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The inflation Targeting effect on the inflation series: A New Analysis Approach of evolutionary spectral analysis

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Abstract

In this work, we study the inflation targeting effect on the inflation dynamics in the case of four industrial countries. Our objective is to check whether the inflation targeting policy (ITP) has a significant impact on the change of the inflation path. We use a non-parametric approach that doesn't require any previous modelling. This is the evolutionary spectral analysis, as defined by Priestley (1965-1996). Then, we use a test that can detect many break points on the time series. This test is inspired by Subba Rao (1981). We use an extension to this test to allow the detection of multiple breaks. We base this on the extension of Ahamada and Boutahar (2002). This is the first time that this method is used in the case of inflation-targeting countries. We find that the inflation-targeting policy had a transition period for countries that had a high and volatile inflation experience before the inflation-targeting adoption. There is the case of New Zealand, Canada and Sweden. In these countries, we identify a structural change in the inflation series resulting to the inflation targeting intervention. However, In the case of other countries like United Kingdom that have a relatively lower inflation rate experience before the ITP adoption, we didn't find a break point caused by this monetary policy intervention. In this case, the ITP had a role of ensuring this price stability. This result is explained by the fact that the inflation targeting is relevant when the initial inflation to be stabilized is near the target range (Artus, 2004). So, in this paper we justify the intuition of Artus (2004). The second result in our paper consists on the nature of inflation stabilization during the inflation-targeting period. The results proof a long-term stabilization on the inflation dynamic in the period of IT. These results traduce the success of this new framework to anchor the inflation expectation anchoring. So, we can conclude that this policy is preferment to ensure price stability in the case of industrials countries.

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1 Introduction

The inflation-targeting policy was adopted without the inherent theory. The practice of this policy precedes its theory, which came later: Svenson (1999, 2000), Walsh (1998), Woodford (2003) and Gionnoni and Woodford (2003). As a result of the lateness of the inflation-targeting theory, many debates arose. The recent debate has been about the macroeconomic performance of the ITP.

Many researchers have attempted to check whether the adoption of ITP originated a structural change in the economy. In these work, we find two kinds of results. On one hand, some economists conclude that the IT made no statistical difference to the macroeconomic performance of IT countries (Honda, 2000; Hum, 1996; Bernanke and Mihov, 1998; Bernanke et al, 1999; Lane and Van Den Heuvel, 1998; Da Silva and Portugal, 2000). Some of them prove the ITP didn't cause a structural break in the inflation rate path. On the other hand, some authors show a contradictory conclusion (Almeida and Goodhrat, 1996; Laxton et al., 1994; Fillon and Leonard, 1997; Choi, Jung and Shambora, 2003; Pétursson, 2004;). They conclude that the ITP reduced inflation persistence and they identify a structural break in the inflation dynamic caused by the ITP.

The research cited above uses a less rigorous case-study approach. Indeed, much research is based on the VAR model. This technical model wasn't interested in the stationary state of the data. These VAR models anticipate a return in the historical value of the data that did not exist. This mis-specification biases the result. In addition, some of these studies check the existence of the break in the inflation data by using the error prevision technique. This method consists in using some econometric models (ARCH, ARMA, GARCH and VAR) to model the inflation rate. Then, they estimate the values of inflation for a period prior to the adoption of ITP. Next, they use the estimated models to make a prediction for the post-target period. After that, they test the significant difference between the real value and the predicted value. In this approach, we suggest that the model following the ARMA (or GARCH) process with structural change could be confused with the ARIMA (or IGARCH) model. So, the possibility of mis-specification is present in this technique. Another approach consists in dividing the data of inflation into two sub-series. The first is just before the IT adoption. The second sub-sample starts from this date up to now. Then, they apply a Chow test. They conclude that the ITP did not cause a structural break. We suggest that this technique is less rigorous because the authors test whether the date of IT adoption is the date of a structural break or not. Other research uses the Markov Switching or CUSUM test. These techniques can detect only one break.

The purpose of this paper is to examine the possibility of structural change in the inflation data following the adoption of IT. We also check the effectiveness of this policy by the character of stability on inflation. Thus, we hope to achieve two goals: one is to contribute to the quantitative literature on the topic; and the other

is to have a more reliable yardstick in hand before recommending that any Central Bank joins the IT bandwagon.
Our empirical technique is used for the first time on the case of inflation-targeting theory. Indeed, we adopt the evolutionary spectral analysis as defined by Priestley (1965-1996). Then, we base the test on that of Subba Rao (1981) to detect the break point endogenously. Then, we adopt an extension of Ahamada and Boutahar (2002) to allow this test to detect multiple break points. This method is based on frequency analysis, which is the reason for our choice of this method. Indeed, the frequencies analysis gives us the character stability in the data after every break point. So, we wait to find a medium-term or long-term stability of the inflation during the period of the inflation-targeting policy. In this case, we justify the effectiveness of this policy because its principal objective is to ensure price stability.
The paper is organized as follows. Section 2 is an empirical analysis. Section 3 consists of data and results. Then, section 4 concerns interpretations. The last section encompasses the conclusion.

2 Empirical Analysis

2.1 Theory of the evolutionary spectrum

In this section, we start with the definition of the evolutionary spectrum proposed by Priestley (1965). Then, we present the estimation method of the evolutionary spectrum (Priestley, 1965, 1988). At the end, we present the test that we defined based on the test presented by Subba Rao (1981) and the extension of Ahamada and Boutahar (2002).

