more evidence of non-linearities. Inflation rates show non-linear adjustments in response to all four error correction terms.

6.5.3 Inflation Targeting in Canada and The Independence of the Central Bank of Mexico

In the case of both Canada and Mexico there have been important changes in the monetary sector during the period considered in this paper. These changes were made in order to reduce inflationary pressures.

In 1991, as mentioned above, Canada adopted a system of "inflation targeting" to ensure that the inflation rate lies within a one and three percent band. This policy has been very successful in keeping the inflation rate low. A dummy variable was created in order to take this policy into account. The dummy variable is denoted DIT_t which is equal to zero from 1980:1 to 1991:1 and equal one from 1991:2 to 2002:2. Two inflation models were estimated in order to determine whether or not the inflation targeting policy has had an impact on inflation. Both models contain the same specifications as Model 1 and Model 2 augmented by the inclusion of the dummy variable and the cross product of the error correction terms with the dummy variable. These latter variables represent the interactions between the original error correction terms and the dummy variable ($cv_{1t-1}^{mon-can} \times DIT_t$). In both models the coefficients of the dummy variables are not significant implying that there has not been a change in the autonomous components. In the first model we can see that the effect of monetary sector on inflation when there is no inflation targeting is equal to 0.3%; once inflation targeting was introduced it went down to 0.2%. The effects of the foreign and labour sectors change from 1% to 0.9% and 9.3% to 9.2%, respectively.

The second model estimated in this section gave the following results: the effect of the foreign sector is 0.7% when there was no inflation targeting and it increased to 1.2% once the policy was introduced. The labour sector on the other hand has almost the same impact on inflation before and after the policy was implemented, that is, 11.2% down to 11.18%. The reduction in these coefficients is very small, meaning that possibly Canadian inflation was already experiencing a downward trend when the inflation targeting policy was introduced. In other words one could say that before the inflation target was introduced the Bank of Canada was already working on keeping the inflation rate low.

On the other hand, in 1993, a very important constitutional reform was introduced in Mexico. In fact, the Mexican Central Bank, Banco de Mexico, became independent. We have created a dummy variable, denoted DCB_t, to take this change in monetary policy into account. The dummy variable is equal to one starting in 1994:1 to the end of the sample period, and it is equal to zero otherwise. An inflation model is estimated using the same specification as Model 1, the four error correction terms, the dummy variable DCB_t, and the interaction variables ($cv_{1t-1}^{mon-mex} \times DCB_t$). The coefficient of the dummy variable is not significant; implying that there has not been a change in the autonomous component of the model. The effect of the monetary sector before the Central Bank became autonomous was 1.6% and after 1994 the coefficient was reduced to 0.01%. This is a very significant change. It is very clear that the new monetary policy affected inflation behaviour. Both the labour sector cointegrating vectors present significant differences before and after the independence of the central bank. The coefficient of the first cointegrating vector has a more important change, that is, a change from 0.3% to 0.1% a reduction equal to three times. The coefficient of the second cointegrating vector went from -9.6% down to -5.7%. The coefficient of the foreign cointegrating vector experiences a very small reduction from 20.4% to 19.5%. Note that the coefficients before and after central bank independence are high implying that the inflation rate in Mexico is greatly affected by foreign disequilibrium.

7 Conclusions

This paper investigated the role of monetary, foreign and labour disequilibria as the main determinants of the inflation rate in Canada and Mexico. Multivariate cointegration techniques (Johansen 1988, 1995) were used to calculate the number of disequilibria in each macroeconomic sector. Economic interpretations were used to identify the cointegrating relationships. An inflation model was estimated using these disequilibria as the main explanatory variables. An analysis of asymmetries and nonlinearities was also performed.

The results can be summarized as follows. First, we found an important number of macroeconomic disequilibria in Canada and Mexico. The monetary factor seems to be more important in Mexico than in Canada, possibly reflecting the fact that the Canadian system of inflation targeting achieves its main goal. Foreign factors are also more important in Mexico. Labour disequilibrium is shown to be important in Canada and Mexico. Second, the analysis of asymmetries and nonlinearities shows interesting effects of the disequilibria on the inflation rate.

In terms of economic theory, we can affirm that inflation rate in Canada is explained by internal factors represented by the labour sector. The effects from the disequilibrium in the money market are small possibly indicating the good performance of the inflation targeting system. In the case of the Mexican economy, we found that disequilibrium in the foreign sector is the main determinants of the inflation rate. We found that the impact of disequilibria in the labour sector is clear, indicating that the role of wages through its relationship with unemployment rate (a Phillips' curve) and the domestic price level (through indexation contracts) are important.

8 Data Appendix

8.1 Definitions

- **Money.** For Canada we use the definition M1b, that is, currency and all check deposits. In millions of Canadian dollars. For Mexico between 1980-1985, we consider currency plus domestic demand deposits. For the period 1986-2002 we use currency plus domestic and foreign currency demand deposits. In millions of Mexican pesos.

- **Output.** For Canada, we use the Gross Domestic Product (GDP) at constant prices (1995 = 100). In millions of Canadian dollars. For Mexico, we work with the Gross Domestic Product at constant prices (1993 = 100). In Millions of Mexican pesos.

- **Prices.** For Canada we use the Canadian Consumer Price Index. And for Mexico the Mexican Consumer Price Index.

- **Interest Rates.** For Canada and Mexico we use the Yield of 90 day demand deposit Rate. In percent terms per annum.

- **Foreign price.** Consumer Price Index in the United States of America. In American dollars.

- **Nominal exchange rate.** For Canada we use the exchange rate expressed in Canadian dollar per US dollar while for Mexico we use Mexican Pesos per US Dollar.

- **Unemployment rate.** For Canada we consider the unemployment rate in both sexes, 15 years and over. In percentage terms. For Mexico, we use for the period 1981-1986, an average of the unemployment rate in three major urban areas (Mexico City, Guadalajara and Monterrey). For the period between 1987-2002 we use the average unemployment rate in urban areas. In Percentage terms.

- **Wages.** For Canada we use hourly rate. In Canadian dollars. For Mexico, we use the nominal average compensation index (average wages, salaries and benefits) of the manufacturing sector. This index is a fix index calculated using the Laspeyres index.

- **Productivity Rate.** For Canada it is calculated by multiplying constant GDP times one million and then diving the product by the employment rate.

- **Employment Rate.** For Canada we consider the employment rate in both sexes, 15 years and over. Millions of persons.

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Table 1. ADF results of Canadian Series in Levels

Series	Lag Length	Test Statistic	Deterministic Components	Decision
m_t	$k=5$	-2.521	{1,t}	I(1)
y_t	$k=1$	-2.157	{1,t}	I(1)
R_t	$k=0$	-2.496	{1,t}	I(1)
p_t^{can}	$k=5$	-2.178	{1,t}	I(1)
p_t^{us}	$k=3$	-2.442	{1,t}	I(1)
er_t	$k=3$	-1.904	{1,t}	I(1)
w_t	$k=5$	-2.827	{1,t}	I(1)
U_t	$k=3$	-2.125	{1,t}	I(1)
$prod_t$	$k=4$	-2.564	{1,t}	I(1)

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 2. ADF results of Canadian Series in First Difference

Series	Lag Length	Test Statistic	Deterministic Components	Decision
m_t	$k=3$	-3.716^a	{1}	I(0)
y_t	$k=5$	-3.600^a	{1}	I(0)
R_t	$k=5$	-4.583^a	{1}	I(0)
p_t^{can}	$k=3$	-2.958^c	{1}	I(0)
p_t^{us}	$k=5$	-5.349^a	{1}	I(0)
er_t	$k=2$	-4.147^a	{1}	I(0)
w_t	$k=3$	-2.650^d	{1}	I(0)
U_t	$k=4$	-4.258^a	{1}	I(0)
$prod_t$	$k=5$	-3.312^c	{1}	I(0)

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 3. ADF results of Mexican Series in Levels

Series	Lag Length	Test Statistic	Deterministic Components	Decision
m_t	$k=5$	-0.702	{1,t}	I(1)
y_t	$k=5$	-2.715	{1,t}	I(1)
R_t	$k=0$	-2.552	{1,t}	I(1)
p_t^{mex}	$k=5$	-1.178	{1,t}	I(1)
p_t^{us}	$k=3$	-2.442	{1,t}	I(1)
er_t	$k=3$	-1.910	{1,t}	I(1)
w_t	$k=5$	-1.038	{1,t}	I(1)
U_t	$k=3$	-2.172	{1,t}	I(1)

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 4. ADF results of Mexican Series in First Differences

Series	Lag Length	Test Statistic	Deterministic Components	Decision
m_t	$k=2$	-6.489^a	{1}	I(0)
y_t	$k=5$	-5.188^a	{1}	I(0)
R_t	$k=0$	-8.266^a	{1}	I(0)
p_t^{mex}	$k=0$	-2.636^c	{1}	I(0)
p_t^{us}	$k=5$	-5.349^a	{1}	I(0)
er_t	$k=5$	-2.884^c	{1}	I(0)
w_t	$k=2$	-4.627^a	{1}	I(0)
U_t	$k=5$	-4.323^a	{1}	I(0)

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 5. Johansen Cointegrating Tests for Canada

