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FACULTY OF COMMERCE, LAW, AND MANAGEMENT

Essays on Inflation Targeting and Macroeconomic Performance

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A thesis submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements of the Doctor of Philosophy in Economics.

10 June 2024

Declaration

I, Norbert Sfiso Buthelezi hereby submit this thesis for the degree of Doctor of Philosophy (Economics) at the University of Witwatersrand. I hereby declare that this thesis is my own work and has not been submitted by me for any degree or examination at any other university.

Signed: 

Name of the Student: Norbert Sfiso Buthelezi

10 June 2024

Dedication

I dedicate this doctoral thesis to my departed parents, Henry and Lydia Buthelezi and my beautiful sister, Lungile Ursula Buthelezi who also left this world too young. My parents sacrificed everything to ensure that I get the best available education during the dark days of apartheid South Africa.

Acknowledgement

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List of Acronyms and Abbreviations

IT - Inflation Targeting

CB - Central Bank

RBNZ- Reserve Bank of New Zealand

FED - Federal Reserve Board

BOE - Bank of England

BCB - Banco Central do Brasil (Brazil's Central Bank)

FRED - Federal Reserve Economic Data

NAIRU - Non- Accelerating Inflation Rate of Unemployment

ARDL - Autoregressive Distributed Lag

EU - European Union

USA - United States of America

OECD - The Organization for Economic Cooperation and Development

UK- United Kingdom

Abstract

This thesis focuses and investigates the impact of inflation targeting on macroeconomic performance, whether the level of the inflation target is consistent with optimal economic performance and finally, we investigate whether inflation targeting affects the behaviour of fiscal policy in such a way as to deliver fiscal sustainability. This is important because many central banks have adopted inflation targeting as their monetary policy framework.

In chapter 2, we investigate the effect of inflation targeting on macroeconomic performance. We do so by formulating a measure of IT that is closely related to the degree of monetary policy activism that is used in the literature. Applying this to advanced and emerging market economies, we find that IT has an ambiguous effect on economic growth in advanced economies and it has negative effect in emerging markets.

We also find mixed results on the effect of IT on inflation performance. Lastly, we find that IT tends to lower bond yields across economies. We argue that the financial market benefits of IT do not find expression in real economic activity because of the disconnect that may exist between financial markets and real economic activity.

In chapter 3 we argue that there exists a non-linear relationship between inflation one hand and economic growth and unemployment rates on the other. IT requires an explicit announcement of a numerical target for inflation. However, it is not clear whether the announced targets are consistent with maximum economic growth and minimum unemployment rates. We derive a simple growth model in which economic growth and the unemployment rate are nonlinearly related to the inflation rate.

Our findings are that there are some advanced economies that sacrifice growth to maintain low inflation rates. This sacrifice is more prevalent in emerging markets, and it ranges from 0.5 percentage points to 3 percentage points. The same results hold for the unemployment rate, excess unemployment rate to maintain the low inflation targets ranges from 0.5 to 4.5 percentage points. We argue that policymakers should consider ways to align inflation targets to optimal levels in order to include more people into employment.

In chapter 4 we investigate whether the implementation of fiscal policy is consistent with the monetary policy stance. A number of economies have adopted inflation targeting as an overall

framework to guide monetary policy. However, a key requirement of this framework is that fiscal policy should not be implemented in a manner that is not consistent with inflation targeting. We investigate the behaviour of fiscal authorities under inflation targeting by estimating simple fiscal rules that incorporate the targets of monetary policy as normally specified in simple Taylor rules.

Our results suggest that for many of the economies in our sample, fiscal authorities respond in a counter-cyclical manner. In advanced economies they do not restrain fiscal policy when inflation rises. This is in contrast to fiscal authorities in emerging markets. Lastly, we do not find uniform adherence to Bohn's principle of fiscal sustainability across economies.

Keywords: Inflation Targeting, Fiscal Policy Rules, Public Debt, Public Deficits, Taylor Rule.

1. Inflation Targeting as a Monetary Policy Framework

1.1. Background

The Reserve Bank of New Zealand is the first central bank to adopt inflation targeting (IT) as its new monetary policy framework. "That was the result of the Reserve Bank of New Zealand Act 1989 and came into effect in February (1990)", McDermott and Williams (2018). Before this new approach, countries were mainly focusing on money supply, credit or exchange rate target as a way of controlling inflation. Those approaches did not yield desired results as far as controlling inflation was concerned. Since this adoption of IT, by New Zealand, many other countries have followed. They include both developed and emerging economies. Australia, UK, Canada, Japan, Brazil, Chile, South Africa and many others.

