Business School

WORKING PAPER SERIES

Working Paper

2014-099

The Price Stability Under Inflation Targeting Regime : An Analysis With a New Intermediate Approach

Zied Ftiti
Walid Hichri

http://www.ipag.fr/fr/accueil/la-recherche/publications-WP.html

IPAG Business School
184, Boulevard Saint-Germain
75006 Paris
France

The Price Stability Under Inflation Targeting Regime : An Analysis With a New Intermediate Approach

December 2, 2013

Abstract

This paper analyzes the relevance of the inflation targeting (IT) policy in achieving its primary goal of medium-term price stability. Contrary to previous studies, we propose, in this work, a new approach; *an intermediate approach* that consists in conducting a time-series analysis (employed in the literature under unilateral cases-absolute approach-) with a comparison of inflation performance of IT countries and those of non-IT countries (comparison made in literature under the relative approach). Empirically, we employ a frequency analysis based on evolutionary spectral theory of Priestley (1965-1996) in order to distinguish between different inflation horizons; short-run and the medium-run inflation rate. To check the stability of spectral density functions for inflation series for each country under studied frequencies, we apply a Bai and Perron (2003a, b) test. Our results show that after IT framework implementation, there is no break point in inflation series in short and medium terms. This result is not verified for non-IT countries. Therefore, IT is more relevant in achieving price stability and consequently more effective on inflation expectation anchoring than other monetary policies.

Keywords: Inflation Targeting, Inflation Stability, Structural Change, Evolutionary Spectral Analysis, intermediate approach, pre-requisite.

JEL Classification: C40, E52, E63.

1 Introduction

Since the early 90s, a new monetary policy, called "Inflation Targeting (IT) policy", has been adopted. It has been defined as a framework of monetary policy which consists in announcing an inflation target in advance to the public. The target level (or range) is the main argument in the central bank loss function. The Central Bank boards are independent in choosing the instrument to be followed in order to minimize the loss function.

In the IT literature, Bernanke *et al.* (1999) define the IT in a relatively precise way as follows: *"Inflation targeting is a framework for monetary policy characterised by the public announcement of official quantitative targets (or target ranges) for the inflation rate over one or more time horizons, and by explicit acknowledgement that low, stable inflation is monetary policy's primary long-run goal. Among other important features of IT are vigorous efforts to communicate with the public about plans and objectives of monetary authorities, and in many cases, mechanisms that strengthen the central bank's accountability for attaining those objectives".* Another aspect of IT regime considers it as a framework of constrained discretion on the part of the central bank. This aspect leads to different ways of implementing IT policy. Indeed, countries like Germany, and Australia...have had inflation focused monetary policies. They have not made any explicit acknowledgement and are not regarded as IT countries (Bernanke and Mishkin, (1997); Lee, (1999); Dueker and Fisher, 1996-2006).
In these two kinds of countries[1] we observe great inflation stability since the ninety decade. Researchers in favour of IT policy suggest that the increased monetary policy stability under IT regime is achieved through the medium-term target announced to the public and through the great communication, transparency, and Central Bank accountability imposed by this new framework. However, others suggest that this stability is achieved where the Central Bank exerts a greater control over the expectations of the forward-looking private sector. For this reason, a large debate in the literature has been emerged about the relevance of IT. Indeed, since two decades, there exists, in the academic literature, a rough debate between the proponents and the opponents to IT; such as the discussion opposing Mishkin, (2004) and Friedman (2004). Mishkin (2004) recommends strongly for the Federal Reserve Bank (FRB) the adoption of IT strategy allowing monetary policy to be Forward-looking and preemptive. This recommendation is justified by the ability of IT policy to ensure transparency, accountability and by proposing the disadvantages of the *"just do it"* strategy followed by the FRB such as the lack of explicit nominal anchor.[2] In response to Mishkin (2004), Friedman (2004) invites FRB policymaker's to reject all calls to adopt IT. On a conceptual level, he argues that this policy did not provide transparency and accountability. Secondly, he rejects the arbitrary choice of inflation as the only target policy. In addition, Friedman (2004) considers that rational IT is a consequence of Phelps-Friedman 'natural rate' model allowing trade-off between real outcomes (output) and nominal outcomes (inflation). However, this trade-off is only for finite horizon and he vanishes in the long-run.[3]

This debate has been accentuated by the fact that the majority of empirical studies devoted to industrialized countries did not reach a consensus on a significant impact of IT adoption on inflation performance, contrary to studies on emerging economies. In other words, this large literature about IT policy has some struggling in detecting the net effect of IT policy. Two kinds of methodologies are commonly employed for evaluating the effect of an economic reform. The first one is an approach in absolute terms (time-series econometrics) which consists in comparing the evolution of economic aggregates before and after the implementation of this policy, i.e. only in countries which have adopted this policy -such as in Huh, (1996); Almeida and Goodhart, (1998); Bernanke and Mihov, (1998); Lane and Van Den Heuvel, (1998); Honda, (2000); Choi *et al.*, (2003); Ftiti and Essaadi, (2008) ; Mollick *et al.*, (2008), Ftiti, (2010), Tas (2012)-. The second kind of literature is based on an approach in relative terms (panel data econometrics) which consists in comparing performance of IT with performance of non-IT countries, such-as in Ball and Sheridan (2003), Wu (2004), Pétursson, (2004); Lin and Ye (2007), Angeriz and Arestis (2008), Ball (2010), Willard (2012).

[1] Countries which adopt a strict IT strategy, as defined by Bernanke *et al.* (1997), i.e. respecting all pre-conditions of IT adoption, named in this paper IT-countries and countries which had inflation focused monetary policies named non-IT countries.

[2] For more details, please see Mishkin (2004), pages 2 and 3.

[3] For more details, please see Friedman (2004), page 131.

The above literature reaches mixed results about the relevance of IT strategy. We believe that the followed methodologies are the main reason of these conflicting results. In one hand, the absolute approach (unilateral evidence) is problematic and biased when external factors can also influence economic performance. As Dueker and Fisher (1996) think, we argue that the conclusion based on unilateral evidence can be misguided because many countries have shared a parallel disinflationary environment without employing any formal targeting framework. On the other hand, a relative approach makes implicitly the hypothesis that the IT strategy is the same in all IT countries, requiring consequently a control group reasonably comparable to the treatment group.

As a result of this recent debate, the objective of this paper is to provide further insights into the above unresolved issue. In other words, the aim of this paper is to assess whether IT-countries achieve their primary monetary policy goal of medium-term price stability better than non-IT countries or not.
Unlike previous studies, we propose in this work a new approach, called an intermediate approach that consists in combining between the above two approaches presented in literature. It consists in conducting a time-series analysis (employed in the literature under unilateral cases-absolute approach-) with an inflation performance comparison between IT-countries and non-IT countries (comparison made in literature under relative approach). As a perspective of the country-pairing strategy employed earlier by Dueker and Fisher (1996) and Lee (1999), this study employs a bilateral framework by pairing Canada with the United States of America (USA), United-Kingdom (UK) with France and Sweden with Norway. Our choice of only three IT-countries (Canada, UK and Sweden) is justified by their longer IT experiences and the fact that they are the most IT-countries used in previous works. Our choice of the paired countries is motivated by the studies of Dueker and Fisher (1996, 2006) and Lee (1999).[4]

In this paper, we propose a new empirical methodology based on a frequency approach: The evolutionary spectral analysis (ESA) as defined by Priestley (1965-1996). This technique is suitable for our intermediate approach for several reasons. Firstly, our objective consists in checking the achieving of the IT primary goal -price stability in the medium-term- We need to distinguish between short-term inflation rate, medium-term and the long-run one. The approach we present can achieve this exercise. Secondly, the ESA does not depend on any previous modelling. In other words, it allows us to model non stationary time series without appealing a differentiation or detrending techniques. Thirdly, it has not an "end-point problem": no future information is used, implied or required as in band-pass or trend projection methods. At the end, to check the stability of inflation series for different horizons and especially in the medium-term, we apply the Bai-Perron test (1998, 2003a, 2003b) which is able to detect endogenously multiple break points.