Sector	Lag	λ_i	H_0	H_1	λ-Trace	λ-Trace*	H_0	H_1	λ-Max	λ-Max*
Monetary Sector	$k=1$	0.408	$r=0$	$r>0$	105.51[a]	95.92[a]	$r=0$	$r=1$	46.14[a]	41.95[a]
		0.368	$r\leq 1$	$r>1$	59.37[a]	53.97[a]	$r=1$	$r=2$	40.38[a]	36.71[a]
		0.156	$r\leq 2$	$r>2$	18.99	17.26	$r=2$	$r=3$	14.89	3.73
Foreign Sector	$k=2$	0.772	$r=0$	$r>0$	159.88[a]	154.49[a]	$r=0$	$r=1$	131.49[a]	127.06[a]
		0.165	$r\leq 1$	$r>1$	28.39[b]	27.43[c]	$r=1$	$r=2$	16.00	15.46
		0.130	$r\leq 2$	$r>2$	12.39	11.97	$r=2$	$r=3$	12.39	11.97
labour Sector	$k=1$	0.449	$r=0$	$r>0$	121.35[a]	110.31[a]	$r=0$	$r=1$	52.34[a]	47.58[a]
		0.403	$r\leq 1$	$r>1$	69.00[a]	62.73[a]	$r=1$	$r=2$	45.46[a]	41.33[a]
		0.137	$r\leq 2$	$r>2$	23.54	21.40	$r=2$	$r=3$	13.02	9.56

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 6. Johansen Cointegrating Tests for Mexico

Sector	Lag	λ_i	H_0	H_1	λ-Trace	λ-Trace*	H_0	H_1	λ-Max	λ-Max*
Monetary Sector	$k=1$	0.917	$r=0$	$r>0$	258.46[a]	246.71[a]	$r=0$	$r=1$	219.00[a]	209.24[a]
		0.189	$r\leq 1$	$r>1$	39.26	37.48	$r=1$	$r=2$	18.48	17.64
		0.160	$r\leq 2$	$r>2$	20.78	19.84	$r=2$	$r=3$	15.36	14.66
Foreign Sector	$k=1$	0.285	$r=0$	$r>0$	44.73[c]	41.64[d]	$r=0$	$r=1$	29.17[b]	27.16[c]
		0.123	$r\leq 1$	$r>1$	15.55	14.48	$r=1$	$r=2$	11.40	10.61
		0.046	$r\leq 2$	$r>2$	4.16	3.87	$r=2$	$r=3$	4.16	3.87
labour Sector	$k=1$	0.587	$r=0$	$r>1$	105.56[a]	101.92[a]	$r=0$	$r=1$	76.85[a]	74.20[a]
		0.218	$r\leq 1$	$r>2$	28.71[a]	27.72[c]	$r=1$	$r=2$	21.44[a]	20.70[c]
		0.080	$r\leq 2$	$r>3$	7.27	7.02	$r=2$	$r=3$	7.27	7.02

a, b, c and d denotes 1%, 2.5%, 5% and 10% significance levels, respectively.

Table 7. Estimates of the VECM, Monetary Sector of Canada

Variables	Δm_t		Δy_t		Δp_t^{can}		ΔR_t	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values	Coefficient	t-value
$cv_{1t-1}^{mon-can}$	-0.040	(-2.63)	-0.027	(-5.13)	-0.005	(1.42)	-0.529	(-0.58)
$cv_{2t-1}^{mon-can}$	0.073	(2.44)	0.037	(3.70)	0.056	(8.15)	1.794	(1.02)
C	0.139	(2.82)	0.089	(5.35)	0.012	(1.08)	0.758	(0.26)
Δm_{t-1}	0.403	(4.25)	0.030	(0.94)	-0.009	(-0.42)	-0.420	(-0.08)
Δy_{t-1}	-0.464	(-1.36)	0.114	(0.99)	0.009	(0.11)	79.54	(3.95)
ΔR_{t-1}	-0.003	(-1.72)	0.002	(2.61)	-0.001	(-0.69)	0.038	(0.33)
$CSeasonal$	0.000	(0.012)	0.003	(1.48)	0.003	(2.10)	0.291	(0.91)
$CSeasonal_{t-1}$	0.006	(1.07)	-0.001	(-0.49)	0.004	(2.78)	0.062	(0.19)
$CSeasonal_{t-2}$	0.002	(0.385)	-0.001	(-0.17)	0.002	(1.82)	0.171	(0.54)
$D91_t$	-0.002	(-0.107)	0.004	(0.82)	0.010	(3.13)	0.011	(0.01)
$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value	F-Statistic	p-value
$AR\ (1-5)$	1.402	(0.234)	1.206	(0.315)	0.827	(0.535)	1.023	(0.408)
$Normality-\chi^2$	6.599	(0.037)	0.783	(0.676)	2.443	(0.295)	27.001	(0.000)
$ARCH\ (1-4)$	0.080	(0.988)	2.671	(0.039)	1.922	(0.116)	9.463	(0.000)
$Hetero$	1.620	(0.114)	3.766	(0.000)	3.040	(0.002)	3.254	(0.001)
$Hetero-\times$	1.065	(0.410)	2.293	(0.007)	1.583	(0.086)	5.161	(0.000)

Table 8. Estimates of the VECM, Foreign Sector of Canada

Variables	Δe_t		Δp_t^{can}		Δp_t^{us}	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values
$cv_{1t-1}^{for-can}$	-0.049	(-1.89)	0.002	(0.41)	-0.016	(-3.42)
$cv_{2t-1}^{for-can}$	-0.039	(-1.93)	-0.035	(-9.00)	-0.031	(-8.84)
C	0.373	(1.97)	0.324	(8.89)	0.299	(8.95)
$CSeasonal$	0.0001	(0.06)	0.002	(1.81)	0.0002	(0.14)
$CSeasonal_{t-1}$	-0.002	(-0.35)	0.004	(2.98)	0.001	(0.61)
$CSeasonal_{t-2}$	-0.001	(-0.14)	0.003	(1.97)	0.001	(0.91)
$D91_t$	-0.009	(-0.47)	0.0139	(3.80)	-0.003	(-0.84)
$D91_{t-1}$	-0.0169	(-0.88)	-0.008	(-2.20)	-0.002	(-0.59)
$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value
$AR(1-5)$	1.778	(0.128)	0.840	(0.525)	1.141	(0.347)
$Normality-\chi^2$	0.759	(0.684)	1.155	(0.561)	8.792	(0.012)
$ARCH(1-4)$	0.205	(0.935)	1.678	(0.165)	1.360	(0.256)
$Hetero$	0.486	(0.817)	0.756	(0.607)	2.291	(0.044)
$Hetero-\times$	0.820	(0.587)	0.720	(0.674)	1.683	(0.118)

Table 9. Estimates of the VECM, Labour Sector of Canada

Variables	Δw_t		Δp_t^{can}		ΔU_t		$\Delta prod_t$	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values	Coefficient	t-value
$cv_{1t-1}^{lab-can}$	0.020	(0.77)	0.105	(6.79)	9.348	(7.75)	0.022	(0.78)
$cv_{2t-1}^{lab-can}$	0.136	(3.99)	0.023	(1.14)	-9.918	(-6.38)	-0.041	(-1.11)
C	0.635	(1.98)	1.621	(8.60)	114.466	(7.79)	0.234	(0.68)
ΔU_{t-1}	0.001	(0.90)	0.001	(1.52)	0.388	(5.22)	-0.002	(-1.11)
$CSeasonal$	0.001	(0.40)	0.006	(4.80)	1.414	(13.6)	0.0001	(0.16)
$CSeasonal_{t-1}$	-0.008	(-1.72)	0.014	(5.06)	-0.681	(-3.27)	-0.054	(-11.1)
$CSeasonal_{t-2}$	-0.011	(-5.22)	0.007	(5.49)	-0.053	(-0.529)	-0.047	(-20.0)
$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value	F-Statistic	p-value
$AR(1-5)$	1.580	(0.176)	2.367	(0.047)	0.785	(0.564)	1.420	(0.227)
$Normality - \chi^2$	32.931	(0.000)	14.454	(0.001)	0.759	(0.684)	6.288	(0.043)
$ARCH(1-4)$	0.562	(0.691)	0.722	(0.580)	0.018	(0.999)	0.581	(0.678)
$Hetero$	0.663	(0.680)	1.877	(0.096)	0.152	(0.988)	1.559	(0.171)
$Hetero - \times$	1.110	(0.367)	2.256	(0.028)	0.523	(0.853)	2.152	(0.040)

Table 10. Estimates of the VECM, Monetary Sector of Mexico

Variables	Δm_t		Δy_t		Δp_t^{mex}		ΔR_t	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values	Coefficient	t-value
$cv_{1t-1}^{mon-mex}$	-0.122	(-3.69)	-0.005	(-0.625)	0.008	(0.61)	3.112	(0.91)
C	0.097	(5.29)	0.015	(3.13)	0.013	(1.87)	2.412	(1.27)
Δy_{t-1}	-1.056	(-2.45)	-0.239	(-2.08)	-0.199	(-1.20)	-44.70	(-1.00)
Δp_{t-1}^{mex}	0.256	(1.62)	-0.088	(-2.10)	0.773	(12.80)	-47.853	(-2.94)
$CSeasonal$	-0.125	(-2.49)	-0.60	(-4.44)	0.043	(2.24)	4.116	(0.79)
$CSeasonal_{t-1}$	-0.156	(-5.88)	-0.030	(-4.20)	-0.022	(-2.21)	-1.866	(-0.69)
$CSeasonal_{t-2}$	-0.125	(-3.41)	-0.085	(-8.77)	0.0001	(0.008)	1.536	(0.41)
$D87_t$	0.102	(2.13)	0.015	(1.18)	0.067	(3.68)	12.585	(2.56)
$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value	F-Statistic	p-value
$AR(1-5)$	0.680	(0.640)	2.300	(0.053)	2.928	(0.018)	2.946	(0.018)
$Normality - \chi^2$	25.367	(0.000)	15.453	(0.000)	55.017	(0.000)	49.628	(0.000)
$ARCH(1-4)$	0.914	(0.461)	0.879	(0.481)	0.616	(0.653)	0.032	(0.998)
$Hetero$	1.052	(0.403)	1.921	(0.079)	14.633	(0.000)	37.143	(0.000)
$Hetero - \times$	0.606	(0.841)	1.258	(0.261)	7.977	(0.000)	25.485	(0.000)