Inflation targeting refers to the target of inflation that is set either by government, the central bank or both, that must be achieved by the central bank as a way of protecting the value of currency, (price stability). Demertzis and Viegi (2008) define an inflation targeter as a central bank that that communicates a quantitative target, and they further say that a "central bank that does not try to explicitly quantify the term "price stability" and communicate it to the public is in turn a "non-inflation targeter".

Pollin and Zhu (2014) say these targets are low, in most cases between 2% and 5%.

It is interesting to note that when inflation targeting was adopted by RBNZ, it was less about 2 percent, but more about indicating to the market commitment to low inflation. Lockyer (2022) says, "initially when 2 percent inflation targets were adopted, to indicate to the markets commitment to low inflation, it was not meant to be a level considered optimal in the long term". The reality now is that many central banks consider it to be optimal.

The proponents of IT, like Mishkin (2000) cites the following advantages of IT: (a) it allows monetary policy to respond better to shocks to domestic economy; (b) unlike monetary targeting, stable relationship between money and inflation is not essential for its success; (c) it is transparent and therefore easily understood by the populace; (d) it increases accountability by monetary authorities; (e) Clifton (2001) says it discourages inflationary opportunism because financial markets will be quick to spot it.

However, since IT adoption, empirical research has resulted in heterogeneous findings about the effectiveness of IT as a monetary policy framework to accomplish optimal macroeconomics outcomes. There are those who say whether you adopt or not, it does not matter. That is the argument of Ball and Sheridan (2005). They say the improvement of inflation performance may be because of mean reversion, and not necessarily because of IT.

Rose (2006) argues that IT is beneficial to the economy. He says countries that adopt IT "experience lower exchange rate volatility". Goncalves and Salles (2008) also concluded that "the choice of the IT regime proved beneficial, especially for emerging markets. They say that countries that "chose to inflation target saw a greater reduction in growth volatility than those opting for alternative monetary policy arrangements".

Junankar and Wong (2020), using various estimation methods in a large sample countries found that, "growth rates increased for both inflation targeters and non-targeters at about the same time". Therefore, growth could not be attributed to inflation targeting.

Galindo (2005) says although IT could have succeeded in decreasing inflation, that was done at a cost of poor growth performance. Brito and Bystedt (2014) also do not agree that IT adoption results in positive macroeconomics outcomes. They say there are no statistical grounds to conclude that the IT framework improves performance in developing countries, as measured by the behaviour of inflation and output.

In the light of these conflicting outcomes, this thesis contributes to the further understanding of the impact of IT on macroeconomic performance. We adopt a methodology which is based on the Taylor rule. This is because inflation targeting central banks set their interest rates in order to target the inflation by following the Taylor rule. A related issue is whether the level of the inflation target is consistent with optimal economic performance. We investigate this issue by specifying a model that postulates a non-linear relationship between inflation and other macro-economic variables. Lastly, we investigate whether inflation targeting affects the behaviour fiscal policy in such a way as to deliver fiscal sustainability.

1.2. Research Problem

As we have demonstrated above, despite agreeing that high inflation is bad for the performance of the economy, there is still no agreement on whether inflation targeting is the correct monetary policy. As an example, Mishkin and Schmidt (2001) argue that IT has been successful in controlling inflation and improving economic performance. On the other hand, Ball and Sheridan (2004) say it is questionable whether the improvement in inflation performance in several countries was due to IT or not, because even with non-targeters, inflation performance improved.

The question then arises as to whether the targets chosen by inflation targeters are appropriate ones. Do they deliver better outcomes as far as economic growth, bond yields, unemployment, etc. are concerned? We continue getting conflicting empirical results. This may be partly explained by differing methodologies employed by different scholars and researchers. Ball and Sheridan (2005) use difference in difference, while Goncalves use propensity score matching method, and Lin and Ye (2009) use panel data models. Thornton (2012) highlighted the problem that may arise because of the differences in the data used. All these may provide reasons for these heterogenous findings.