2.1.1 Definition

The theory of the evolutionary spectrum of Priestley (1965) is concerned with the non-stationary process that is defined as follows:

$$X_t = \int_{-\pi}^{\pi} A_t(w) e^{iwt} dZ(w). \tag{1}$$

where, for each w, the sequence $A_t(w)$is a time dependent and has a generalized Fourier transform whose modulus has an absolute maximum at the origin. $dZ(w)$ is an orthogonal process on$[-\pi, \pi]$ with $E[dZ(w)] = 0$, $E[|dZ(w)|^2] = d\mu(w)$ and $\mu(w)$ a measurement. Without loss of generality, the evolutionary spectral density of the process $X_t$is defined by $h_t(w)$ as follows:

$$h_t(w) = \frac{dH_t(w)}{dw}, -\pi \leq w \leq \pi. \tag{2}$$

Where $dH_t(w) = |A_t(w)|^2 d\mu(w)$. The variance of X_t at t is:

$$\sigma_t^2 = Var(X_t) = \int_{-\pi}^{\pi} h_t(w) dw \tag{3}$$

2.1.2 Estimation of the evolutionary spectrum

According to Priestley (1965), the estimation of the evolutionary spectrum is performed by using two windows g_u and w_v.
Without loss of generality, $\widehat{h_t}(w)$ is constructed as follows:

$$\widehat{h_t}(w) = \sum_{v \in Z} w_v |U_{t-v}(w)|^2, \tag{4}$$

Where $U_t(w) = \sum_{u \in Z} g_u X_{t-u} e^{-iw(t-u)}$. We choose g_u and w_r in the following way:

$$g_u = \left\{ \begin{array}{cc} 1/(2\sqrt{h\pi}) & if|u| \leq h \\ 0 & if|u| > h \end{array} \right| \tag{5}$$

$$w_v = \left\{ \begin{array}{cc} 1/T' & if|v| \leq T'/2 \\ 0 & if|v| > T'/2 \end{array} \right| \tag{6}$$

In this paper, we take $h = 7$ and $T' = 20$. We opt for this choice, as do Priestley (1995), Artis et al. (1992), Ben Aissa and Ahamada (2004) and Boutahar and Ahamada (2002). According to Priestley (1988), we have $E(\widehat{h}(w)) \approx h_t(w)$, $var(\widehat{h}(w))$ decreases when T' increases.
$\forall(t_1, t_2), \forall(w_1, w_2)$, $cov(\widehat{h_{t_1}}(w_1), \widehat{h_{t_2}}(w_2)) \approx 0$, if one of the two conditions (i) and (ii) are satisfied.

$$(i) \quad |t_1 - t_2| \geq T' \qquad (ii) \quad |w_1 \pm w_2| \geq \pi/h \tag{7}$$

2.2 Test detecting structural break

The test that we will present is carried out from the test of Subba Rao (1981). This test consists of checking the stability of the spectral density around a reference value. The approach requires the preliminary choice of a reference value k around which are supposed to fluctuate the values of the spectral density. This test was used by Artis et al. (1992), but they didn't provide a rigorous justification for the choice of the value K. We base this limit on the proof of Ahamada and Boutahar (2002). This proof allows us to resolve the problem of the choice of the reference value . Now, we will present the test.
let X_t be a non-stationary process that represents the inflation date for each country in this study. According to Priestley (1965), it has an evolutionary spectral density $h_t(w)$. Let $(t_i)_{i=1}^I$be a set of size I representing the time scale in which the elements satisfy the condition (i) given in (2.5). According to Priestley and Subba Rao (1969), $h_{iw} = log(h_{ti}(w))$ and $Y_{iw} = log(\widehat{h_{t_i}}(w)$, where $\widehat{h_{t_i}}(w)$is an estimator of $h_{t_i}(w)$ according to equation (4).
$\mu_w = \frac{1}{I}\sum_{i=1}^I Y_{iw}$; $\hat{\sigma}_w^2 = \frac{1}{I}\sum_{i=1}^I (Yiw - \mu_w)^2$ and $S_r^w = \frac{1}{\hat{\sigma}_w\sqrt{I}} \sum_{i=1}^r (Y_{iw} - \mu_w)$ when $r = 1, ..., I$ According to Priestley (1988), we have:

$$Y_{iw} \approx h_{iw} + e_{iw}, \tag{8}$$

The sequence e_{iw} is approximately independent and identically distributed normally. stable frequency concept implies that, for all $w \in (-\pi, \pi)$, we say that w

is a stable frequency of the process X_t if the value of the evolutionary spectral density evaluated at w is independent of time. In other words, $h_t(w) = c_w$ is a time independentn constant. Then, a process is stationary if its spectral density is independent of time, and therefore if all frequencies are stable.

The test T_w that detects the structural break in inflation series consists of testing the null hypothesis of the stability of w at the significance level α, i.e. $Pr(T_w > C_\alpha)$[1]. We will adopt the proof of Ahmada and Boutahar (2002) to determine the limited distribution of T_w based on the theorem of Ploberger and Kramer (1992). According to this approach, the test T_w consists of detecting the maximum value of S_r^w. This test is presented as follows:

$$T_w = max_{r=1,...,I}|S_r^w|, \tag{9}$$

The methodology of the test presented up to now has some advantages. It can detect the unstable frequencies and the date from which they emerge. Indeed, if the instable frequency is close to zero, then the observed regime-shift concerns the long-term, otherwise it is about an instability concerning the middle- or short-term. The problem is that, until this step of analysis, we can detect only one break, because we take the maximum value of . Then, if another break point in the series exists, this procedure of estimation can detect it. For this reason, we take the procedure of Inclan and Tiao (1994). They use an iterative algorithm based on the CUSUM test to detect the variance instability. Ben Aîssa and Ahamada adopt this algorithm to detect different structural break points in USA inflation series. The procedure of the test is as follows:

1. The first step is to estimate a maximum value of , i.e. we determine the frequency with which it reached the highest value. Two cases are possible in this step:
   (a) If $T_w = |S_{rmax}^w > C_\alpha|$, then the point r_max is considered as the first break point. We start the second step.
   (b) If $T_w = |S_{rmax}^w > C_\alpha|$, then a break point did not exist in this series. The programme ends.
2. Two sub-samples are derived from the results of 1-a, the first from the beginning of the date until the date of the first break point detected in 1-a, and the second from the date of break +1 until the end of the data. To these two sets, we re-apply the test. This step is to seek the existence of another break point. During this stage, we can determine at most two new breaks. Two cases exist in this step.
   (a) If we identify a new break in these sub-samples, we continue the same procedure as in step 2. We devise the two previous sub-samples on four samples limited by the new break and re-apply the test. The programme is set up if we don't identify a new break after the last division of data.
   (b) If we don't detect a new break in these sub-samples, the programme ends. The conclusion is the existence of one break point.

[1] $C_{0.1=1.22}$, $C_{0.05=1.36}$ and $C_{0.01=1.63}$.

3 Data and Results

3.1 Data

The data were collected from the consumer price indices (CPI) of all items in Canada, New Zealand, Sweden and the United Kingdom from the IMF International Financial Statistics (IFS) database. The inflation data for all the countries,π, are calculated from the CPI, as:

$$\pi = Ln\frac{CPI_t}{CPI_{t-1}} \tag{10}$$

The period of the studies is 1960Q1-2007Q1 for all the countries. The choice of this period is due to two reasons. On one hand, the evolutionary spectral analysis needs a large number of observations. On the other hand, we need to compare our result with some other research on this topic, which uses the same period.

3.2 Results

Table 1: Break date and mean of inflation for each sub periods

countries	$\widehat{T}_1$		$\widehat{T}_2$		$\widehat{T}_3$	
United-Kingdom	1970Q3		1982Q3		1988Q3	
	0.0098	0.0304		0.0111		0.0086
Sweden	1970Q3		1976Q3		1988Q3	
	0.0097	0.0198		0.0201		0.0065
Canada	1982Q3		1988Q3		1994Q3	
	0.0142	0.0110		0.0076		0.0050
New Zealand	1988Q3					
	0.0216	0.0062				

Table 2: Frequencies of each break point

countries	Break date	Frequecies						
United-Kingdom	1970 Q3							$19\pi/20$
	1982 Q3		$4\pi/20$	$70\pi/20$	$10\pi/20$			
	1988 Q3	$\pi/20$				$13\pi/20$	$16\pi/20$	
Canada	1982 Q3		$4\pi/20$	$7\pi/20$	$10\pi/20$		$16\pi/20$	
	1988 Q3	$\pi/20$						$19\pi/20$
	1994 Q3					$13\pi/20$		
New Zealand	1988 Q3	$\pi/20$	$4\pi/20$	$7\pi/20$	$10\pi/20$	$13\pi/20$	$16\pi/20$	$19\pi/20$
Sweden	1970 Q3							$19\pi/20$
	1976 Q3					$13\pi/20$	$16\pi/20$	
	1998 Q3	$\pi/20$	$4\pi/20$	$7\pi/20$	$10\pi/20$			

These tables summarize the result of our empirical methodology. The first shows different break points that occurred in the four countries. In the second table, we find the different frequency that allow us the know information about the nature of stability after each structural break.

4 Interpretation

Tables 1 and 2 summarize the results. As we show in these tables, our methodology allows us to identify more than two breaks from one country. In addition to this advantage, Table 2 gives information about the stability (instability) character. In this section, we try to analyse the economic facts occurring in this period of study to show if these results are significant.

4.1 Case of New Zealand

The result of Table 1 shows one structural change in the New Zealand (NZ) inflation dynamic. The break point occurred in the third quarter of 1988. Thus, the NZ inflation rate has two different experiences: the first from January 1960 to the third quarter of 1988 and the second from this date up to now. We try to explain the economic events during this period to check whether this structural change was due to the inflation-targeting policy.