Table 11. Estimates of the VECM, Foreign Sector of Mexico

Variables	Δer_t		Δp_t^{mex}		Δp_t^{us}	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values
$cv_{1t-1}^{for-mex}$	0.013	(0.12)	0.110	(5.75)	0.009	(2.05)
C	-0.030	(-0.14)	-0.205	(-5.54)	-0.014	(-1.68)
Δer_{t-1}	0.109	(0.69)	0.081	(3.01)	-0.008	(-1.30)
Δp_{t-1}^{mex}	0.651	(1.61)	0.321	(4.66)	-0.022	(-1.46)
Δp_{t-1}^{us}	1.036	(0.52)	0.196	(0.58)	0.587	(7.75)
$CSeasonal$	-0.035	(-0.99)	0.018	(3.04)	0.001	(0.63)
$CSeasonal_{t-1}$	-0.094	(-2.50)	-0.015	(-2.37)	0.001	(1.01)
$CSeasonal_{t-2}$	-0.059	(-1.70)	-0.009	(-1.46)	0.001	(0.97)
$D87_t$	-0.014	(-0.20)	0.067	(5.77)	5.60E^{-005}	(0.02)

$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value
$AR(1-5)$	1.556	(0.183)	1.511	(0.197)	0.676	(0.643)
$Normality - \chi^2$	100.13	(0.000)	14.595	(0.000)	22.916	(0.000)
$ARCH(1-4)$	2.540	(0.047)	4.505	(0.003)	3.786	(0.008)
$Hetero$	0.917	(0.516)	2.191	(0.033)	0.937	(0.499)
$Hetero - \times$	1.132	(0.347)	2.920	(0.001)	0.761	(0.734)

Table 12. Estimates of the VECM, Labour Sector of Mexico

Variables	Δw_t		Δp_t^{mex}		ΔU_t	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-values
$cv_{1t-1}^{lab-mex}$	0.004	(1.17)	-0.004	(-1.42)	0.164	(3.63)
$cv_{2t-1}^{lab-mex}$	0.112	(4.44)	0.020	(0.92)	-0.745	(-2.11)
C	0.485	(4.71)	0.098	(1.08)	-3.144	(-2.18)
Δw_{t-1}	-0.037	(-0.31)	-0.013	(-0.12)	-4.369	(-2.57)
Δp_{t-1}^{mex}	0.345	(2.74)	0.692	(6.23)	8.562	(4.86)
$CSeasonal$	-0.214	(-12.30)	0.031	(2.03)	1.073	(4.42)
$CSeasonal_{t-1}$	-0.110	(-5.51)	-0.024	(-1.34)	-0.373	(-1.33)
$CSeasonal_{t-2}$	-0.119	(-11.30)	-0.011	(-1.13)	0.901	(6.10)
$D87_{t-1}$	0.103	(4.77)	-0.073	(3.82)	-0.620	(-2.05)

$Tests$	F-Statistic	p-values	F-Statistic	p-values	F-Statistic	p-value
$AR(1-5)$	3.947	(0.003)	4.119	(0.002)	0.720	(0.611)
$Normality - \chi^2$	38.855	(0.000)	52.576	(0.000)	10.079	(0.007)
$ARCH(1-4)$	0.083	(0.988)	1.564	(0.193)	1.506	(0.210)
$Hetero$	0.755	(0.658)	8.641	(0.000)	3.161	(0.003)
$Hetero - \times$	0.547	(0.922)	9.180	(0.000)	1.751	(0.055)

Table 13. Estimates of the Canadian Inflation Model (t-statistics in parenthesis)

Model 1		Model 2	
Variables	Coefficients	Variables	Coefficients
C	1.409	C	1.642
	(8.392)		(19.577)
$cv_{1t-1}^{mon-can}$	0.002	$cv_{1t-1}^{for-can}$	0.007
	(1.582)		(3.289)
$cv_{1t-1}^{for-can}$	0.009	$cv_{1t-1}^{lab-can}$	0.110
	(3.778)		(19.623)
$cv_{1t-1}^{lab-can}$	0.095	$D91_t$	0.017
	(8.675)		(5.131)
$D91_t$	0.016	$MA(2)$	-0.421
	(4.977)		(-4.079)
$MA(2)$	-0.451		
	(-4.427)		
R^2	0.844		0.841

Table 13 (continues). Estimates of the Canadian Inflation Model (t-statistics in parenthesis)

Model 3		Model 4		Model 5	
Variables	Coefficients	Variables	Coefficients	Variables	Coefficients
C	0.009	D_{1t}	0.004	D_{1t}	0.004
	(8.613)		(3.169)		(3.011)
$cv_{1t-1}^{mon-can+}$	0.003	$cv_{1t-1}^{mon-can}$	0.024	$cv_{1t-1}^{mon-can}$	-0.093
	(0.701)		(0.799)		(-0.249)
$cv_{1t-1}^{mon-can-}$	0.001	$(cv_{1t-1}^{mon-can})^2$	-0.003	$(cv_{1t-1}^{mon-can})^2$	0.029
	(0.178)		(-0.783)		(0.290)
$cv_{2t-1}^{mon-can+}$	0.009	$cv_{2t-1}^{mon-can}$	0.002	$(cv_{1t-1}^{mon-can})^3$	-0.003
	(0.543)		(0.129)		(-0.333)
$cv_{2t-1}^{mon-can-}$	0.023	$(cv_{2t-1}^{mon-can})^2$	0.030	$cv_{2t-1}^{mon-can}$	0.009
	(1.740)		(0.908)		(0.201)
$cv_{1t-1}^{for-can+}$	0.004	$cv_{1t-1}^{for-can}$	0.026	$(cv_{2t-1}^{mon-can})^2$	0.012
	(0.601)		(1.320)		(0.074)
$cv_{1t-1}^{for-can-}$	0.010	$(cv_{1t-1}^{for-can})^2$	-0.029	$(cv_{2t-1}^{mon-can})^3$	0.018
	(1.219)		(-1.163)		(0.120)
$cv_{2t-1}^{for-can+}$	-0.010	$cv_{2t-1}^{for-can}$	0.166	$cv_{1t-1}^{for-can}$	0.034
	(-1.291)		(0.437)		(0.356)
$cv_{2t-1}^{for-can-}$	-0.003	$(cv_{2t-1}^{for-can})^2$	-0.009	$(cv_{1t-1}^{for-can})^2$	-0.061
	(-0.292)		(-0.448)		(-0.214)
$cv_{1t-1}^{lab-can+}$	0.027	$cv_{1t-1}^{lab-can}$	-0.090	$(cv_{1t-1}^{for-can})^3$	0.034
	(0.933)		(-0.514)		(0.126)
$cv_{1t-1}^{lab-can-}$	0.050	$(cv_{1t-1}^{lab-can})^2$	-0.005	$cv_{2t-1}^{for-can}$	11.591
	(1.807)		(-0.898)		(0.479)
$cv_{2t-1}^{lab-can+}$	0.057	$cv_{2t-1}^{lab-can}$	0.818	$(cv_{2t-1}^{for-can})^2$	-1.268
	(1.282)		(0.452)		(-0.475)
$cv_{2t-1}^{lab-can-}$	-0.068	$(cv_{1t-1}^{lab-can})^2$	0.173	$(cv_{2t-1}^{for-can})^3$	0.046
	(-1.806)		(0.463)		(0.471)
$D91_t$	0.018	$D91_t$	0.019	$cv_{1t-1}^{lab-can}$	0.942
	(5.215)		(5.570)		(0.398)
$MA(2)$	-0.624	$MA(2)$	-0.557	$(cv_{1t-1}^{lab-can})^2$	0.030
	(-6.302)		(-5.297)		(0.371)
				$cv_{2t-1}^{lab-can}$	33.816
					(0.343)
				$(cv_{1t-1}^{lab-can})^2$	13.700
					(0.337)
				$(cv_{1t-1}^{lab-can})^3$	1.848
					(0.329)
				$D91_t$	0.019
					(5.312)
				$MA(2)$	-0.5412
					(-4.876)
R^2	0.850		0.846		0.837

Table 14. Diagnostic Tests for the Canadian Inflation Model (p-values in parenthesis)

Statistics	Model 1		Model 2		Model 3		Model 4		Model 5	
$Q(2)$	0.358	(0.550)	0.326	(0.568)	2.981	(0.084)	1.368	(0.242)	1.680	(0.195)
$Q(4)$	1.722	(0.632)	1.632	(0.652)	6.487	(0.090)	3.629	(0.304)	3.805	(0.283)
$Q(8)$	2.378	(0.936)	2.611	(0.918)	6.875	(0.442)	4.652	(0.7020	4.699	(0.697)
$Q(2)\ r^2$	2.443	(0.118)	3.698	(0.054)	2.269	(0.132)	1.368	(0.242)	1.680	(0.195)
$Q(4)\ r^2$	2.810	(0.422)	3.845	(0.279)	2.741	(0.433)	3.294	(0.348)	4.211	(0.240)
$Q(8)\ r^2$	3.630	(0.821)	4.687	(0.698)	4.517	(0.719)	5.011	(0.659)	6.017	(0.538)
JB	0.040	(0.980)	0.019	(0.990)	0.761	(0.684)	0.995	(0.608)	0.789	(0.674)
$LM(1)$	0.053	(0.819)	0.007	(0.936)	2.570	(0.113)	0.913	(0.343)	1.282	(0.262)
$LM(2)$	0.681	(0.509)	0.816	(0.446)	1.613	(0.207)	0.988	(0.377)	1.064	(0.351)
$LM(3)$	0.692	(0.560)	0.673	(0.571)	2.437	(0.072)	1.278	(0.289)	1.305	(0.281)
$LM(4)$	0.513	(0.726)	0.499	(0.736)	1.830	(0.133)	0.945	(0.443)	0.969	(0.431)
$ARCH(1)$	0.163	(0.687)	0.160	(0.690)	1.566	(0.214)	1.376	(0.244)	2.035	(0.157)
$ARCH(2)$	1.141	(0.325)	1.748	(0.180)	1.002	(0.371)	1.318	(0.273)	1.625	(0.203)
$ARCH(4)$	0.713	(0.586)	0.962	(0.433)	0.597	(0.666)	0.734	(0.571)	0.861	(0.491)
$F-Het$	0.647	(0.769)	0.970	(0.466)	1.403	(0.136)	1.509	(0.104)	1.527	(0.086)
$Ramsey(1)$	4.038	(0.048)*	2.106	(0.151)	0.160	(0.691)	1.571	(0.214)	1.381	(0.244)
$Ramsey(2)$	2.561	(0.084)	1.500	(0.230)	0.166	(0.848)	1.436	(0.245)	1.669	(0.196)
$Ramsey(3)$	1.720	(0.170)	0.991	(0.401)	2.153	(0.102)	1.623	(0.192)	1.577	(0.204)