This paper is organized as follows. Section 2 presents stylized facts about IT-countries and non-IT countries in our sample and the related literature. Section 3 explains the methodology developed in this paper. Section 4 analyzes our main finding results and Section 5 concludes.

2 Stylized fact about Inflation Targeting countries and related literature

Since the 70s, many central banks have believed that the main objective of monetary policy is to ensure price stability. This consensus is the result of widespread recognition of the negative repercussions on economies with high inflation and boom-bust cycles.[5] In addition, the seventies decade has been marked

[4]They used three pairs: Canada vs. USA; United-Kingdom vs. Germany; Sweden vs Norway. However, according recent classifications in the academic literature, Australia is considered as an inflation targeting country. Therefore, we replace the first pair by Sweden vs. Norway. This last choice is justified by their common economic specificities, their different official policy rules and their high degree of Business cycle correlation (Bergman and Jonung, (2010)). Norway focuses on targeting money growth. Dueker and Fisher (1996) and Lee (1999) compared UK to Germany. However, in our IFS database the consumer price index data is available only since 1995Q1. Consequently and based on business cycle correlation we replace Germany by France.

[5]There are many costs that flow from an environment of high inflation resulting on longer-term decisions of savers and investors, investment decisions, distortions of relatives' prices, increase of taxation, bad effects on long-term bond markets…Other potential

by the collapse of the international monetary system Bretton-Woods (1944-1971) and the occurrence of multiple crises (1973, 1979 ...) as consequences of deteriorations of many macroeconomic indicators and especially a high inflation rate. Until the seventies decade, central banks have generally saw assign broad mandates or inaccurate involving difficult trade-offs between different objectives. In this period, large literature has emerged showing the role of nominal anchoring in monetary policy framework in order to achieve price stability (Friedman, (1968), Phelps, (1968); Lucas, (1972), (1976) ;...).[6] During the period 1970-1990, the nominal anchor was achieved through intermediate target such as monetary aggregate and exchange rate. For example, for our sample countries (appendix A), inflation rates remain high (double digit values) during this period (1970-1990). In most of the countries of the world, these monetary policies failed in achieving price stability. In addition to other causes,[7] their failures have been attributed to their degree of discretion and the lack of credibility of their actions (Kydland and Prescott, 1977; Barro and Gordon, 1983).

As a consequence, IT policy emerged in February 1990 in New Zealand as an alternative solution of nominal anchor. This policy has been developed in order to resolve the limits and the causes of failure for previous monetary policies based on intermediate targets such-as the lack of credibility, transparency and independence. The IT policy is based on the success to anchor inflation expectation of private sector through institutional and strategic conditions. The main institutional conditions consist in a high degree of central bank accountability, a high degree of central bank independence and a strong banking and financial system. Concerning the strategic conditions, central banks must have a high degree of communication with public; for example publishing a policy target agreement with all details for the monetary policy objective, the price index to be targeted, the horizon of the target, the range of inflation targets, and the instruments. All these conditions are known as pre-requisites of IT implementation.
The development of this policy has coincided with two major important economic facts. Since the beginning of the 90s decade, industrial countries have a lower and a more stable inflation rate than the last decades (Fig1, Fig2, Fig3; Appendix A)[8]. For example, in the case of Canada, Fig 3 (Appendix A) shows that the inflation rate has fallen since the adoption of the IT regime. Before the IT adoption, the inflation rate average was 6.84 with standard deviation equal to 6.28. However, since the IT adoption, this statistic passed to 2.00 with a standard deviation of 2.61 (Table 1, Appendix C1). Consequently, we observe that the level and the volatility of inflation rate have been reduced when the IT has been adopted. This change in the dynamic of inflation is verified for all the IT countries in our sample (Fig 2 and 3, Appendix A; Table 1, Appendix C1). For all of them, we observe a lower and a stable level of inflation.
The drawback of the inflation rate is not only for IT-countries. Many of industrial non-IT countries have known this similar pattern. Fig 1, 2 and 3 (Appendix A) show that the inflation rate has decreased since the 90's decade respectively for France, USA and Noarway. Table 1 (Appendix C1) shows that the means of Inflation for these countries has become lower since the 90's decade. In addition, the volatility of the inflation rate has been declined during this period.
When we compare the IT countries and non-IT countries in our sample (Fig 1, 2 and 3; Appendix A) we observe that, before the IT adoption, the inflation rate is relatively lower in non-IT countries regarding to its value in the IT countries. However, the inflation rate becomes lower in case of the IT countries in comparison to the same rate in non-IT countries since the 90's decade (beginning of the IT adoption). So, with the IT adoption, the performance of inflation for the IT countries is better than the non-IT countries.

implications of high and volatile inflation relates on unemployment and output volatility. For more details, see Freedman and Laxton (2009) pages 3 to 6.

[6]This literature started with Friedman (1968) and Phelps (1968) who showed the importance of expectations on the monetary policy mechanisms. They proved that the output gap is a result of bad expectations on prices and wages and not of a change in the aggregate demand. Then, Lucas (1972, 1976) showed that, in the case of rational expectations and flexible prices and wages, there is no trade-off between inflation and output in short-run, leading to price stability. He concludes that monetary policy must not have as objective the stabilization of production because such a policy is not able to do so.

[7]In one hand, the most important failure reason's of monetary targeting policy is the instability in the demand for money function resulting from bank system deregulation and bank's financial innovations. On the other hand, countries adopting exchange rate targeting, are exposed to speculative attacks against their currencies and they loss their monetary policy independence in the context of capital mobility. For more details, see Freedman and Laxton (2009) pages 8 and 9.

[8]These graphs are plotted by author via MATLAB Software according consumer price index collected from IFS database.

is the macroeconomic performance observed during the period of the IT adoption just a good luck? Or, is it the consequence of the robustness of the monetary regime practice (IT policy)? What does literature tell us about these questions: Is it a relevant policy ?
Many researchers have attempted to check the relevance and the performance of the IT policy. Most of them assess the relevance of the IT policy via its impact on the inflation path.[9] Principally, two methodologies were applied.