1.3. Research Questions

In chapter 2 we are asking whether inflation targeting results in superior macroeconomic performance as Goncalves et al. 2006 argue. We look at the impact of IT on economic growth, bond yields, and inflation rate. Are inflation targeters producing better outcomes compared to non-targeters? Huang et al. 2019 argue that IT is associated with lower trade-off between output and inflation. We also want to investigate whether the impact of IT is the same or different between advanced and emerging economies. Brito and Bystedt (2014) conclude that there is no evidence that IT regime improves economic performance, as measured by the behaviour of inflation and output growth in developing countries.

In chapter 3 we investigate whether the current inflation targets are consistent with maximum economic growth and minimum unemployment rates? We also check if the actual inflation target is close to this optimal point or not and estimate the "unemployment costs" of the deviation of the inflation target from the optimal inflation rate. Horvath and Mateju (2011) found that there is no evidence that many central banks conducted studies before determining the existing threshold levels, they simply state the inflation target without explaining how they arrived at it. We therefore ask, "are inflation targets optimum"?

In chapter 4, we investigate whether the adoption of inflation targeting has affected the setting of fiscal policy. As pointed out by Woodford (2001) and Clarida et al. 1999, stability requires that a central bank adopts an activist monetary policy against inflation. The question that arises from this is whether fiscal authorities consider the targets of monetary policy in their decision-making?

Is there monetary policy dominance, which is an important condition for inflation targeting, as pointed out by Bernanke and Mishkin (1997)? Is fiscal policy set in a manner which undermines monetary policy or not? Under inflation targeting, fiscal policy cannot be set in a way that undermines the ability of the central bank to achieve its inflation target (Sims, 2005). Is the behaviour of fiscal authorities in developed and emerging economies the same or not? Therefore, hypothetically, we expect that the targets of monetary policy to form an important part of fiscal policy.

1.4. Contribution

Firstly, our approach therefore differs with most existing literature in that we do not regard IT as a treatment effect. We directly measure IT based on estimating the time-varying reaction of the central bank to inflation and other target variables. In this way, our approach is closely related to the degree of policy activism proposed by Leeper (1991) and Sargent and Cogley (2005). We estimate a Taylor-type rule with time-varying coefficients and on this basis, construct a time-varying measure of the degree of IT.

Secondly, we investigate whether current inflation targets are consistent with maximum economic growth and minimum unemployment rates. We derive a simple model of long run economic growth based on the rate of capital accumulation. The interest rate again follows a simple IT rule in which the reaction coefficients vary non-linearly with the level of inflation, optimal inflation points. We then check if the actual inflation target is close to this optimal point or not and estimate the "unemployment costs" of the deviation of the inflation target from the optimal inflation rate.

Lastly, we investigate whether the adoption of inflation targeting has affected the setting of fiscal policy. As pointed out by Woodford (2001) and Clarida et al. 1999, stability requires that a central bank adopts an activist monetary policy against inflation. In addition, Bonam and Lukkezem (2018), add that fiscal policy must be sustainable for macroeconomic stability to be achieved.

1.5. Structure of the study

Chapter 2 investigates the effect of inflation targeting on macroeconomic performance, like economic growth, unemployment rate, bond yields and inflation. In chapter 3 we ask the question whether inflation targeting is consistent with maximum economic growth and minimum unemployment rate. In chapter 4 we investigate the effect of IT on the conduct of fiscal policy. Chapter 5 concludes, summarizes key findings, and make some policy recommendations.

2. Inflation Targeting and Macroeconomic Performance: A Taylor Rule Approach

2.1. Introduction

Since its adoption in 1990 by the Reserve Bank of New Zealand, followed by Canada (1991) and the UK (1992) several central banks have moved towards inflation targeting (IT) as their monetary policy framework. Jonsson (1999) argues that the popularity of IT was nourished by the consensus among policymakers and economists that there is no long-term trade-off between inflation and output, and that price stability fosters economic growth.

Issing (2003) agrees with this sentiment and argues, " the awareness of the cost of inflation and of the absence of a long -run trade-off between inflation and real activity" are among the reasons for adopting IT. Huang et al. (2019) show that both in developed and developing countries, the output-inflation trade-off is "significantly lower in IT countries" compared to those who do not adopt this monetary policy. Thus, Epstein and Yeldan (2008) mention that even the IMF encourages the adoption of IT, and it may consider making IT one of its conditions when offering financial assistance.