Table 15 Estimates of the Mexican Inflation Model (t-statistics in parenthesis)

Model 1		Model 2	
Variables	Coefficients	Variables	Coefficients
C	-0.465	C	0.078
	(-5.001)		(15.288)
$cv_{1t-1}^{mon-mex}$	0.015	$cv_{1t-1}^{mon-mex+}$	0.015
	(6.354)		(4.943)
$cv_{1t-1}^{for-mex}$	0.199	$cv_{1t-1}^{mon-mex-}$	0.017
	(12.323)		(2.525)
$cv_{1t-1}^{lab-mex}$	0.004	$cv_{1t-1}^{for-mex+}$	0.210
	(2.779)		(11.499)
$cv_{2t-1}^{lab-mex}$	-0.072	$cv_{1t-1}^{for-mex-}$	0.106
	(-4.948)		(3.879)
$D83_t$	0.041	$cv_{1t-1}^{lab-mex+}$	0.003
	(4.070)		(0.746)
$D88_t$	0.091	$cv_{1t-1}^{lab-mex-}$	0.004
	(7.037)		(1.999)
$D95_t$	-0.0196	$cv_{2t-1}^{lab-mex+}$	-0.064
	(-2.056)		(-2.769)
Δp_{t-3}^{mex}	-0.089	$cv_{2t-1}^{lab-mex-}$	0.016
	(-2.073)		(0.693)
		$D83_t$	0.048
			(4.598)
		$D88_t$	0.088
			(7.343)
		Δp_{t-2}^{mex}	-0.097
			(-2.114)
R^2	0.951		0.958

Table 15 (continues). Estimates of the Mexican Inflation Model (t-statistics in parenthesis)

Model 3		Model 4		Model 5	
Variables	Coefficients	Variables	Coefficients	Variables	Coefficients
$cv_{1t-1}^{mon-mex}$	0.015	$cv_{1t-1}^{mon-mex}$	-0.456	$cv_{1t-1}^{mon-mex}$	-0.448
	(0.757)		(-3.160)		(-4.739)
$(cv_{1t-1}^{mon-mex})^2$	0.0001	$(cv_{1t-1}^{mon-mex})^2$	-0.048	$(cv_{1t-1}^{mon-mex})^2$	-0.048
	(0.102)		(-3.250)		(-5.080)
$cv_{1t-1}^{for-mex}$	-0.191	$(cv_{1t-1}^{mon-mex})^3$	-0.002	$(cv_{1t-1}^{mon-mex})^3$	-0.002
	(-1.338)		(-3.235)		(-5.198)
$(cv_{1t-1}^{for-mex})^2$	0.077	$cv_{1t-1}^{for-mex}$	-4.134	$cv_{1t-1}^{for-mex}$	-4.041
	(2.576)		(-2.751)		(-3.682)
$cv_{1t-1}^{lab-mex}$	-0.001	$(cv_{1t-1}^{for-mex})^2$	1.834	$(cv_{1t-1}^{for-mex})^2$	1.861
	(-0.150)		(2.832)		(3.941)
$(cv_{1t-1}^{lab-mex})^2$	-0.001	$(cv_{1t-1}^{for-mex})^3$	-0.258	$(cv_{1t-1}^{for-mex})^3$	-0.273
	(-1.347)		(-2.801)		(-4.059)
$cv_{2t-1}^{lab-mex}$	-0.120	$cv_{1t-1}^{lab-mex}$	0.001	$cv_{1t-1}^{lab-mex}$	0.002
	(-1.285)		(0.383)		(1.117)
$(cv_{2t-1}^{lab-mex})^2$	-0.013	$(cv_{1t-1}^{lab-mex})^2$	-0.001	$(cv_{1t-1}^{lab-mex})^2$	-0.002
	(-0.949)		(-0.290)		(-1.806)
$D83_t$	0.053	$(cv_{1t-1}^{lab-mex})^3$	-0.001	$(cv_{1t-1}^{lab-mex})^3$	-0.001
	(5.338)		(0.780)		(-0.429)
$D88_t$	0.091	$cv_{2t-1}^{lab-mex}$	-0.495	$cv_{2t-1}^{lab-mex}$	-0.467
	(7.638)		(-0.522)		(-0.628)
Δp_{t-3}^{mex}	-0.077	$(cv_{2t-1}^{lab-mex})^2$	0.075	$(cv_{2t-1}^{lab-mex})^2$	0.070
	(-1.883)		(0.322)		(0.395)
$MA(2)$	0.248	$(cv_{2t-1}^{lab-mex})^3$	0.023	$(cv_{2t-1}^{lab-mex})^3$	0.021
	(1.946)		(1.179)		(1.517)
		$D83_t$	0.038	$D83_t$	0.044
			(4.191)		(3.831)
		$D88_t$	0.083	$D88_t$	0.67
			(7.467)		(6.597)
R^2	0.957		0.964		0.956

Table 16. Diagnostic Tests for the Mexican Inflation Models (p-values in parenthesis)

Statistics	Model 1		Model 2		Model 3		Model 4		Model 5	
$Q(2)$	0.858	(0.651)	5.247	(0.073)	0.232	(0.630)	5.355	(0.069)		
$Q(4)$	2.242	(0.691)	6.466	(0.167)	1.895	(0.595)	6.877	0.143	4.449	0.349
$Q(8)$	4.858	(0.773)	10.485	(0.233)	6.757	(0.455)	13.553	0.094	10.487	(0.233)
$Q(2)\ r^2$	0.426	(0.808)	1.165	(0.559)	2.563	(0.109)	14.689	(0.001)*		
$Q(4)\ r^2$	1.868	(0.760)	8.790	(0.067)	4.795	(0.187)	23.321	(0.000)*	5.493	(0.240)
$Q(8)\ r^2$	4.00	(0.857)	10.883	(0.208)	10.264	(0.174)	24.628	(0.002)*	7.866	(0.447)
JB	5.259	(0.072)	2.941	(0.230)	9.496	(0.009)*	3.604	(0.165)	1.084	(0.582)
$LM(1)$	0.086	(0.770)	0.032	(0.859)	0.231	(0.633)	1.891	(0.173)		
$LM(2)$	0.402	(0.671)	2.816	(0.066)	0.126	(0.882)	2.360	(0.102)		
$LM(3)$	0.386	(0.763)	2.550	(0.062)	0.672	(0.572)	1.597	(0.198)		
$LM(4)$	0.588	(0.673)	1.908	(0.119)	0.892	(0.474)	1.942	(0.113)		
$ARCH(1)$	0.298	(0.586)	1.050	(0.308)	1.838	(0.179)	10.797	(0.002)*	0.208	(0.649)
$ARCH(2)$	0.201	(0.818)	0.548	(0.580)	1.351	(0.265)	5.943	(0.004)*	0.468	(0.628)
$ARCH(4)$	0.378	(0.824)	2.025	(0.099)	1.071	(0.377)	4.847	(0.002)*	1.215	(0.311)
$F-Het$	1.936	(0.040)*	2.053	(0.014)	1.729	(0.058)	2.831	(0.001)*		
$Ramsey(1)$	1.824	(0.181)	0.153	(0.697)	2.375	(0.128)	0.001	(0.992)		
$Ramsey(2)$	0.969	(0.384)	0.947	(0.393)	1.962	(0.148)	0.887	(0.416)		
$Ramsey(3)$	1.874	(0.141)	1.358	(0.263)	6.409	(0.001)	1.358	(0.263)		