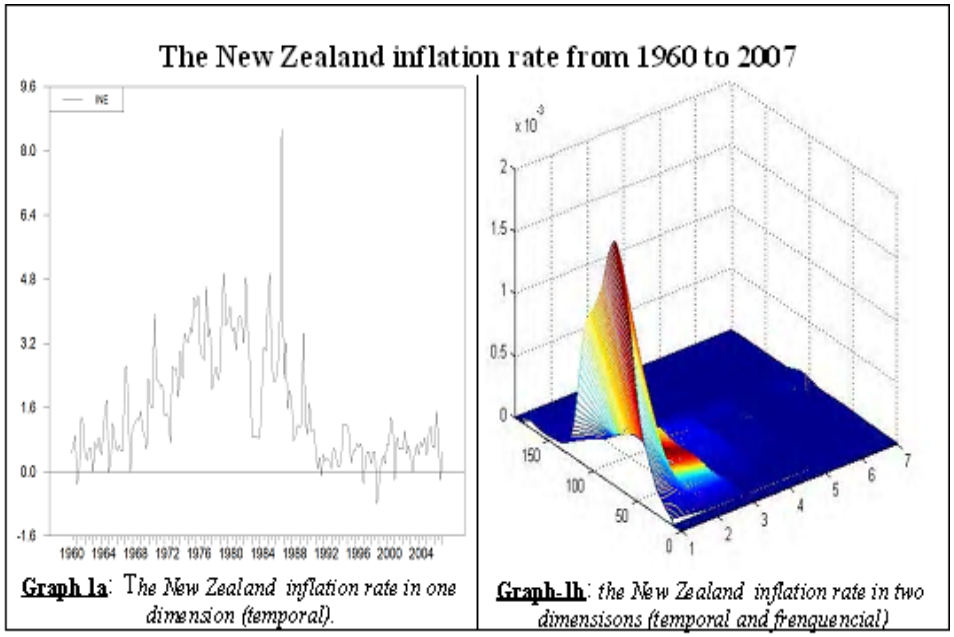


Figure 1: The NZ inflation rate graphics in two dimensions

During the period prior to 1988, NZ had an experience of volatile and high-level inflation rates. This was explained by some economic events. As indicated by the graphic (graph.1) above, at the beginning of 1960, the quarterly inflation rate had a level of 2%. At the beginning of 1967, the NZ inflation rate started to increase gradually. It reached a peak of 5% at the beginning of the 1970s. This was explained by some economic events. Indeed, after the Second World War, the principal trade partner was the United Kingdom. So, the integration of the United Kingdom into the European Community in 1973 ended its economic relations with New Zealand. This action represented a cultural and economic shock for New Zealand. It caused a contraction in the actual production and unevenness due to the loss of private income ensured by the Britannic market. These factors reduced the New Zealand economic growth and increased the inflation rate. In addition to this fact, the oil shock which occurred in 1973 aggravated the situation. It reached the bed of economic growth and high inflation rate in New Zealand.

The inflation stabilization was considered as a serious problem. Both monetary and political authorities tried to find new instruments and new economic policies to cure this problem. They made, in the 1970s, a wage and price control system. This policy didn't succeed in reducing inflation. At the beginning of the 1980s, they introduced a new policy, which consisted of a general blockade of wages, prices, interest rate, rent, dividend and exchange rate, but didn't succeed in stabilizing inflation. The successive failures of these systems caused the collapse of the political regime. The Labour Party won the legislature in 1984 and 1987. This political party came to power with an idea to act directly on inflation.

Indeed, starting from 1985, much radical reform was undertaken. These reforms were favourable to create successfully a disinflation environment. Indeed, after a 20% devaluation of the New Zealander dollar that put an end to foreign exchange market crises, decisions succeeded at a fast pace. In 1985, NZ abandoned the fixed exchange rate and allowed currency floating. So, the monetary policy became the only instrument to cure inflation. At the same time, they renounced the price and wage control. They involved the liberalization of capital accounts, banking liberalization, deregulation of interest rates, abolition of subsidized credit to interest groups/borrowers, removal of state guarantees for all private credit etc. Also, we find the liberalization of foreign investment to the effect that they had virtually no restrictions on foreign investment. In addition, they introduced the liberalization of international goods and services trade, the deregulation of product markets, the rationalization of competition policy and the instauration of goods and services tax in 1986 at the rate of 10%. In 1989, the Reserve Bank of New Zealand becomes independent.

All these reforms contributed to increasing the confidence degree from the public to the labour party. This confidence is resulted by the winning of the election in 1987. All these reforms contributed to the progress of the inflation rate decrease. So, these were the reasons that contributed to the progress ensuring the falling inflation rate from 1985 to 1988, as indicated by Figure 1 (inflation decreased by 9 percentage points after March 1985). According to Hodgettes and Clements (1989), we can say that the fall of inflation starting in 1985 was due to domestic influences,

including gains and wage growth, and the firming exchange rate was revealed as having the strongest contribution to disinflation over the whole of 1988. We suggest that these reforms are an objective of the preparation of an inflation-targeting climate.

We conclude to the idea of the inflation targeting climate preparation because, in 1985, the New Zealand Reserve Bank received the instruction to act directly on inflation. In early April 1988, Roger Douglas[2] (Brash, 2000) said "we should get inflation down to a range of 0 to 2% per annum". We can conclude from the citation of the Minster of Finance that the inflation-targeting climate was prepared and that is the date on which the ITP can be established. This date coincides with the date of structural change in the inflation dynamic that we find. So, it is the date of cut of the higher inflation rate. In this case, we can justify our result by the theoretical conclusion of Artus (2004), who said, "The inflation targeting is relevant when the initial inflation to stabilize is near to the target range". Thus, we justified this conclusion empirically. Indeed, it is completely logical to find a period that we name the "period of IT preparation climate". This period is characterized by some radical reforms to establish a disinflation environment with the objective of having a lower inflation level. Then, we can adopt the ITP to ensure this level throughout the period. We suggest that these reforms must increase to a degree of confidence on the actions taken by the policy-makers. This is the case of New Zealand when, six months after this announcement, it gains its independence.

Our result appears very significant. Indeed, a recent debate exists about the date of ITP adoption that we must consider. Indeed, Fracasso et al. (2003) consider the date of April 1988 as the date of the official adoption of IT in the case of New Zealand. Bernanke and Mishkin (1997) consider April 1989 as the official date[3]. Plantier and Scrimgeours (2002) say that the date of the official adoption of ITP is February 1990[4]. We suggest that, whatever the date of adoption, the break point that occurred in the third quarter of 1988 was owing to the inflation-targeting policy. This point occurred because the case of New Zealand had an experience of a high inflation rate before this policy. So, the inflation rate must remain at a lower level near to the target range.

From this analysis, we justify the ITP causing a change in the inflation dynamic. This analysis contributes to the theoretical literature of inflation targeting because we define in this paper the notion of a "climate preparation period" occurring before the adoption of this policy. Artus (2004) and Lee (1999) call it the disinflations environment, but they don't provide any empirical justification. In this period, we will prepare all the success conditions for this policy. In addition, our analysis proves some responses to the debate of inflation targeting as a framework or a simple rule. According to our analysis, it is clear that the ITP is a framework.