The first strand of literature evaluates the effect of the IT adoption according to an absolute term approach based on time-series econometrics. This approach consists in comparing the evolution of economic aggregates (in most cases, it concerns inflation series) before and after the implementation of this strategy, i.e. only in countries which have adopted this policy. Genc *et al.* (2007) specified the inflation rate for 4 industrial IT countries (New Zealand, Canada, Sweden and United-kingdom) by an ARMA model during the pre-IT adoption. Then, they use both one-step ahead forecast and multi-step ahead (dynamic) forecast. They show that there is no difference between the realized inflation and the estimated one. Choi *et al.* (2003) used a Markov switching model to show the dynamic of inflation pre and post IT adoption in the case of New Zealand. Their main finding is that inflation rate has been changed at a date correponding to New Zealand IT adoption period. Some other works built a VAR models to assess the impact of the IT policy on macroeconomic variable such as inflation rate, output, interest rate and exchange rate (Mishkin and Posen, 1997; Bernanke *et al.*, 1999; Honda, 2000). They get different conclusions. While Mishkin and Posen (1997) Bernanke *et al.* (1999) show that the IT adoption did not have a significant impact on the inflation path, Honda (2000) shows the opposite.

Angeriz and Arestis (2008) used an intervention analysis to multivariate Structural Time Series models, in order to assess whether a significant change in the trend corresponds to inflation and inflation expectation and if the inflation rate has remained 'locked-in' at low levels after the implementation of IT. This approach avoids certain biases encountered in the use of conventional regression estimators. Authors produced a new empirical evidence for the case of a number of OECD countries. Angeriz and Arestis (2008) show that although IT policy has gone hand-in-hand with low inflation, the strategy was introduced well after inflation had begun its downward trend. But, then, IT locks in low inflation rates. Authors show, also, that non-IT central banks have also been successful on this score. In another paper, Lee (1999) assesses the relevance of the IT policy by causing a disinflationary environment. He used a data decomposition procedure. He involves cointegration analysis and canonical correlation analysis to remove common trend and cyclical components from historical data that the sample of the IT countries (New Zealand, Canada and United-Kingdom) had with their neighbouring non-IT countries (Australia, US, Germany). Simulations based on resulting country-specific data for inflation and other economic aggregates reveal scant evidence of regime-shift effect as exhibited in the observed data. Lee (1999) concluded the role of the IT policy in reducing volatility in inflation and output.
Other researchers used time-series analysis in absolute terms in order to check if the IT policy reduces uncertainty. Ftiti (2010) checks the ability of IT policy to reduce uncertainty on the macroeconomic environment. This is based on the literature about cycles volatilities and performance. He applied the dynamic coherence function to assess the co-movement between inflation, interest rate and growth rate. By developing a dynamic coherence function measuring jointly the co-movement of the above three series, he shows that the IT policy reduces uncertainty in the economy. Kontonikas (2004) used a GARCH model and GARCH-M model to assess the capacity of IT policy to reduce uncertainty and the variability of inflation. He concludes to the relevance of this regime to act positively on uncertainty.
According to this same approach (absolute approach: time-series analysis), some works analyze IT's impact on inflation expectation. Demir and Yigit (2008) try to check the effect of the IT adoption on the level of expectation for two IT-countries (New Zealand and United-Kingdom). By using a state space model, they measure the time-varying credibility and show that the target announcement contributes in changing the public's learning behaviour. Levin *et al.* (2004) analyze the macroeconomic performance of the IT policy through its effect on inflation expectation and inflation persistence. Firstly, they estimated the

[9] As the primary objective of the IT policy is the price stability, this monetary policy was qualified by relevant when it leads to a stable and lower level of inflation.

sensitivity of expected inflation on the realised one. Then, by using a maximum autoregressive root, they estimated the inflation persistence. They show that the IT policy has a positive impact on inflation expectation and inflation persistence. Johnson (2002) tests if the IT policy reduces the level of expected inflation in 5 countries adopting this policy (New Zealand, Canada, Sweden, Australia and United-Kingdom). Firstly, he estimates a model measuring the effect of knowing information variables on the direct measure of expected inflation for the pre-IT period.[10] Secondly, he predicts typical forecasts, during a specific 12-month post-target period, using the estimated model below and information variables known to forecasters at this period. Finally, the gap (difference between the actual individual forecasts and the typical predicted) provides a measure of the IT effect on the level of inflation expectations. Johnson (2002) repeats this exercise for five 12-month periods after IT implementation for five IT-countries and he reaches mixed results. He shows that the IT adoption has an immediate effect on reducing the level of inflation expectations, in the case of New Zealand and Sweden. This effect is smaller and slower to develop in the case of Canada and Australia. In the case of United-Kingdom, this effect vanishes.

The second strand of literature is based on an approach in relative terms by using panel data econometrics, which consists in comparing the performance of the IT countries with those of the non-IT ones (Ball and Sheridan, (2003); Wu, (2004); Pétursson, '2004); Ball, (2010); Willard, (2012)). Their common methodology consists in estimating inflation equation and/or expected inflation with a dummy variable that takes the value one if one country applies the IT policy and zero otherwise. This methodology consists in checking if the dummy variable coefficient is significant or not. While Pétursson (2004) and Wu (2004), by using seemingly unrelated regression with the fixed effect on country, find that the IT policy reduces the inflation by 2.5% for developing countries, this impact is ambiguous in the case of industrial ones. Ball and Sheridan (2003) find, using cross-country regression, that the IT policy did not have a significant impact on the inflation path. However, Willard (2012) used the "placebo" technique to estimate the inflation equation in order to take into account the endogeniety between inflation rate and the dummy variable missed by the studies above. He found that the IT policy did not have an impact on the inflation path.

Previous studies, cited above, reach different conclusions. There is definitely a lack of consensus about the role of the IT policy to ensure price stability. These studies suffer from many drawbacks. Firstly, studies under absolute terms approach are problematic and biased when external factors can also influence the economic performance. As argued by Ball and Sheridan (2003: p.11) in the case of IT: *"[...] many measures of economic performance improved on average between the pre-targeting and post-targeting periods. In most major economies, the period since the early 1990s has seen low and stable inflation and stable output growth. If we examine IT-countries alone, there are clear economic improvements that one might be tempted to attributed to targeting. However, to learn the true effects of targeting, we must compare improvements in targeting countries to improvements in non-targeting countries"*. In addition, many studies choose exogenously the data of IT adoption as an exogenous break in inflation path.[11] Secondly, other studies which used VAR model loose information behind series differentiation in order to respect the stationary condition imposed by such a model. Thirdly, most of studies, except in Lee (1999) and Angeriz and Arestis (2008), are based on unilateral evidence that can be misguided. In the case of Angeriz and Arestis (2008), they use a sample of emergent IT-countries which can explain the confusing results between countries. Concerning the second strand of literature, that employs a relative-terms approach (panel data econometrics), they implicitly make the hypothesis that IT is the same in all countries, requiring consequently a control group reasonably comparable to the treatment group. In this paper, we propose a new approach to overcome all these drawbacks.

[10] Johnson (2002) constructs 12-month constant horizon forecasts and he conceptualizes the process of individual expected inflation as a liner function of two domestic variables (k lags of domestic inflation, domestic unemployment) and two world variables (a measure of world inflation pressure and a measure of business cycle).

[11] Many studies (Mishkin and Posen, (1997); Bernanke et al., (1999); Honda, (2000)) modelled the inflation rate during the pre-IT according to time series model. The optimal selection model is used, then, to forecast the inflation series during the IT-regime. At the end, they compare the forecasting series with the realized ones. Therefore, this approach consists implicitly in testing if the date of IT adoption is a date of structural break in inflation or no.