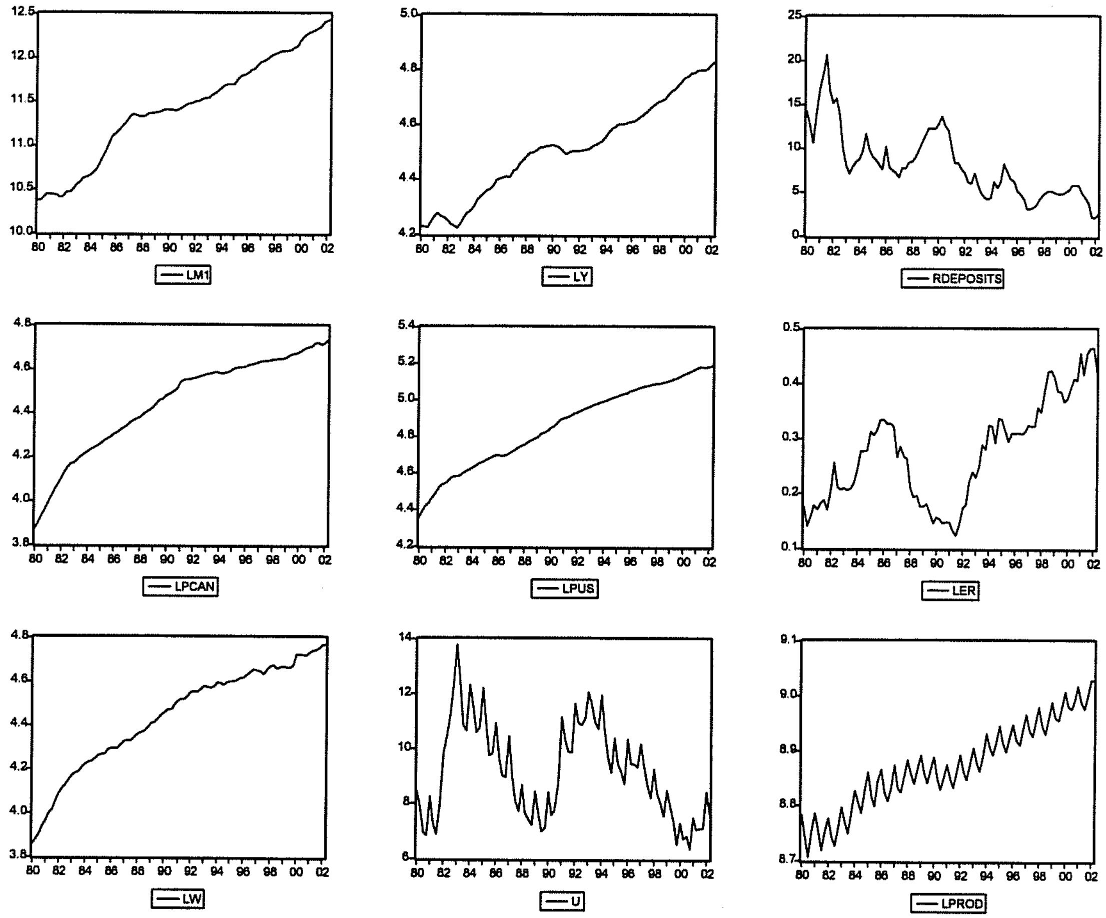


Figure1. Canadian Series in Levels

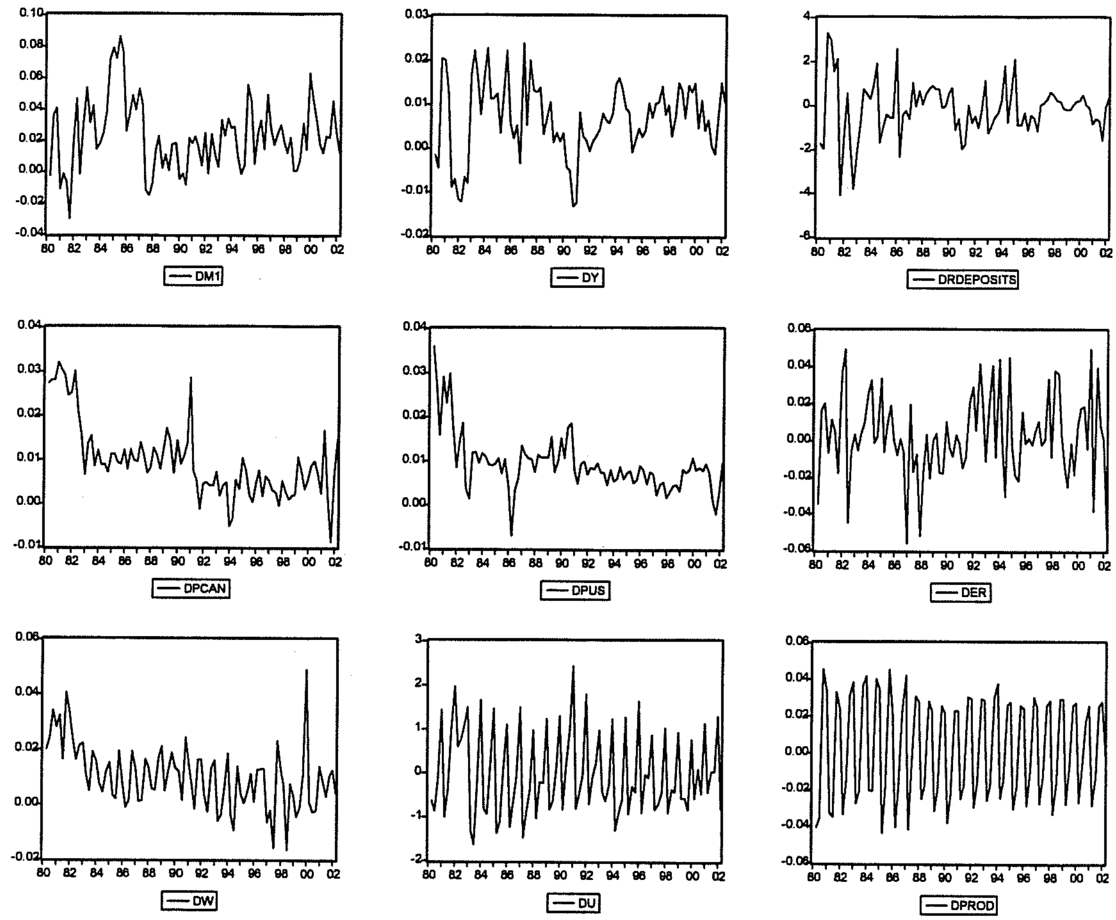


Figure 2. Canadian Series in First Differences

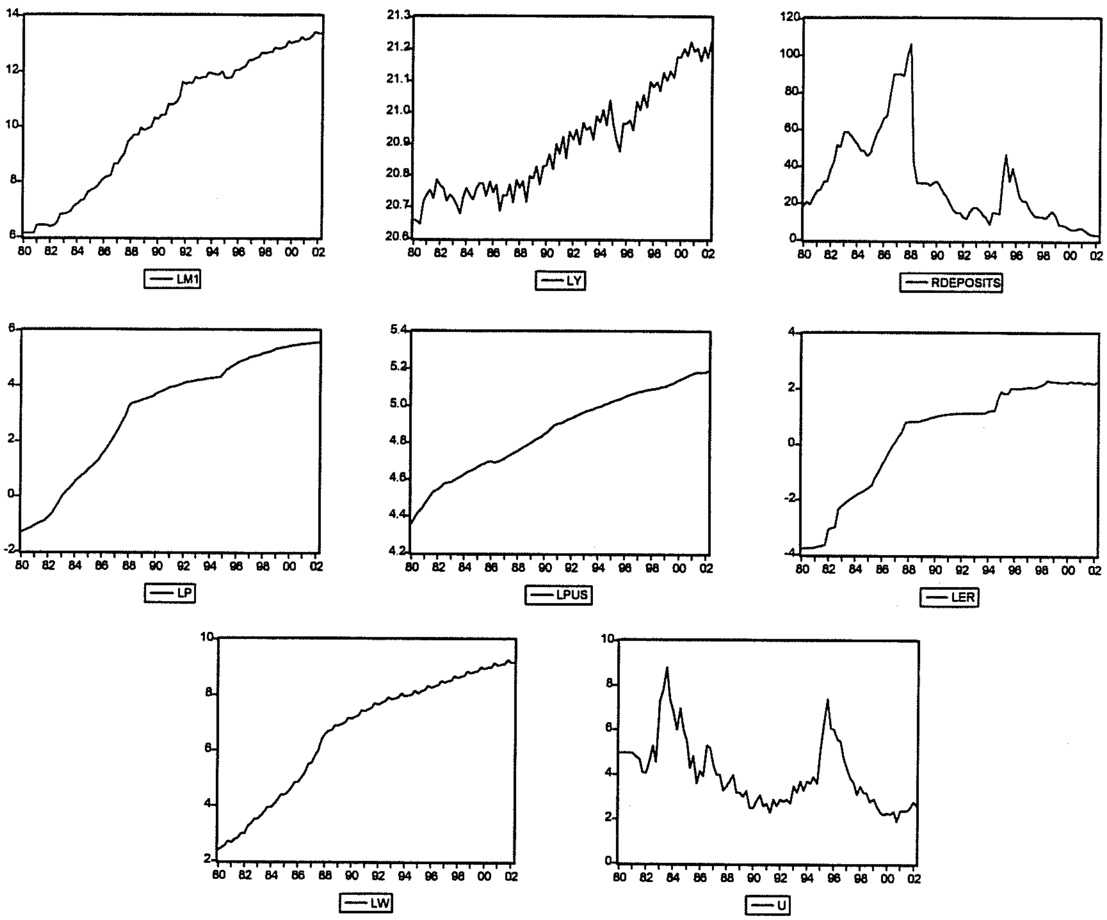


Figure 3. Mexican Series in Levels