The second important result provided by our empirical methodology is given by the frequency interpretation (shown in Table 2). The result and graphic show a frequency of stability ensured since 1989. Our test suggests that the stability has a

[2]Minister of Finance in 1984 in New Zealand. He is a Labour Party member.

[3]Date of the Central Bank independence.

[4]Date of publication of the first policy target agreement.

long-run character. This is an attempt result. Indeed, the inflation targeting had a medium-term objective of price stability. In the case of New Zealand, the first PTA was fixed in 1989 and had a three-year horizon; after that, the New Zealand reserve bank modified the PTA according to the economic evolution to satisfy the objective of a low inflation rate. However, in 1993, the objective fixed by the first PTA was prolonged to the end of 1995, so it ensured the continuity in the price stability at the medium-term inflation rate reached long-term price stability. That is the reason we can say that ITP was a successful policy in the case of New Zealand.

4.2 Case of Canada

In this case, our test identifies three break points. The first occurred in the third quarter of 1982. The second break point came in about the third quarter of 1988 and the last occurred in the third quarter of 1994. Our result appears very significant, because these four phases of inflation are clear in the graphic (Figure 2) and correspond to some important economic events.

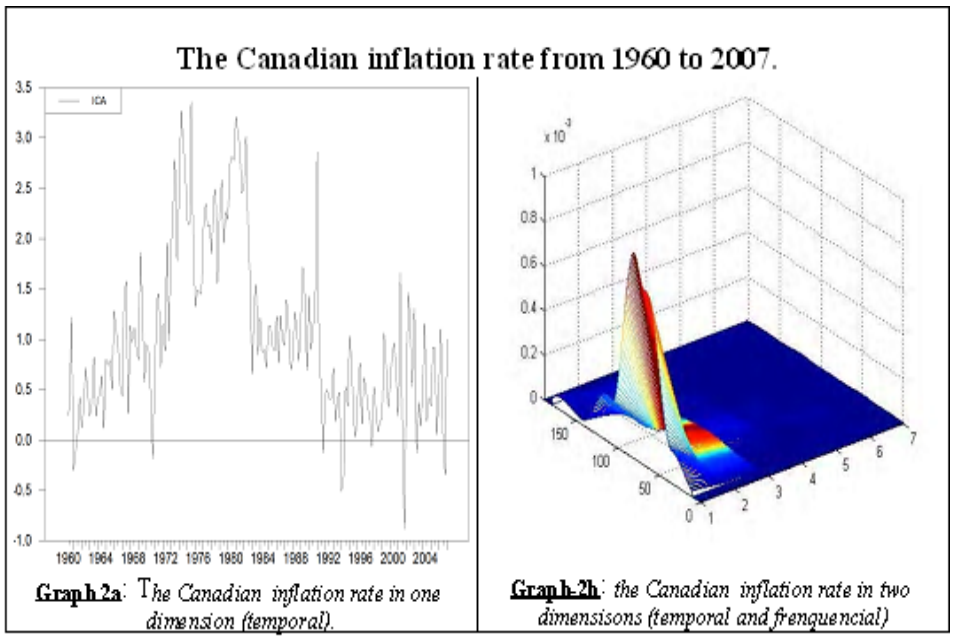


Figure 2: The Canadian inflation rate graphics in two dimensions

The Canadian inflation rate had a bad experience during the 1960s and 1970s. This high inflation rate was explained by several reasons. The two oil crises in the 1970s played an important role. In addition, Bordo and Redish (2005) suggest that the monetary policy followed at this period was at the root of this high inflation

rate. Indeed, in this period, the policy-makers adopted a Monetarist monetary policy[5] based on the control of prices and wages. Targeting M1 concretized this approach. The range target was fixed at the beginning between 10% and 15%. Then, this range was cut back to 8-12%. This attempt successfully reduced the inflation rate in 1978 (as shown in Figure 2) but the inflation remained high in 1979. This has been explained by some facts. On one hand, some innovations were introduced into the financial market, which weakened the relationship between M1 and nominal expenditure. On the other hand, there was the occurrence of the second oil shock in 1979. So, the successive failure of these monetary policies to ensure price stability let the policy-makers test another approach. In 1982, they chose to control inflation with a discretionary policy. This date of monetary policy change coincides with our second break point, which occurred in the third quarter of 1982. This break point had a medium-term frequency. In other words, the inflation became stable around 1.1% for a medium period. As a consequence of the divergence between the expectations of the economic entity and those of the policy-makers, this policy didn't have a long-term effect. That's why the Canadian inflation rate remained higher in 1984. This is proved by our result that shows a short-term character of the frequency of the break point occurring at this period, as indicated in Table 2.

In the middle of the 1980s, many conferences and seminars were organized to present to the public what the inflation-targeting policy meant. In this context, Governor Bouey (1985) said, "we are finding a place to stand ... what doesn't mean inflation targeting policy"[6]. This citation lets us think that he was talking about the solution of practising the inflation-targeting policy, because he explains that they must define exactly what the inflation-targeting policy doesn't mean and define it in the best way. In 1987, there was a growing shared desire to create a policy that would provide a better anchor for inflation expectations, since the policy-makers remembered the Act[7] of 1967. Moreover, for the objective to be credible, the government's backing is required. So, starting from this period, the policy-makers explained to the public what inflation targeting doesn't mean and they insisted on the Bank of Canada's independence. So, we agree with the idea of Ravenna (2002), who proves a structural break between the time of monetary policy shift and inflation targeting. Indeed, he explains that Canada implemented an inflation-targeting policy after having established a great level of credibility. Since 1988, the numbers of seminar on the Canadian Bank has arisen to present the inflation-targeting policy and the act of independence of the Central Bank. Our result shows a structural change in the inflation series in the third quarter of 1988. This break can be explicated by the rise of the credibility and transparency levels on the policy-makers' action linked to the climate preparation of inflation targeting. Our result converges with some studies. Indeed, Dodge (2002) and Ravenna

[5]Rule of K% proposed by Friedman (1959).