3 Empirical methodology

Our intermediate approach consists in comparing the evolution of the price stability-the ultimate objective of central banks- before and after IT implementation. In order to avoid a bias source from external factors, our methodology is based on inflation performance comparison between IT and non-IT countries. However, our comparison is made out differently from previous studies, i.e. not arbitrary. We compare IT-countries with a reasonable control group in order to avoid the limit of previous works that consider that the IT strategy is the same in all IT countries, by using a panel of all IT-countries with non-IT ones.

Therefore, our choice of IT-countries sample and the control group is thoroughly built. Indeed, the IT and non-IT developed countries have in practice similar monetary policies; both kinds of countries have price stability as a primary objective of monetary policy with the same instrument-interest rate-. However, we believe that the difference, when it exists, comes from the IT pre-requisites which are able to succeed the inflation expectation anchoring. So, we consider in this paper, in line with Dueker and Fisher (1996, 2006) and Lee (1999), a country as an adopter of IT when it respects all pre-conditions of IT implementation, cited above. According to the definition of Angeriz and Arestis (2008), only Full-Fledged IT are concerned. The choice of control group is based, in one hand, on country-pairing strategy employed by Dueker and Fisher (1996) and Lee (1999) for UK vs. France and Canada vs. USA, and on the other hand, on business cycle correlation study of Bergman and Jonung (2010) for Sweden vs. Norway.[12]

Given that the objective of this work is to assess the achievement of medium-term price stability of IT-countries compared to non-IT countries, we must employ an empirical technique allowing a decomposition of inflation series to different horizons. Therefore, we differ from previous works by employing a frequency analysis based on ESA as defined by Priestley (1965-1996), that can distinguish between short-run, medium-run and long-run evolution of inflation series. In addition, the ESA (Priestley, 1965-1996) presents other advantages techniques. In fact, it did not require any upstream treatment, based on the verification of the stationarity of series. The evolutionary spectral representation, that we adopt, is valid in both stationary and non-stationary series. Besides, contrary to time series analysis, spectral analysis did not depend on any previous modelling and any particular detrending technique. Furthermore, it has not an "endpoint problem": no future information is used, implied or required as in band-pass or trend projection methods.

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 briefly how we are checking the stability of evolutionary spectral density function of inflation (Bai and Perron test).

3.1 Theory of the evolutionary spectral analysis

3.1.1 Definitions

The evolutionary spectrum theory (Priestley,1965) defined any non-stationary process as follows:

$$X_t = \int_{-\pi}^{\pi} A_X(w,t) e^{iwt} dZ_X(w), \tag{1}$$

Where, for each w, the sequence $A_X(w,t)$ is a time dependent and has a generalized Fourier transform whose modulus has an absolute maximum at the origin. $\{dZ_X(w)\}$ is an orthogonal process on $[-\pi,\pi]$ with $E[dZ_X(w)] = 0$. Without loss of generality, the evolutionary spectral density of the process $\{X_t\}$ is defined by $h_t(w)$ as follows:

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

[12] We have calculated the Business cycle correlation of each pair of countries and we confirm our choice.

Where $dH_t(w) = |A_X(w,t)|^2 d\mu_X(w)$. The variance $\sigma^2_{X,t}$ of $\{X_t\}$ at time t depends on the evolutionary spectral density $h_t(w)$ through the following equation.

$$\sigma^2_{X,t} = Var(X_t) = \int_{-\pi}^{\pi} h_t(w)dw. \tag{3}$$

3.1.2 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, $\hat{h}_t(w)$ is constructed as follows:

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

Where $\{g_u\}$ and $\{w_v\}$ are defined as follows:

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

and

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

In this paper, we take $h = 7$ and $T' = 20$. We opt for this choice[13], as in Priestley (1996), Artis *et al.* (1992), Ahamada and Boutahar (2002) and Ben Aissa and Ahamada (2004). According to Priestley (1988), we have $E(\widehat{h_t}(w)) \approx h_t(w)$, $var(\widehat{h_t}(w))$, decreases when T' increases. $\forall(t_1,t_2), \forall(w_1,w_2)$, if at least one of the following conditions *(i)* or *(ii)* is satisfied:

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

In order to respect these two conditions (i) and (ii) (equation 7), we chose $\{t_i\}$ and $\{w_j\}$ as follows: $t_i = \{20i\}_{i=1}^{I}$, where $I = [\frac{T}{20}]$ and T is the sample size; $w_j = \{\frac{\pi}{20}(1+3(j-1))\}_{j=1}^{7}$.

3.2 Stability of evolutionary spectral density functions of inflation series

The estimation of the evolutionary spectral density function of inflation series, for each studied country, is made through equation (4) with respecting the two windows (equations 5 and 6) defined by Priestley (1965-1996).[14] According to conditions *(i)* and *(ii)* of equation (7), we will have a decomposition of inflation series on 7 frequencies ($\frac{\pi}{20}$, $\frac{4\pi}{20}$, $\frac{pi}{20}$, $\frac{10\pi}{20}$, $\frac{13\pi}{20}$, $\frac{16\pi}{20}$, $\frac{19\pi}{20}$).[15] We finally have an evolutionary spectral density function in 7 frequencies. Owing to the fact that our objective is to check if IT-countries achieve their primary goal of medium-term price stability better than non-IT countries or not; we retain only the frequencies traducing the horizon of monetary policy objective. According to Hammond (2012), the horizons of inflation target vary between 12 months and 5 years (see please table A page 9 of Hammond, (2012)).

According to our ESA decomposition, we have only three frequencies representing the horizon of the inflation target. The first one is ($\frac{10\pi}{20}$, 1year) which defines the dynamic of inflation in the short-run term. However, the two later frequencies ($\frac{7\pi}{20}$, 1.5 years) and ($\frac{4\pi}{20}$, 4years) reflect the medium-term inflation rate, respectively for 18 months and for 4 years.

Our objective is to test the instability of the evolutionary spectral density function of inflation series for the studied frequencies. In other words, we look if IT-countries succeed in reducing regime shift in inflation dynamic better than non-IT countries. Therefore, we suggest that the Bai-Perron test is the suitable test for our purposes. For each studied frequency, we try to determine their mean-shifts. The Bai-Perron test

[13] The choice of these values are justified by the respect of the (i) and (ii) conditions (equation 7).

[14] These windows presented by Priestley (1965-1996) have been adopted by other studies, such as: Artis *et al.* (1992), Ahamada and Boutahar (2002), Ben Aissa and Ahamada (2004).

[15] These frequencies are obtained through W_j according to the parameters fixed by Priestley (1965-1996)

allows us to identify endogenously multiple break[16] points in each series. We use GAUSS software and we obtain the estimate by running the code created by Bai and Perron (1998, 2003b).[17]

4 Empirical results

4.1 The data

The data that we used to construct the inflation series is the consumer price index (CPI) of all items in Canada, France, Norway, United-Kingdom, United States of America and Sweden. These series were collected from the International Monetary Fund on their database: International Financial Statistics (IFS). The inflation data for all the countries, π, is calculated from the CPI as follows:

$$\pi_t = ln(\frac{CPI_t}{CPI_{t-1}}). \tag{8}$$

The period of the study is 1970Q1-2010Q3. We choose this period for two reasons. First, the evolutionary spectral analysis needs a large number of observations. Second, we need to compare our results with some other research on this topic that uses the same period. Note that for the evolutionary spectral estimation necessity, we lose ten observations at the beginning and at the end. So, the estimated[18] evolutionary spectral density functions of inflation series for our countries sample's started from 1972 Q3 to 2008 Q1.