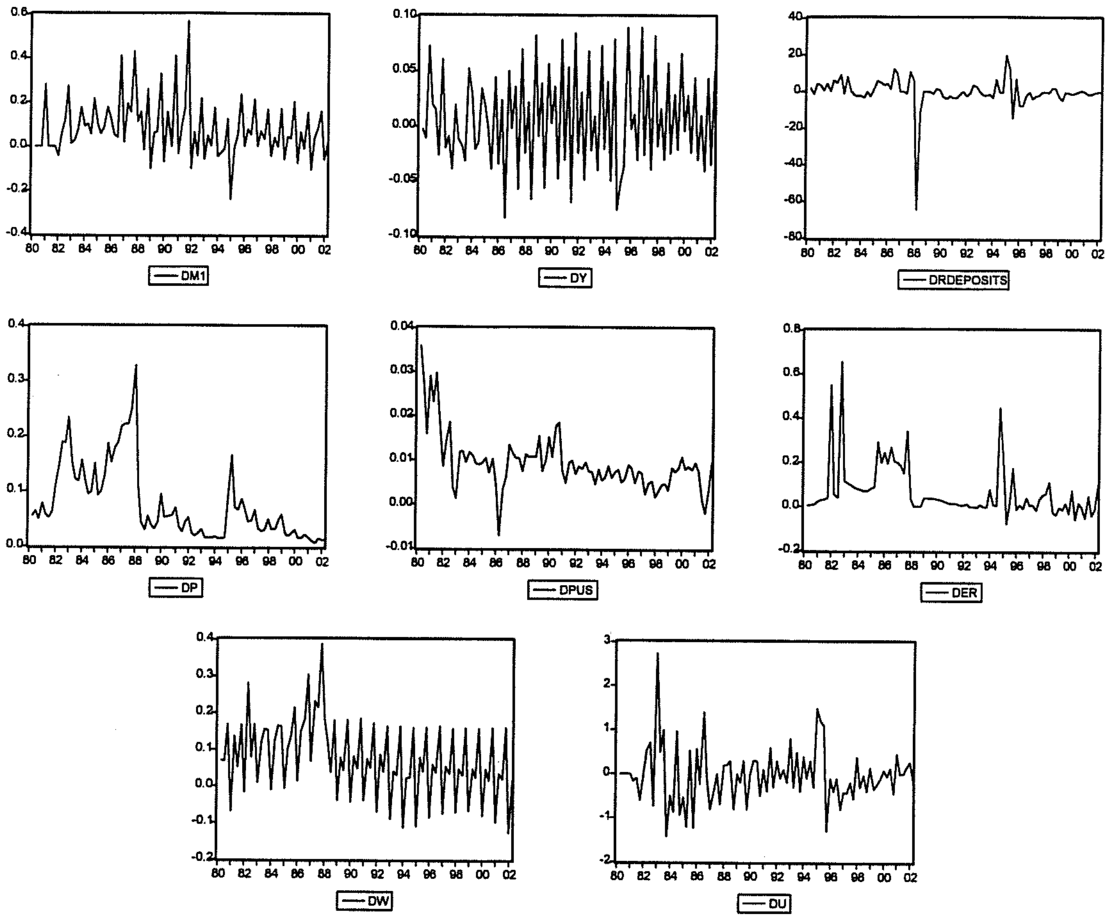


Figure 4. Mexican Series in First Differences

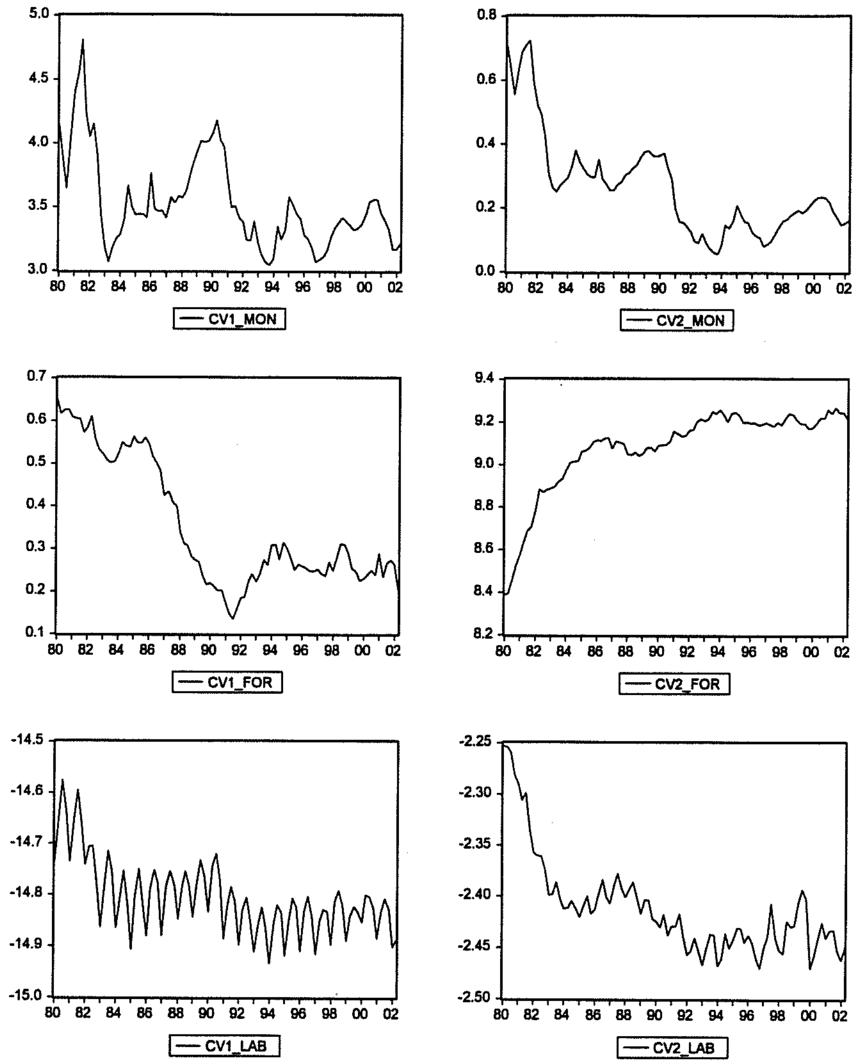


Figure 5. Cointegrating Vectors of Canada

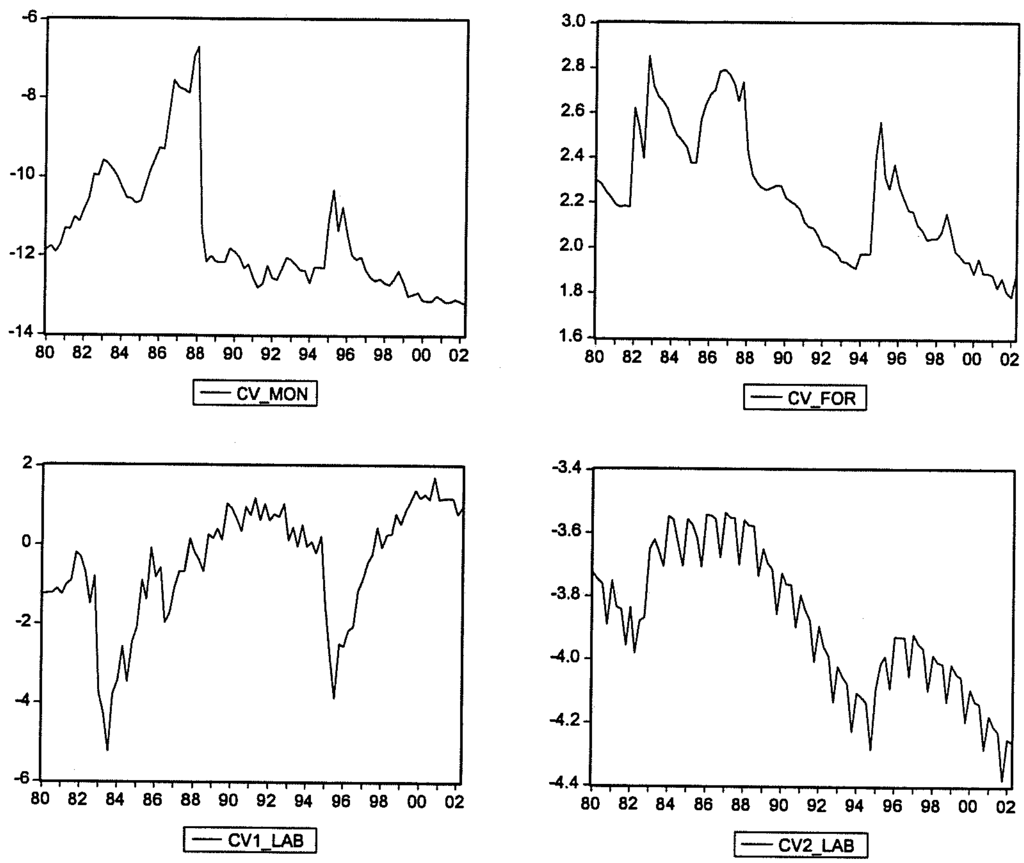
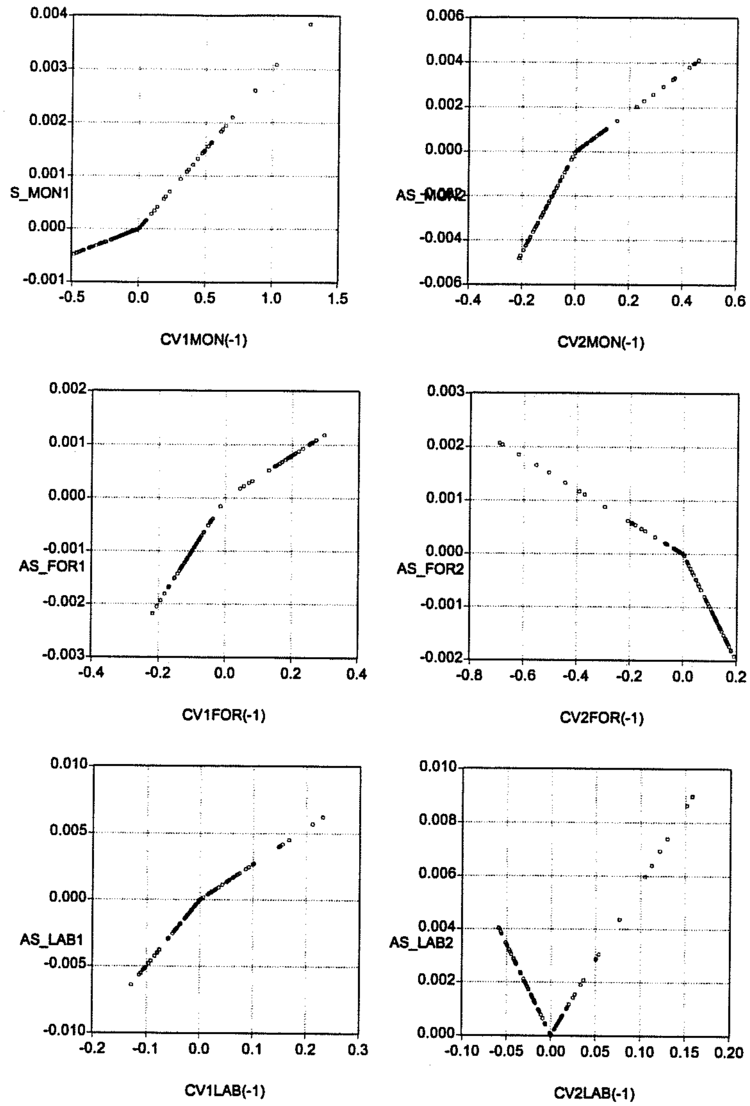