[6]Bordo and Redish (2005, p. 8).

[7]The Bank of Canada Act has granted a directive power to the government that allows to it to instruct openly the bank to carry out specific actions over a specific time period. This power has never been used.

(2002) proved that the Canadian inflation dynamic had changed since 1988. In addition, McCallum (1996) said, "*The ultimate realization of a stable price level has become the focal point of monetary policy in 1988 when Governor John Crow gave to Eric J. Hanson January 18, 1988, a plan (Memorial Lecture), where he expressed that they want to reduce inflation to achieve, ultimately, to price stability. During this conference the governor of the time (Crow) explained that the regime of inflation targeting could not begin until February 1991*". According to this citation, we conclude that our result is very pertinent. Because the date of 1988 corresponds to an inflation level very much lower, near to the range target fixed in 1991, it must realize some progress on the credibility and transparency level before the effective establishment of an inflation-targeting policy. This break point provides a long-term character of stability. In other words, the Canadian inflation became stable around a mean value of 0.8% (as indicated by Tables 1-2). The official announcement of the inflation-targeting policy came in February 1991. An agreement was signed between the Central Bankgovernor and the Minister of Finance, and was published in the form of a press release. So, between 1988 and 1991, some actions to progress the credibility and transparency levels were at work. This is justified by our result, as we find a third structural change in the third quarter of 1994. Canada has conducted the reforms in a gradual manner. The third point of rupture reflects the perfect anchoring of inflation expectations, which led to an average inflation rate of 0.5% since 1994, while during 1988 to 1994 it was 0.8%. This break may be explained by the change of the Central Bank's governor in 1991, which led to a range target change. In 1991, the target range was fixed at with an allowed variation of . In 1994, the Bank of Canada acted on the monetary condition index (MCI). This break had a medium-term stability character. This result is fully logical. After long-term stability found in 1988 and after the progress on credibility actions, it is logical to detect a reduction of the inflation rate to an average value of 0.5% and have a medium-term objective. Indeed, we conclude that, in 1994, the inflation-targeting policy succeeded in the anchoring of the expectation of inflation.

In conclusion, our result appears significant and coherent with the Canadian economic history. The case of Canada shows that the inflation-targeting policy influences the inflation dynamic. This influence depends on the manner in which we carry out the reforms. For example, some differences exist between the New Zealand and Canada cases. New Zealand carried out the reforms in a radical manner. Canada, after progress on inflation reduction, then preoccupied itself with the transparency and credibility level.

4.3 Case Of United Kingdom

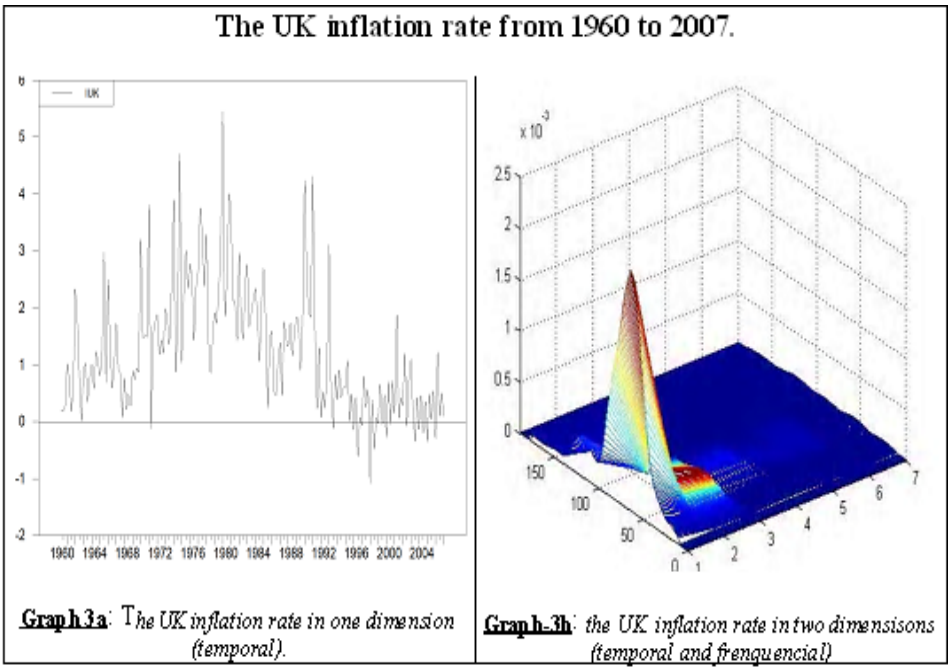


Figure 3: The UK inflation rate graphics in two dimensions

In the case of the United Kingdom, our test identifies three break points. The first point occurred in the third quarter of 1970. According to McWilliams et al. (1992), this period of a high inflation rate can be explained by some technical difficulties in controlling the economy. Financial deregulation distorted monetary indicators and meant that economic monetary policy was increasingly governed by judgements rather than by reference to reliable indicators. In addition, the world was confronted, during the 1970s, with two international oil shocks in 1973 and 1979. In this period, as shown in the figure, the UK consumer price index rose and picked up a level of 25%. So, we can conclude that the import prices have an impact on rising inflation and especially in this period the UK adopted an exchange rate regime. The break point had a short-term frequency, so it had a transitory effect. As a result of this high inflation rate and the successive oil shock, the monetary aggregate M3 was chosen as a target to conduct the monetary policy of price stability. The choice of this aggregate was made after several pieces of research. In fact, Gazeley and Newell[8] (1999) agree that this objective was achieved in the monetary policy without "touching" the income policy (i.e. wages). According to Petreski (2006), this objective was made to tighten fiscal policy. As a consequence, the inflation became lower at the beginning of 1983. This justifies our result of a second break point in the third quarter of 1982. Our non-parametric test identifies a middle-