4.2 Results

In this part of our analysis, we start by making out some insights from descriptive statistics (Table 1, appendix C1). Two main results can be deducted. Firstly, for all IT-countries of our sample, the inflation remains more stable and less volatile under the IT regime than in previous periods. The comparison between IT countries (UK, Canada and Sweden) and their neighboring non-IT countries (France, USA, Norway) shows that, under the IT regime, the inflation rate of the first group is lower than the second group. Behind these disclosures, we can suspect that the IT policy can be at the origin of this performance on price stability. To avoid any confusion, we will base our analysis on the following empirical methodology results to bring the relevant conclusions.

Appendix B displays the graphical pattern of the evolutionary spectral density function (ESDF)[19] of inflation series for each pair of countries included in our sample in three frequencies. From the appendix B1, we have the graphical pattern of ESDF of inflation series in short-run (1 year). Figure 4 shows the ESDF of inflation series for UK and France. The comparison between these countries discloses some important results. Firstly, before the 90s, we observe that the short-run inflation series in the case of France is lower than the one in the case of UK. However, this pattern was being inversed since the 90s decade. Indeed, the short-run ESDF of inflation series in the case of UK remains below the ESDF of inflation series in the case of France. This result is clearly verified in the case of Sweden and Norway and at a lower level in the case of Canada and USA (Fig 5 and 6).
For robustness, we applied a multiple break test (Bai-Perron test) to look for a significant shift in short-run ESDF of inflation series. Table 2, in appendix C2, shows the results of a multiple break points test. The row 1 of table 2 displays the result of multiple break points for the sort-run ESDF of inflation series for the studied countries. Firstly, for all cases, the test shows that the IT-countries had a less number of break points than their neighboring of non-IT application. Secondly, after the IT adoption, we did not find any break point, which traduces the success of the price stability under this regime. However, their neighboring

[16] In our analysis, we define the break point as a change in the inflation dynamic which occurred as response to exogenous shocks or change in monetary policy

[17] The code is available on the Perron home page: http://people.bu.edu/perron/.

[18] Authors develop the code on MATLAB Software to estimate the evolutionary spectral density functions of inflation series for each country according to the methodology of Priestley (1965) presented in section 3.1.2.

[19] Graphs in appendix B are plotted by authors using MATLAB Software.

non-IT countries have known a regime shift in the short-run ESDF of inflation series during the 90s decade and/or at the beginning of 2000s. For example, in the case of UK, we find two break points. The first one occurred in the first quarter of 1977 and the second on in the Q2 of 1992 (when the IT was adopted [20]). However, in the case of France, the inflation remains less stable than in the case of UK during the 90s decade. In this country, three break points are identified and one of them occurred after 90s (Q2 2004). Behind this case, we can say that the IT is relevant to achieve price stability.
These results are similar for the two other pairs of countries Canada-USA and Sweden-Norway. In the case of Canada, two breaks are identified in the short-run ESDF of inflation series when the last occurred at the moment when the IT was applied. Concerning its neighboring country (USA), which did not apply explicit IT policy, the USA has known three breaks in short-run ESDF of inflation series.

Appendix B2 shows the pattern of ESDF of inflation series for cases studied under the frequency 18 months. The patterns of ESDF of inflation series, under this frequency, are similar to those under a frequency of 1 year. The same thing for Bai-Perron test (row 2, table 2, appendix C2). Appendix B3 presents the pattern of ESDF of inflation series for cases studied under the frequency 4 years. Figure 10, 11 and 12 show clearly that under the IT policy, the medium-term ESDF of inflation rate, for IT-countries, is very low in comparison to those of non-IT countries. In addition, we show that the medium-term inflation rate in the case of IT-countries is clearly lower than those at the short-run. This is explained by the fact that the three IT-countries of our sample adopt -in most cases- a medium-run horizon of inflation target rather than a short-run target. Row 3 of table 2 (appendix C2) shows that, under the IT policy, we did not have any regime shift in medium-term inflation rate. However, for other countries, we have some breaks in the 90s decade.

Overall, these results confirm some previous findings. Firstly, the IT policy has a significant impact on maintaining a lower level of inflation rate. Secondly, there is no break point on downturn or on upturn of the inflation rate. In other words, the inflation rate has remained stable since the IT adoption.
Our results confirm the findings of some studies such as Choi *et al.* (2003), Gnec *et al.* (2007), Ftiti (2010) − and showing that the IT policy succeeds its primary goal of achieving price stability. However, contrary to different other studies, -as in Huh (1996); Bernanke and Mihov (1998); Lane and Van Den Heuvel (1998); Bernanke *et al.* (1999); Honda (2000)- we avoid confusion in the relationship between the IT policy and the path of the inflation rate. This confusion concerns the impact of the IT policy on inflation: did the IT reduce the inflation rate or it maintained the inflation level? For this reason, our methodology appears relevant to avoid this embarrassment when we adopt an endogenously multiple break test (Bai-Perron test) to relax the implicit hypothesis, adopted by some works- such as, Mishken and Posen (1997), Bernanke *et al.* (1999), Honda (2000), Angeriz and Arestis (2008), ... - and consisting in the fact that the date of the IT adoption is a date of inflation rate regime shift. To our knowledge, this is the first work that deals with such a problem. In addition, the approach we develop in this paper "*intermediate approach"*, avoids some bias source from external factors (bias available in absolute approach when we analyze only IT-countries) and avoids considering that all IT policies are the same for all countries (bias available in relative approach, panel data econometrics), i.e. in our work, we consider only Full-Fledged IT policy as defined by Angeriz and Arestis (2008). So, the confused literature results are explained by considering all kinds of IT framework (Full-Fledged, Lite and Eclectic inflation targeting, Angeriz and Arestis, 2008) as the same.

According to our methodology, we have reached two main findings. The first one, after the IT implementation, medium-term inflation rate remains stable and in a lower level. No upward or downward break is detected after this IT implementation. The second one concerns the date of the IT adoption that seems to be a date of structural break in the medium-term inflation series. These results have some important economic implications. The first result implies that the IT framework is more relevant on anchoring inflation expectation than other monetary frameworks. From our point of view, the success in ensuring price stability under the IT policy is explained by the pre-requisites of the IT implementation. Indeed, the two kinds of countries, that we compare, have loosely a same monetary objective focused on medium-term price

[20]The column 1 of table 1, appendix C1, presents the date of IT adoption in the studied IT-countries.

stability. However, the difference between IT-countries and non-IT-countries lies in pre-conditions of the IT adoption such as transparency and accountability of central banks. In our point of view, democratic accountability of central banks (when the government and the central bank decision makers published jointly a policy target agreement of IT) traduces a great level of credibility and accountability to ensure the objective of price stability; This is one of the conditions that are not verified in the case of non-IT. The second result (the date of the IT adoption is a date of break) traduces the relevance of the IT policy to make out a disinflationary environment. Therefore, we are not agree with Carare *et al.* (2002), who suggest that the IT must be adopted when inflation is at a low level, i.e. low level of inflation is not an important pre-requisite for adopting IT.