According to Mishkin (2000) IT encompasses five elements: a) a public announcement of medium term numerical targets for inflation; b) an institutional commitment to price stability as the primary goal of monetary policy; c) an information inclusive strategy in which many variables are used for deciding the setting of policy instruments; d) increased transparency of the monetary policy strategy through communication with the public and the markets; and e) increased accountability of the central bank for attaining its inflation objectives.

Mishkin (2000) then cites the following advantages of IT: (a) unlike exchange rate peg, IT allows monetary policy to respond better to shocks to domestic economy; (b) unlike monetary targeting, stable relation between money and inflation is not essential for its success; (c) IT is also easily understandable by the populace because of its transparency; (d) because there is a numerical point or band of inflation, IT increases accountability; (e) Mishkin further argues that IT "reduces the likelihood that the central bank will fall into the time inconsistency trap".

The latter advantage is also mentioned by Clifton et.al. (2001), who argue that “the transparency of IT is thought to reduce the inflationary bias of monetary policy since financial markets should quickly spot any inflationary opportunism”. Goncalves et al. (2006) cite the added advantages of IT to include, a) lower and less variable inflation and interest rates; b) more stable growth; and c) enhanced ability to respond to shocks without losing credibility. Mishkin and Posen (1997) say IT does have some disadvantages.

They say, "because of the uncertain effects of monetary policy on inflation, monetary authorities cannot easily control inflation". They also cite the very long lag of monetary policy on inflation as a problem. Also, a negative supply shock may tempt monetary authorities to raise interest, and by so doing dampen output growth.

The adoption of IT is also understood to mean low inflation rates, of about 2 percent, Roger and Stone, (2005). Krugman (2014) argue that this level was not arrived at scientifically, except to say it "made both economic and political sense". Blanchard et al. (2010) and Ball (2014) have argued for an inflation rate of at least 4 percent. This argument became louder with the experience of global financial crisis.

When interest rates hit zero percent, monetary policy becomes very blunt in stimulating growth. In fact, Krugman (2014) argues that "there is growing evidence that economies entering a severe slump with low inflation can all too easily get stuck in an economic and political trap, in which there is a self-perpetuating feedback loop between economic weakness and low inflation".

However, since its introduction, there have been divergent views about the impact of IT on macroeconomic performance. Early studies, e.g., Mishkin and Schmidt (2001) report that IT has been successful in controlling inflation and improving economic performance. On the other hand, based on their empirical finding, Ball and Sheridan (2004) argue that it is questionable whether the improvement in inflation performance in several countries was due to IT or not.

Their argument is that non-inflation targeting countries also experienced improved inflation performance in that period. When looking at 20 OECD developed economies, they concluded that whether you adopt or not, it is irrelevant, entailing neither gains nor losses in terms of economic performance. However, Khan (2020), measured the causal relationship between inflation targeting adoption on economic growth. He concludes that, “when compared to the

countries that did not adopt inflation targeting, there is a significant reduction in the average growth rate among the inflation-targeting adopters by over 1/2 percentage point". This proves that the debate about this relationship needs further research, hence this study.

Duong, (2022) investigated 54 countries, with 15 being inflation targeters and concluded that, "the evidence of this study does not conclude that inflation targeting is the best monetary framework and that all countries must adopt it". He says emerging economies may consider it when they face external shocks like the 2007 financial crisis. This challenges the widely held view of "one size fits all" approach when it comes to monetary policy.

Coleman and Nautz (2022) were interested in the performance of inflation expectations when there are shocks like Covid 19 pandemic in Germany. It was found that consistently inflation was below 2 percent. This led to the decline of credibility of the central bank and consequently" de-anchored" inflation expectations.

In this paper, we revisit the question of the impact of IT on economic performance by formulating a time-varying measure of the degree of IT based on Taylor rule. We interpret the degree of IT as the weight of the central bank's reaction to deviations of inflation from target. This measure can be motivated using the results from Svensson (1997, 1999) among others.

As pointed out by Souza et al. (2016), most studies use the difference-in-difference method (Ball and Sheridan (2004), Goncalves and Salles (2008)), propensity score matching (Lin and Ye, 2009) and panel data models (Fouejieu, 2017), to measure IT as a treatment in which a dummy variable is used to separate pre-IT and post-IT adoption periods.

Our approach therefore differs with most existing literature in that we do not regard IT as a treatment effect. We directly measure IT based on estimating the time-varying reaction of the central bank to inflation and other target variables. In this way, our approach is closely related to the degree of policy activism proposed by Leeper (1991) and Sargent and Cogley (2005). We estimate a Taylor-type rule with time-varying coefficients and on this basis, construct a time-varying measure of the degree of IT.