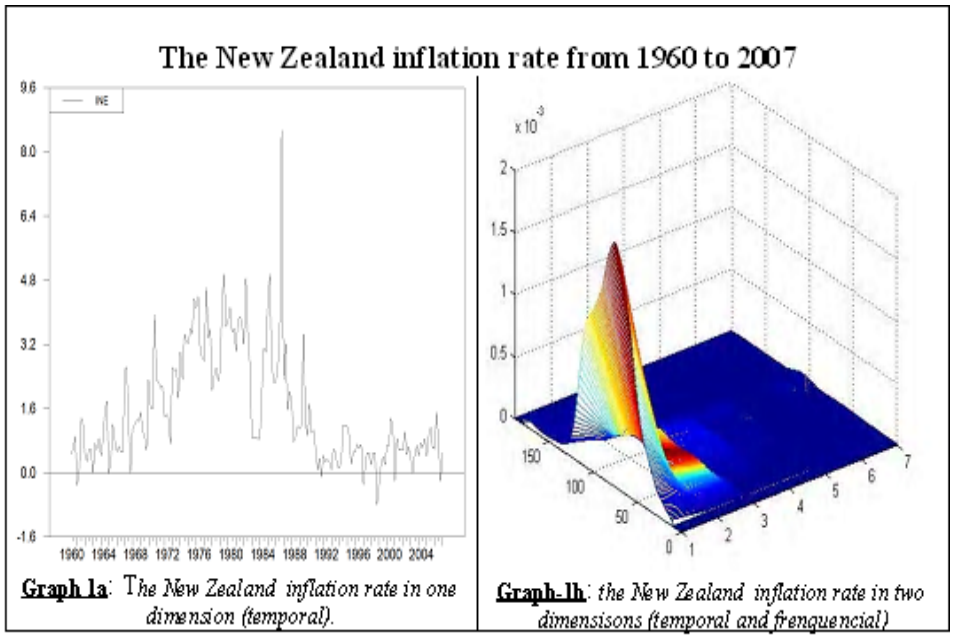
[8]Cited in Petreski, 2006.

term frequency. This result is fully logical. Targeting M3 contributed effectively to low inflation but had some negative effects on other economic indicators. After a few years of this breakdown (4 years=middle term)[9] , the inflation rate rose at the end of 1985 ($\pi = 4.5\%$). Benati (2004) explained this fact by the monetary policy (targeting M3) followed in this period, which raised the unemployment to a record level. As a consequence, the public did not have confidence in the central bank. Then, the Central Banklooked for another anchor point to ensure price stability. So, after some years of relatively high inflation, the United Kingdom had fallen into line with the OECD average of 1983/1984. However, the objective was not achieved. Indeed, the UK inflation rate settled at around 5% in 1985, when other countries were achieving much lower rates. In this period, the UK made the exchange rate a peg system. The basic problem in the mid-1980s was that the domestic demand was allowed to grow more strongly in the United Kingdom than in other countries. This might have been compatible with low inflation: as the economy recovered from recession, it could not be sustained without fuelling inflationary pressures. The direct cause of this fast growth of demand was the coincidence of financial deregulation and an increased desire to borrow, which fuelled consumer demand. These actions made by the government in order to establish a low inflation rate contributed to a relatively low rate of inflation. Indeed, it became very low in 1988 (3%). This is explained by our finding of a breakdown in the UK inflation rate in the third quarter of 1988. The monetary policy action made in the middle of 1980 contributed to a low inflation level. Indeed, in this period, the UK maintained its exchange rate peg and any action reflected the intention to adopt an inflation-targeting policy. Precisely, no index existed that gained public confidence in monetary authority actions. This explains the rise of the inflation rate at the beginning of 1989 by 5% and by 7.5% at the end of 1991. So, we didn't find a decrease in public inflation expectations, such as in the cases of New Zealand and Canada. In October 1992, the United Kingdom adopted the inflation-targeting policy. This monetary policy was adopted without any reforms and without a disinflationary environment, as in the cases of Canada and New Zealand. This is fully logical when we refer to our assumption and those of Artus (2004), who said, "The inflation targeting is relevant when the initial inflation to stabilize is near from the target range". In the case of the United Kingdom, the inflation rate had a level of 4% in the period prior to inflation targeting. Thus, the initial inflation was not far from the target level (fixed in October 1992 at 3%). So, it is normal that we didn't find any reforms, because these reforms have the objective of continuing to lower the initial inflation to the target level. The second important result is that our test identifies a long-term stability in the UK inflation series during the period of the inflation-targeting adoption. So, we can conclude that it was a successful policy to ensure price stability. According to the citation of Artus (2004) and our assumption that we justified, if the level of inflation rate is higher just before the inflation-targeting adoption, we must make some institutional reforms and a disinflation environment so the initial inflation will remain close to the target level. In this case, this environment and these reforms cause a structural break in the

[9]Our result identifies a middle-term frequency of this stability.

inflation series. We note that this break was due to the preparation of an inflation-targeting climate, in a case when a Central Bankadopted an inflation-targeting policy and the inflation series had a relatively high inflation rate. So, in this case, a disinflation environment to reduce inflation was not made, because the initial inflation was close to the target level. Thus, in this case, we didn't find a structural break caused by the inflation-targeting policy. Our result proved long-term stability in the period of the inflation-targeting policy, so we can conclude that is a successful policy to ensure price stability.