These findings are very important for countries which have the intention to adopt the IT policy, especially the emerging markets- which must respect the institutional conditions[21] and strategic decisions[22]. Our results show that the respect of the IT pre-requisites has an important role in succeeding to anchor the inflation expectations.

5 Conclusion

This paper has analyzed the robustness of the IT policy to achieve its primary goal of price stability. It has empirically reevaluated the experiences of three countries whose central banks have implemented Full-Fledged inflation targeting that aim to achieve price stability. Perceptible change of the inflation path since the IT adoption is evidenced in historical data of inflation. In line with earlier studies, such as Engle and Kozicki (1993), Dueker and Fisher (1996) and Lee (1999), we avoid a unilateral evidence which can misguide -either IT or non-IT countries shared parallel disinflationary environment-. We focused, in our methodology, on comparing between three IT-countries with their neighbouring that did not apply explicit IT policy.
A new empirical approach was used to check the relevance of the IT policy in achieving price stability. In this paper, we apply a frequency approach to construct the evolutionary spectral approach, defined by Priestley (1965), to distinguish between short-run horizon of inflation and medium-term one. Then, after pattern graphic comparison between the three pairs of countries (IT-countries with their neighboring), we applied an endogenously break test to ESDF of inflation for each studied frequency. Our main finding is the absence of break points in inflation series since the IT adoption for IT-countries and the presence of breaks during this period for non-IT countries. From this perspective, the IT policy is relevant in achieving its primary goal of price stability and succeeds better than other monetary policies to anchor inflation expectations.

References

Ahamada, B. and M.S. Ben Aïssa (2004) "Testing Multiple Structural Changes in US Output Gap Dynamics: Non-Parametric Approach" *The Quarterly Journal of Finance* **18**, 577-586.

Ahamada, I. and M. Boutahar (2002) "Tests for covariance stationarity and white noise, with application to Euro/US Dollar exchange rate" *Economics Letters* **77**, 177-186.

Almeida, A. and C.A.E. Goodhart (1998) "Does the Adoption of Inflation Targets Affect Central Bank Behaviour?" *Banca Nazionale del Lavoro Quarterly Review* **51**, 19-107.

Angeriz, A. and P. Arestis (2008) "Assessing Inflation Targeting Through Intervention Analysis" *Oxford Economic Papers*, **60**, 293-317

Artis M. J., R. Bladen-Hovell and D.M. Nachane (1992) "Instability of Velocity of Money, a New Approach Based on the Evolutionary Spectrum" *CEPR Discussion Paper number 735*.

[21] Central Bank independence, transparency of policy maker's actions, credibility of policy maker's actions and communication.

[22] Choice of price index, price target announcement, target horizon announcement, target width and communication. For more details see Ftiti and Goux (2011).

Bai, J. and P. Perron (2003a) "Computation and Analysis of Multiple Structural Change Models" *Journal of Applied Econometrics* **18**, 1-22.
Bai, J. and P. Perron (2003b) "Critical Values for Multiple Structural Change Tests" *Econometrics Journal* **1**, 1-7.
Bai, J. and P. Perron (1998) "Estimating and Testing LinearModels with Multiple Structural Changes" *Econometrica* **66**, 47-78.
Ball, L. (2010) "The performance of alternative monetary regimes" *NBER Working Paper 16124*, National Bureau of Economic Research, Cambridge.
Ball, L. and N. Sheridan (2003) "Does Inflation Targeting Matter?" *NBER Working Papers number 9577*: National Bureau of Economic Research, Inc.
Barro, R. J., and Gordon, D. B. (1983) "Rules, discretion and reputation in a model of monetary policy" *Journal of Monetary Economics*, **12**, 101-121.
Bergman, U.M., and Jonung, L. (2010) Business Cycle Synchronisation In Europe : Evidence From The Scandinavian Currency Union, *The Manchester School*, **79**, 268-292.
Bernanke, B.S., T. Laubach., F.S Mishkin and A.S. Posen (1999) "Inflation Targeting: Lessons from the international experience" Princeton University Press: New Jersey.
Bernanke, B.S and I. Mihov (1998) "Measuring monetary policy" *Quarterly Journal of Economics* **113**, 871-902.
Bernanke, B.S. and F.S. Mishkin (1997) "Inflation targeting: a new framework for monetary policy" *Journal of Economic Perspectives* **11**, 97-116.
Carare, A., A. Schaechter and M. Stone (2002) "Establishing initial conditions in support of inflation targeting" *IMF Working Papers 02/102*, International Monetary Fund, Washington D.C.
Choi, K., Ch. Jung, and W. Shalbora (2003) "Macroeconomic effects of inflation targeting policy in New Zealand" *Economics Bulletin* **5**, 1-6.
Demir, B. and T.M. Yigit (2008) "Announcements and credibility under inflation targeting" *Economics Letters* **100**, 249-253.
Dueker, M. and M.A. Fisher (2006) "Do Inflation Targeters Outperform Non-targeters?" *Federal Reserve Bank of St. Louis Review* **09**, 431-450.
Dueker, M. and M.A. Fisher (1996) "Do inflation targets Redefine Central Bank Inflation preferences? Results from an indicator model" *Financial and Monetary Policy Studies* **31**, 21-37.
Engle, R.F. and R. Kozicki (1993) "Testing for common factors" *Journal of Business and Economics Statistics* **11**, pp369-365.
Freedman, C. and D. Laxton (2009) "Why inflation targeting ?" *IMF Working Papers 09/86*, International Monetary Fund, Washington D.C.
Friedman, B. (2004) "Why the Federal Reserve should not adopt inflation targeting" *International Finance* **7**, 129-136.
Friedman, M. (1968) "The Role of Monetary Policy" *American Economic Review* **58**, 1-17.
Ftiti, Z., J.F. Goux (2011) "Le Ciblage d'Inflation: Un essai de Comparaison Internationale" *GATE working paper number 11-07*.
Ftiti, Z. (2010) "The macroeconomic performance of the inflation targeting policy:an approach base on the evolutionary co-spectral analysis" *Economic Modelling* **27**, 468-476.
Ftiti, Z. and E. Essaadi (2008a) The inflation Targeting effect on the inflation series: A New Analysis Approach of evolutionary spectral analysis, *GATE working paper number 08-32*.
Ftiti, Z. and E. Essaadi (2008b) "The transition period to inflation targeting policy" *The International Journal of Economic* **2**, 38-46.
Genc, I.H., M. Lee., C.O. Rodriguez and S. Lutz (2007) "Time series analysis on inflation targeting in selected countries" *Journal of Economic Policy Reform* **10**, 15-27.
Hammond, G. (2012) "The state of the art of inflation targeting" Centre for Central Bank Studies Handbook number 29: Bank of England. February 2012.
Honda, Y. (2000) "Some tests on the effects of inflation targeting in New Zealand, Canada, and the UK" *Economics Letters* **66**, 1-6.
Huh, Ch.G. (1996) "Some evidence on the efficacy of the UK inflation targeting regime: an out-of-sample forecast approach" *FRB International Finance Discussion Paper number 565*.
Johnson, D.R. (2002) "The effect of inflation targeting on the behavior of expected inflation: evidence