The first advantage of our measure is that it is theory-based and has a direct link with seminal macro models of IT such as those by Svensson (1997), Ball (2000), Rudebusch and Svensson (1999) and Clarida et al. (1999). The second advantage of our measure is that it allows for the possibility that even if a central bank has not formally adopted IT, it is possible that we can detect some level of IT.

Furthermore, a central bank that has formally adopted IT may, in some periods, be found to have decreased its degree of IT. The latter case is argued by Barbosa-Fihlo (2007) in Brazil as follows, "even though the BCB has officially abandoned exchange rate targeting in 1999, inflation targeting implies a disguised exchange rate targeting in Brazil".

Our hypothesis is that IT does indeed improve macroeconomic performance. Although this hypothesis has been tested before, the difference is that here we directly measure IT based on estimating the time-varying reaction of the central bank to it and other target variables based on Taylor-type rule, as mentioned above. In the methodology section we show the percentage reaction of the central bank to inflation, relative to all other variables, see eq. (9) and eq. (10). We shall investigate both advanced and emerging economies, depending on the availability of data.

The paper is structured as follows: section 2 is the literature review, section 3 derives and motivates our measure of the degree of IT, section 4 provides empirical results and interpretation and in section 5 we conclude with some policy recommendations.

2.2. Literature review

The move towards inflation targeting by many central banks across the globe is premised on the view that the inflation targeting framework delivers macroeconomic benefits. Yet, as has been pointed out, this premise is not empirically straightforward. The seminal paper by Ball and Sheridan (2005) opened a vast literature which seeks to evaluate the macroeconomic effects of inflation targeting and they found that IT does not matter. They found no significant differences in the performance of IT and non-IT economies.

The heterogeneous findings about the effectiveness of IT in promoting macroeconomic performance poses a theoretical and policy challenge. To illustrate the problem in relation to emerging markets, Brito and Bystedt (2014) conclude, using panel GMM techniques, that there is no evidence that the inflation targeting regime (IT) improves economic performance as measured by the behaviour of inflation and output growth in developing countries.

Yet, Mendonca and Souza (2011), using a propensity score matching methodology, find that IT is an ideal monetary policy regime for developing countries because it reduces inflation volatility and helps drive inflation down to internationally acceptable levels in these countries by enhancing monetary policy credibility. In the light of these contradictory findings, it is not clear which recommendation should policymakers adopt.

Huang et al. (2019) utilizing endogenous switching regression (ESR) approach, which they argue is more robust than techniques used before, concluded that adoption of IT "is associated with lower trade-off between output and inflation, both in developing and developed countries".

Loewald et al. (2022) argue that the costs associated with inflation ratio are short term. Using trend analysis approach to calculate sacrifice ratio in South Africa, they conclude that, "the most recent reduction in trend inflation (2016 – 2019) was not associated with output losses from policy setting. They argue that the sacrifice ratio of post-apartheid South Africa is very low, averaging 0.5.

Ftiti (2010) using cohesion approach investigated whether IT led to a stable monetary environment. A stable monetary environment provides certainty, he argued. He concluded that IT policy "generates a good economic performance in developed countries". Ardakani et al. (2018) found that there was no difference as far as inflation level is concerned between targeters and non-targeters, although IT led to improvement in Debt-GDP ratio in both the developed and developing economies. Lin and Ye (2009) argue that the performance of IT is dependent on "country characteristics such as government fiscal policy, central banks desire to limit the movements of exchange rates and the time length since the policy adoption".

In addition, Brito and Bystedt (2014) further state that, in opposition to the previous views that IT adoption causes efficiency gains, we showed a negative significant relation between IT adoption and output growth, which must be considered for purposes of evaluating the IT policy. When we account for the output growth forgone in the IT disinflation process, there are no statistical grounds to conclude that the IT framework improves performance in developing countries, as measured by the behaviour of inflation and output.

This view is supported by Galindo (2005) where he concedes IT succeeded in moving decreasing inflation from 50 percent to 5 percent but argues that was done at the cost of poor growth performance.