4.4 Case of Sweden



Graph 1a: *The New Zealand inflation rate in one dimension (temporal).*

Graph-1h: *the New Zealand inflation rate in two dimensisons (temporal and frenquencial)*

Figure 4: The Sweden inflation rate graphics in two dimensions

In the case of Sweden, our result identifies three break points. The first occurred in the third quarter of 1970 and the second in 1976, and they have respectively a short-term and middle term frequency. Indeed, during the 1970s, a number of events occurred that had serious consequences for the Swedish economy. In this period, Sweden had a fixed exchange rate regime. After the Second World War, almost all Western countries' currencies were pegged to the United States dollar. This system came into force in 1944 and was called the Bretton Woods System. When this system broke down at the beginning of the 1970s, a currency collaboration was started up between a number of European countries, known as the currency snake, by which the krona was pegged to a currency basket dominated by the German D-mark. In this context, Berg (2000) explains this break point by

the monetary policy regime (Bretton Woods), which raised the wages accompanied by accommodating the macroeconomic and exchange rate policy contributing to high inflation. In addition, the oil prices rose substantially in 1973, which led to much higher inflation than could be considered justified by the actual oil price. The government invested in economic stimulation to bridge over the coming economic recession. The central wage agreements signed in 1975-76 didn't succeed in stabilizing wages. The wage costs rose, per hour, by a total of 38%. Sweden's competitiveness thus deteriorated substantially. According to Öberg (2006), the labour costs per unit produced in industry in relation to the corresponding costs in other countries rose by around 25% between 1974 and 1977.
So, these factors explain these two break points. In this period, the Swedish inflation rate has a digit level that stretched to some years, which justified our result that the second break point had a middle-term frequency.
In the decade of the 1980s, many reforms were undertaken. The credit market was deregulated in 1985 and the final parts of the foreign exchange regulation were abolished in 1989. Much research proved that the fixed exchange rate regime didn't succeed in ensuring price stability. According to Heikensten and Verdin (1998), some forms of Central Bank independence were taken in 1988; they said "that the first step towards making Riks bank more independent was taken in 1988, when governor mandate was lengthened and disconnected from the term of parliament". In this time, a pattern that had virtually become a fixed practice, whereby the broad Central Bank was chaired by an under secretary-of-state from the Ministry of Finance, was also broken at the time. This idea of the independence of Riks bank was reinforced in 1991, when the government then declared "A policy for a fair distribution and full employment must give the fight against inflation precedence over the ambiguous demands". During 1992, the Risk bank was forced to abandon a fixed exchange rate regime and announced the adoption of an inflation-targeting policy starting from February 1993. As shown above, it is clear that the period of the end of the 1980s to the period of inflation-targeting adoption is a transitory period and a preparation for inflation-targeting policy adoption. These acts were not explicitly announced. We think that the result protected the credibility of the policy. Indeed, it is difficult to know how many years the transitory period can take. For example, in the case of New Zealand, it took three years, in the case of Canada four years and in the case of Sweden five years. So, these reforms that are taken as starting in the middle of the 1980s concerned the preparation of an inflation targeting climate, so it is very significant to find a break point earlier than a few years after the inflation-targeting implementation.

5 Conclusion

In this paper, we applied the evolutionary spectral analysis to identify different break points in inflation series. This technical analysis was applied for the first time to the case of inflation-targeting countries. In addition to this objective, the principal goal of this paper was interested in the break point just before inflation

targeting, to show if it is the result of the inflation-targeting adoption or not. Our result and analysis showed that the inflation-targeting policy caused a breakdown in inflation series just a few years before the announcement of the adoption of this policy. This is the result of a disinflation environment made to maintain the level of inflation close to the target. In this manner, we justified the theoretical conclusion of Artus (2004), who said, "The inflation targeting is relevant when the initial inflation to stabilize is near from the target range". In our paper, we agree with the idea of Artus (2004). Indeed, we showed the occurrence of the structural break point in inflation series caused by the adoption of inflation targeting for countries which had a volatile and high level of inflation. The occurrence of this break was justified by the reform undertaken, in the transitory period to the inflation targeting, to maintain the inflation close to the target level: this is the case for New Zealand, Canada and Sweden. In the case of the United Kingdom, which had a relatively low inflation level, we didn't identify a break point caused by the inflation-targeting policy. The reason for this is that the inflation level during the period prior to inflation targeting was close to the target range. So, it was not necessary to make any reforms. However, the advantage of our method is that it gives us information on the nature of stability during the inflation-targeting period. Our result proved either medium-term or long-term stability. This result justified the efficiency of the inflation-targeting policy. This paper, in addition to its empirical contribution to the new technical analysis used in our study for the first time in the case of inflation-targeting countries, presents some theoretical contributions. It of interest more to the countries that intend to adopt an inflation-targeting policy. So, they must analyze their inflation series path in the long-term. After that, they must take into account the period of inflation-targeting climate preparation; in other words, they must make some institutional reforms such as Central Bank independence, more transparency and retaining the initial level close to the target. We suggest that these reforms differ between the countries, depending on whether they are developing or developed countries.

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