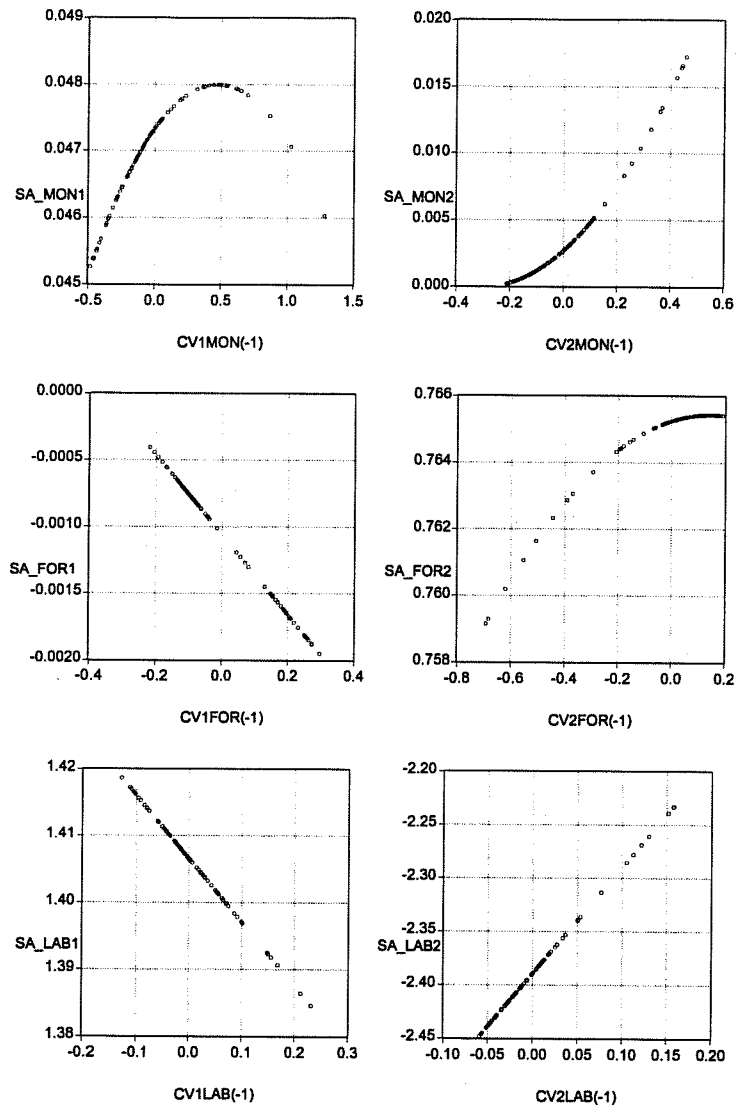
Figure 6. Cointegrating Vectors of Mexico

Figure 7. Asymmetric Adjustments in Canadian Inflation



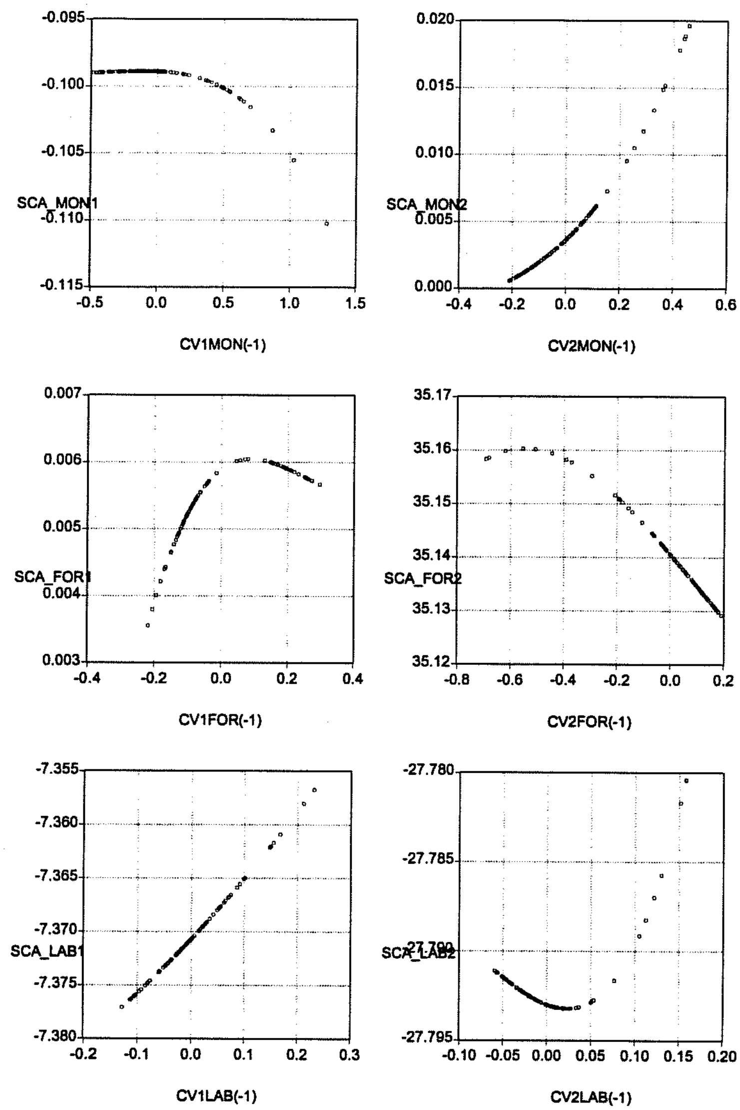
$$(a)\ AS_{1t}^{mon-can} = 0.003cv_{1t-1}^{mon-can+} + 0.001cv_{1t-1}^{mon-can-}$$
$$(b)\ AS_{2t}^{mon-can} = 0.009cv_{2t-1}^{mon-can+} + 0.023cv_{2t-1}^{mon-can-}$$
$$(c)\ AS_{1t}^{for-can} = 0.004cv_{1t-1}^{for-can+} + 0.010cv_{1t-1}^{for-can-}$$
$$(d)\ AS_{2t}^{for-can} = -0.010cv_{2t-1}^{for-can+} - 0.003cv_{2t-1}^{for-can-}$$
$$(e)\ AS_{1t}^{lab-can} = 0.027cv_{1t-1}^{lab-can+} + 0.050cv_{1t-1}^{lab-can-}$$
$$(f)\ AS_{2t}^{lab-can} = 0.057cv_{2t-1}^{lab-can+} - 0.068cv_{2t-1}^{lab-can-}$$

Figure 8. Non-Linear (Square) Adjustments in Canadian Inflation



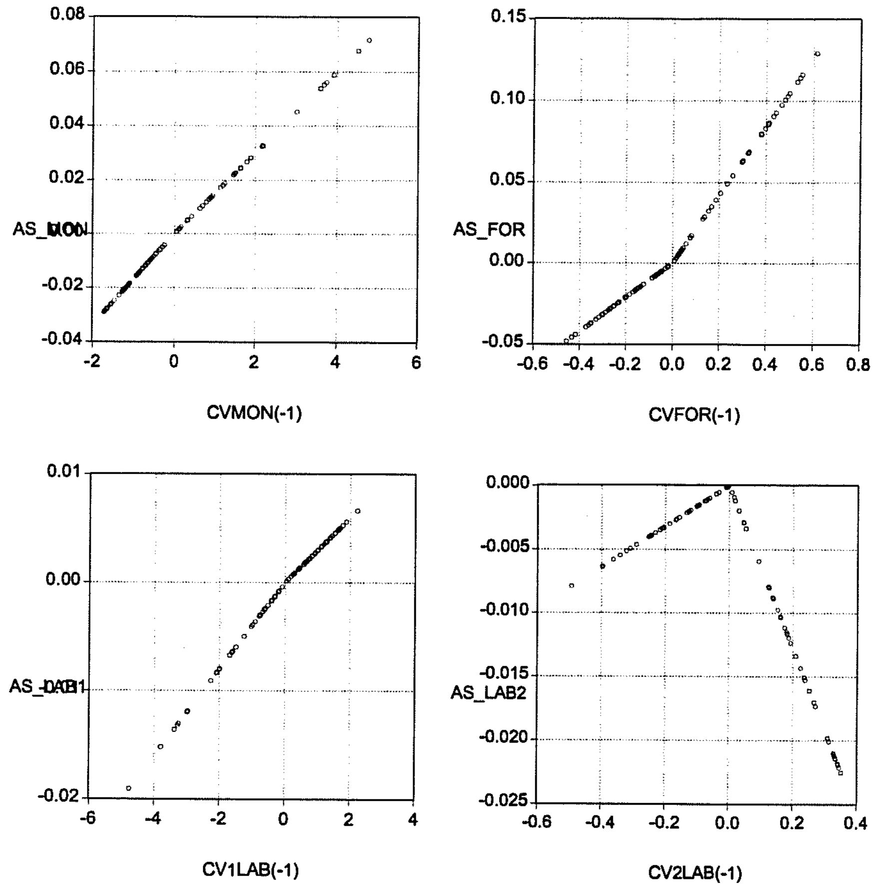
$$(a)\ SA_{1t}^{mon-can} = 0.024cv_{1t-1}^{mon-can} - 0.003(cv_{1t-1}^{mon-can})^2$$
$$(b)\ SA_{2t}^{mon-can} = 0.002cv_{2t-1}^{mon-can} + 0.0301(cv_{2t-1}^{mon-can})^2$$
$$(c)\ SA_{1t}^{for-can} = 0.026cv_{1t-1}^{for-can} - 0.029(cv_{1t-1}^{for-can})^2$$
$$(d)\ SA_{2t}^{for-can} = 0.166cv_{2t-1}^{for-can} - 0.009(cv_{2t-1}^{for-can})^2$$
$$(e)\ SA_{1t}^{lab-can} = -0.090cv_{1t-1}^{lab-can} - 0.005(cv_{1t-1}^{lab-can})^2$$
$$(f)\ SA_{2t}^{lab-can} = 0.818cv_{2t-1}^{lab-can} + 0.173(cv_{2t-1}^{lab-can})^2$$