from an 11 country panel" *Journal of Monetary Economics* **49**, 1521-1538.
Kontonikas, A. (2004) "Inflation and inflation uncertainty in the United Kingdom, evidence from GARCH modelling" *Economic Modelling* **21**, 525-543.
Kydland, F., E. Prescott (1977) "Rules than Discretion: The Inconsistency of Optimal Plans" *Journal of Political Economy* **85**, 473-91.
Lane, T. and S. Van Den Heuvel (1998) "The United Kingdom's experience with inflation targeting" *Working Paper on the International Monetary Fund number 98/87*.
Lee, J. (1999) "Inflation targeting in practice: Further Evidence" *Contemporary Economic Policy* **17**, 332-347.
Levin, A., F. Natalucci and J. Piger (2004) "The macroeconomic effects of inflation targeting" *Federal Reserve Bank of St. Louis Review* **86**, 51-80.
Lin, S. and H. Ye (2007) "Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial economies" *Journal of Monetary Economics* **54**, 2521-2533.
Lucas, R.E. (1976) "Econometric Policy Evaluation : A Critique" *Carnegie-Rochester Conference Series on Public Policy* **1**, 19-46.
Lucas, R.E. (1972) Expectations and the Neutrality of Money, *Journal of Economic Theory* **4**, 103-124.
Mishkin, F.S. (2004) "Why the Federal Reserve should adopt inflation targeting" *International Finance* **7**, 117-127.
Mishkin, F.S. and A.S. Posen (1997) "Inflation Targeting: Lessons from Four Countries" *Economic Policy Review* **3**, 9-110.
Mollick, A.V., R. Cabral and F.G. Carneiro (2011) "Does inflation targeting matter for output growth? Evidence from industrial and emerging economies" *Journal of Policy Modeling* **33**, 537-551.
Pétursson, T.G. (2004) "The effects of inflation targeting on macroeconomic performance" *Central Bank of Iceland, Working Paper Series number 23*.
Phelps E.S. (1968) "Money-Wage Dynamics and Labor Market Equilibrium" *Journal of Political Economy* **76**, 687-711.
Priestley, M. B. (1988) "Non-Linear and Non-Stationary Time Series Analysis" Academic Press: London.
Priestley, M. B. (1981) "Spectral Analysis and Time Series" Academc Press: New York.
Priestley, M. B. (1996) "Wavelets and time-dependent spectral analysis" *Journal of Time Series Analysis* **17**, 85-103.
Priestley, M.B. (1965) "Evolutionary Spectra and Non-Stationary Processes" *Journal of the Royal Statistical Society* **B 27**, 204-237.
Tas, B.K.O (2012) "Inflation Targeting and Inflation Uncertainty" *Scottish Journal of Political Economy* **59**, 283-297.
Willard, L.B. (2012) "Does inflation targeting matter : a reassessment" *Applied Economics* **44**, 2231-2244.
Wu, T. (2004) "Does inflation targeting reduce inflation? An analysis for the OECD industrial countries" *Banco Central do Brazil Working Paper number 83*.

Appendices

A The inflation rate between inflation targeting countries and non inflation targeting countries

Figure 1: The inflation rate between UK and France

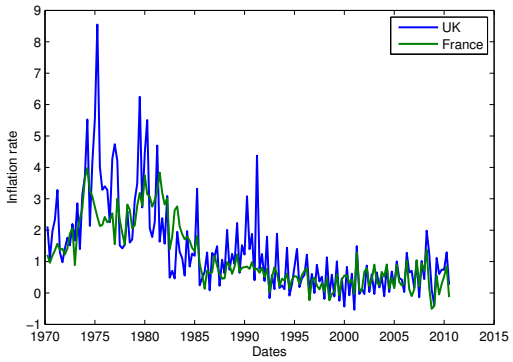


Figure 2: The inflation rate between Sweden and Norway

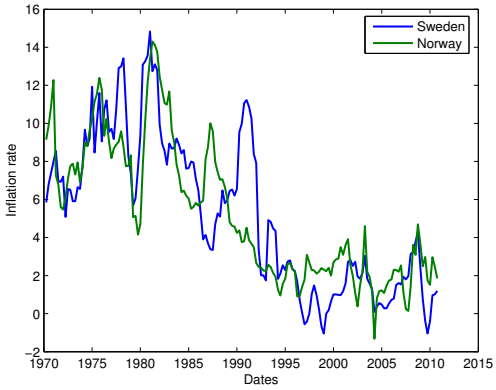
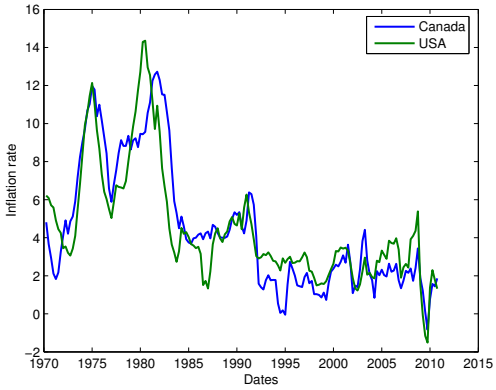


Figure 3: The inflation rate between Canada and USA



B The pattern of the evolutionary spectral density function of inflation for each pair of countries in our sample

B.1 The spectral densities function of inflation series in short-term ($\frac{10\pi}{20}$, 1 year)

Figure 4: The spectral densities function of inflation series for the cases of UK and France

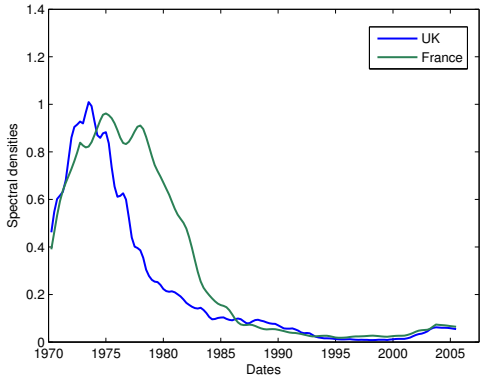


Figure 5: The spectral densities function of inflation series for the cases of Sweden and Norway

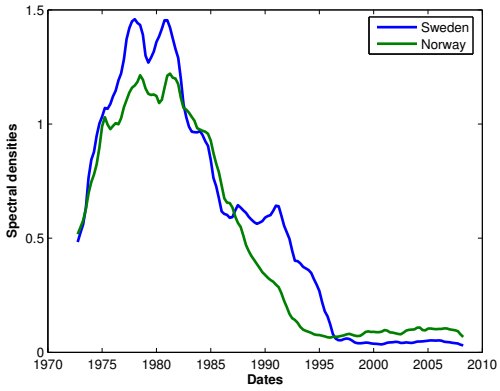
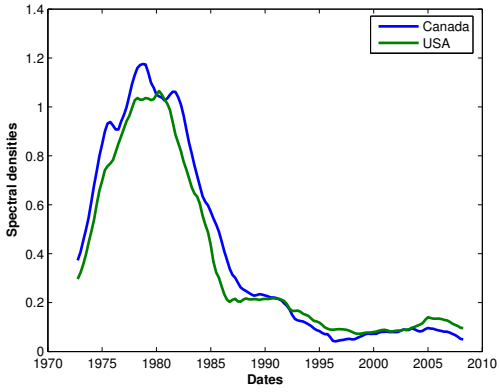


Figure 6: The spectral densities function of inflation series for the cases of Canada and USA



B.2 The spectral densities function of inflation series in short-term ($\frac{7\pi}{20}$, 1.5 years)

Figure 7: The spectral densities function of inflation series for the cases of UK and France

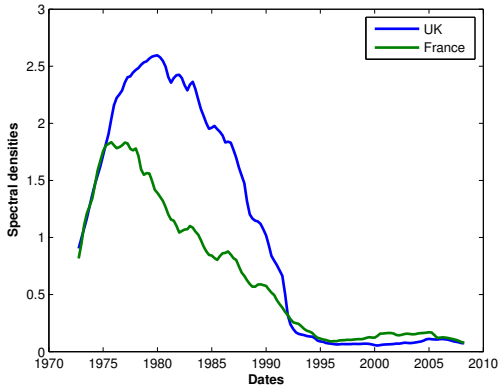


Figure 8: The spectral densities function of inflation series for the cases of Sweden and Norway

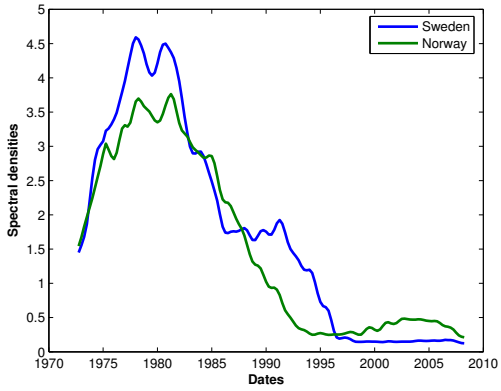
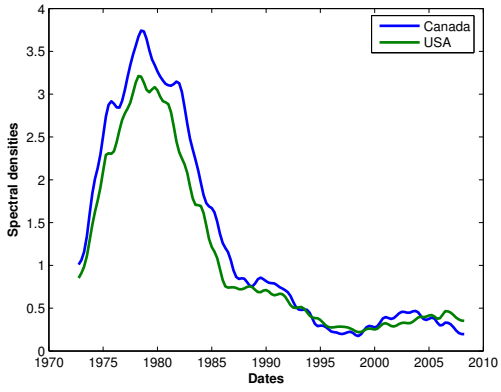


Figure 9: The spectral densities function of inflation series for the cases of Canada and USA



B.3 The spectral densities function of inflation series in medium-term ($\frac{4\pi}{20}$, 4 years)

Figure 10: The spectral densities function of inflation series for the cases of UK and France

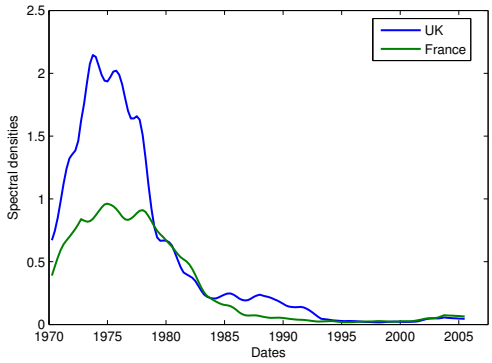


Figure 11: The spectral densities function of inflation series for the cases of Sweden and Norway

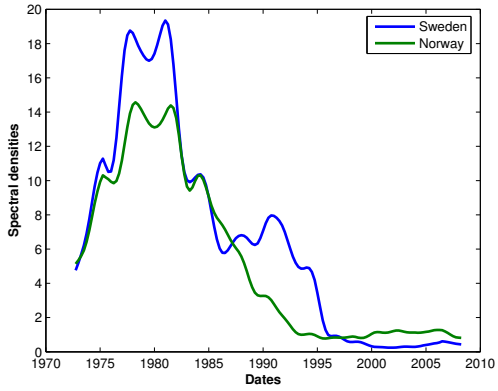
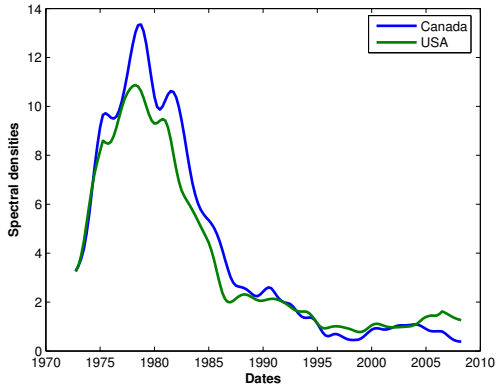


Figure 12: The spectral densities function of inflation series for the cases of Canada and USA



C Tables

C.1 Tables of Inflation statistics for our sample countries

Table 1: Inflation statistics for Inflation targeting countries of our sample[a]

	Date of IT adoption	Entire sample		Pre-IT		Post-IT	
		Mean	SD	Mean	SD	Mean	SD
UK	1992: Q2	1.40	1.44	2.20	1.55	0.54	0.56
France	-	1.14	1.02	1.94	0.94	0.42	0.75
Canada	1992: Q1	4.50	3.35	6.84	3.00	2.00	1.09
USA	-	4.50	3.01	6.28	3.13	2.61	1.12
Sweden	1993: Q1	5.24	4.04	8.14	2.85	1.49	1.49
Norway	-	5.26	3.60	7.6	2.92	2.01	1.00
Mean of inflation IT-countries		5.65	4.36	8.89	3.42	1.95	1.33
Mean of non-IT countries		5.23	3.57	7.67	3.13	2.48	1.28
T-Test of Equal mean (IT-countries: pre-IT and post-It)	3.33***[b]						
T-Test of Equal mean (non-IT-countries: pre-90s and post-90s)	2.66***						
F-test of Equal SD (IT-countries: pre-IT and post-It)	2.57						
F-Test of Equal SD (non-IT-countries: pre-90s and post-90s)	2.44						

[a] Source: Authors calculation.
[b] ***: Significance at level of 1%

C.2 Bai Perron test results

Table 2: Break point in evolutionary spectral density function of inflation series.[a]

Breaks[b] — Countries	UK	France	Canada	USA	Sweden	Norway
(Short-run:1 year)	Q1 1977* Q2 1992*	Q2 1986* Q3 1989** Q3 2004*	Q3 1981* Q2 1992***	Q1 1971* Q2 1989* Q3 1996*	Q3 1984*	Q2 1977** Q3 1997*
(Short-run:1.5 years)	Q2 1992**	Q4 1989*** Q3 1995*** Q2 2001**	Q1 1981* Q1 1995*	Q1 1981* Q3 1986 ** Q2 1999*	Q2 1981* Q3 1991*	Q3 1984** Q3 1998*
(Medium-run:4 years)	Q4 1979*** Q3 1988** 1992Q1**	Q3 1988*** Q2 1988* Q1 2000	Q3 1980** Q3 1987**	Q1 1980 ** Q3 1987*** Q2 2001**	Q1 1977* Q2 1986** Q3 1992**	Q1 1980* Q4 1992

[a] ***: Significance at level of 1%; **: Significance at level of 5%; *: Significance at level of 10%

[b] The standard linear regression model of Bai and Perron test is: $y_t = x_t^{'}\beta_j + \mu_t \quad for \quad t = T_{j-1}+1,...,T_j \quad and \quad j = 1,...,m+1.$
$H_0 : \beta_i = \beta_0 \quad for \quad i = 1,...,n$
$H_1 : \beta_i \neq \beta_0$