Figure 9. Non-Linear (Square and Cube) Adjustments in Canadian Inflation



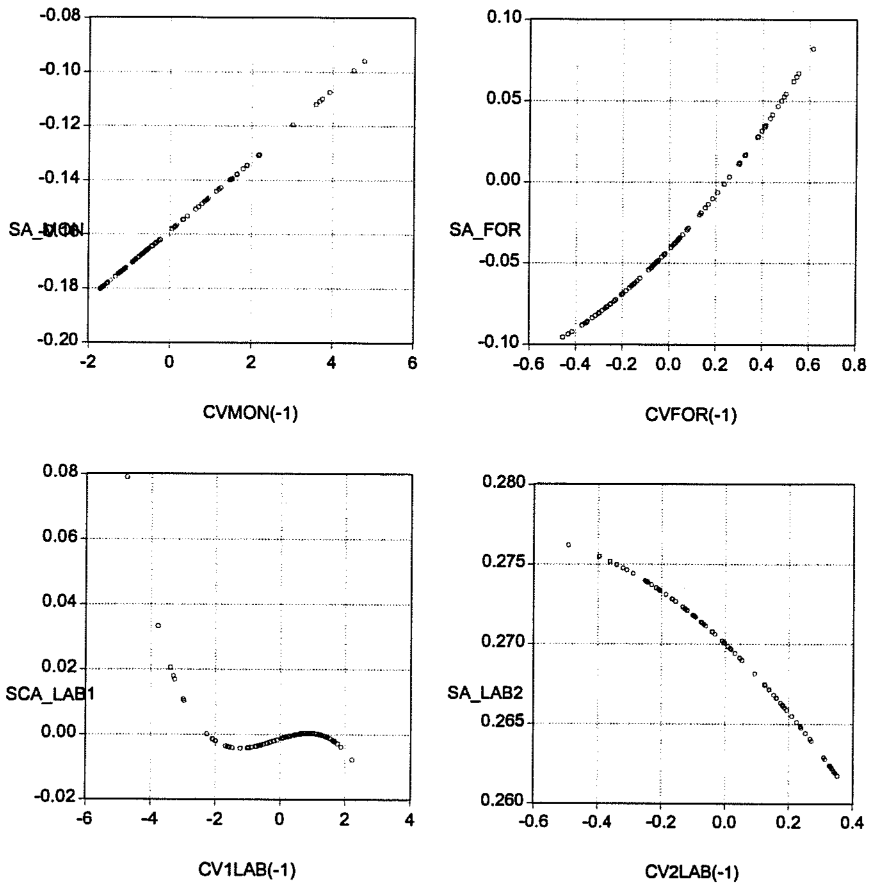
$$(a)\ SCA_{1t}^{mon-can} = -0.093cv_{1t-1}^{mon-can} + 0.029(cv_{1t-1}^{mon-can})^2 - 0.003(cv_{1t-1}^{mon-can})^3$$
$$(b)\ SCA_{2t}^{mon-can} = 0.009cv_{2t-1}^{mon-can} + 0.012(cv_{2t-1}^{mon-can})^2 + 0.018(cv_{2t-1}^{mon-can})^3$$
$$(c)\ SCA_{1t}^{for-can} = 0.034cv_{1t-1}^{for-can} - 0.061(cv_{1t-1}^{for-can})^2 + 0.034(cv_{1t-1}^{for-can})^3$$
$$(d)\ SCA_{2t}^{for-can} = 11.591cv_{2t-1}^{for-can} - 1.268(cv_{2t-1}^{for-can})^2 + 0.046(cv_{2t-1}^{for-can})^3$$
$$(e)\ SCA_{1t}^{lab-can} = 0.942cv_{1t-1}^{lab-can} + 0.030(cv_{1t-1}^{lab-can})^2$$
$$(f)\ SCA_{2t}^{lab-can} = 33.816cv_{2t-1}^{lab-can} + 13.700(cv_{2t-1}^{lab-can})^2 + 1.848(cv_{2t-1}^{lab-can})^3$$

Figure 10. Asymmetric Adjustments in Mexican Inflation



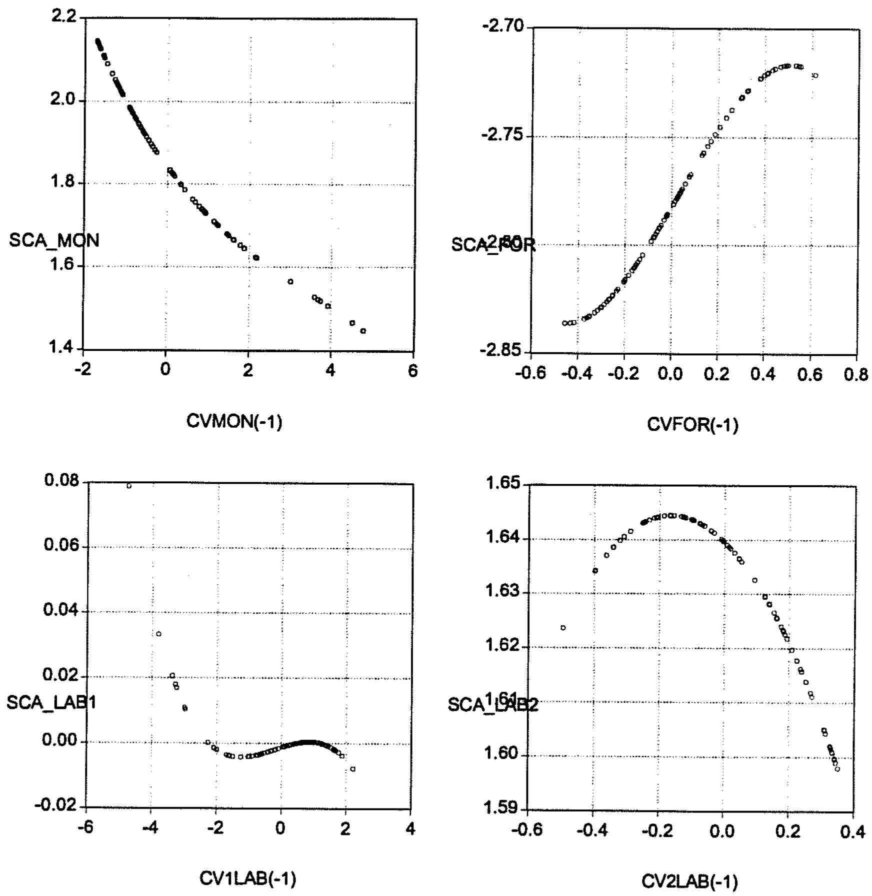
$$(a)\ AS_{1t}^{mon-mex} = 0.015cv_{1t-1}^{mon-mex+} + 0.017cv_{1t-1}^{mon-mex-}$$
$$(b)\ AS_{1t}^{for-mex} = 0.210cv_{1t-1}^{for-mex+} + 0.106cv_{1t-1}^{for-mex-}$$
$$(c)\ AS_{1t}^{lab-mex} = 0.003cv_{1t-1}^{lab-mex+} + 0.004cv_{1t-1}^{lab-mex-}$$
$$(d)\ AS_{2t}^{lab-mex} = -0.064cv_{2t-1}^{lab-mex+} + 0.016cv_{2t-1}^{lab-mex-}$$

Figure 11. Non-Linear (Square) Adjustments in Mexican Inflation



$$(a)\ SA_{1t}^{mon-mex} = 0.015cv_{1t-1}^{mon-mex} + 0.0001(cv_{1t-1}^{mon-mex})^2$$
$$(b)\ SA_{1t}^{for-mex} = -0.191cv_{1t-1}^{for-mex} + 0.077(cv_{1t-1}^{for-mex})^2$$
$$(c)\ SA_{1t}^{lab-mex} = -0.001cv_{1t-1}^{lab-mex} - 0.001(cv_{1t-1}^{lab-mex})^2$$
$$(d)\ SA_{2t}^{mon-mex} = -0.120cv_{2t-1}^{lab-mex} - 0.013(cv_{2t-1}^{lab-mex}$$

Figure 12. Non-Linear (Square and Cube) Adjustments in Mexican Inflation



$$(a)\quad SCA_{1t}^{mon-mex} = -0.448cv_{1t-1}^{mon-mex} - 0.048(cv_{1t-1}^{mon-mex})^2 - 0.002(cv_{1t-1}^{mon-mex})^3$$

$$(b)\quad SCA_{1t}^{for-mex} = -4.041cv_{1t-1}^{for-mex} + 1.861(cv_{1t-1}^{for-mex})^2 - 0.273(cv_{1t-1}^{for-mex})^3$$

$$(c)\quad SCA_{1t}^{lab-mex} = 0.0942cv_{1t-1}^{lab-mex} + 0.030(cv_{1t-1}^{lab-mex})^2$$

$$(d)\quad SCA_{2t}^{lab-mex} = -0.467cv_{2t-1}^{lab-mex} + 0.070(cv_{2t-1}^{lab-mex})^2 + 0.021(cv_{2t-1}^{lab-mex})^3$$