Yet in an earlier study, Goncalves and Salles (2008) concluded that, our results suggest that the choice of the IT regime proved beneficial for emerging economies. They find that: (i) the greater fall in inflation experienced by emerging market targeters can, to some extent, be attributed to the regime itself and not only to mean reversion; (ii) those choosing to inflation target saw a greater reduction in growth volatility than those opting for alternative monetary policy arrangements.

They further state that the view that inflation targeting hinders economic growth is not supported by empirical evidence. Rose (2006) says IT is durable compared to other previous monetary policy regimes. In support of IT he argues, "countries that target inflation experience lower exchange rate volatility and fewer "sudden stops" of capital flows than their counterparts".

These results by Goncalves and Salles (2008) have been questioned by Thornton (2016) on methodological grounds, who found that IT did not help reduce inflation and growth volatility in developing countries compared to the average experience under alternative monetary policy regimes. So, once again, policymakers are left without a clear policy choice from the literature. Perhaps a study that provides a more comprehensive assessment of the macroeconomic effects of IT is Mishkin and Schmidt (2007).

These authors mention five key findings: i) ITers performed better than non-ITers as far as economic performance is concerned, ii) emerging market ITers achieved a significant reduction in output growth volatility and output gap volatility under IT, iii) the response to shocks, e.g. oil shocks, by ITers has led to a reduction in domestic inflation relative to their pre-IT experience, iv) the pass through effects from exchange rate shocks was better absorbed by ITers compared to non-ITers and v) ITers experienced dramatic decline in interest rates sensitivity of output compared to non-ITers.

One of the factors that complicates the assessment of the macroeconomic effects of IT is mean reversion. Ball and Sheridan (2004) argue that it is not conclusive whether the improvement in inflation in the ITers is because of the monetary policy or it is because of regression to the mean

or what they also call inflation convergence. Indeed, Arestis et al. (2014) report that inflation tends to converge across economies independent of the monetary policy framework.

The convergence theory is supported by Bhala, et al. (2023) who argue that "it is not clear why IFIs should continue to advocate formal adoption of IT, since our results show that formal adoption is neither necessary nor sufficient to the attainment of beneficial inflation and growth outcomes". They also say, "central banks and IFIs could …benefit from looking at the evidence on IT with a more critical eye, given the dangers of group thinking at these institutions as highlighted in some quarters." The point made here is that the benefits of IT tend to be exaggerated. Balima et al., (2020) conclude that "empirical literature suffers from publication biases because authors, editors and reviewers prefer results featuring beneficial effects of IT adoption".

The method employed by Goncalves and Salles (2008) sought to identify the effect of IT as distinct from mean-reversion. They find that even after controlling for mean reversion, inflation fell more in the targeters group. Furthermore, Goncalves and Salles (2008) argue that the additional inflation reduction experienced by those adopting IT was not at all immaterial.

Further evidence on the effect of IT on inflation and inflation expectations is provided by Levin et al. (2004), who found that the adoption of IT is not associated with a fall in inflation expectations over longer horizons. The subsequent study by Lin and Ye (2009) seems to arrive at a different result. It reports that IT has large and significant effects in lowering inflation and inflation volatility. Furthermore, Ftiti and Hichri (2014) conclude that the IT policy is relevant in achieving its primary goal of price stability and succeeds better than any other monetary policy in anchoring inflation expectations.

However, Goncalves and Salles (2008) did not find strong evidence that the adoption of IT lowers inflation volatility relative to non-ITers. A favourable result is reported by Capistrin and Ramos - Francia (2010), who assessed the effects of IT on the dispersion of inflation expectations. They found that the dispersion of long run inflation expectations is smaller in targeting regimes after controlling for country-specific effects and other effects. Lastly, Gerlach and Tillman (2012) find that ITers tend to exhibit low inflation persistence compared to non-ITers in the Asia-Pacific region. They find no significant differences in the levels of inflation between ITers and non-ITers.

Linked to the effect of IT on inflation expectations is its effect on financial markets, especially long-term interest rates. Through the expectations theory of the term structure, the anchoring of inflation expectations means, to a large extent, that long term interest rates will be stabilized. Kose et al. (2012) find evidence that the IT regime adopted by the Central Bank of Turkey influenced real long-term interest rates and it ensured that realized inflation is close to target.

A similarly favourable finding on Turkey is reported by Akyurek et al. (2011), who concluded that IT improved the transmission mechanism, and that inflation has become more predictable.

In relation to economic growth, Ghosh and Phillips (1998) argue that very high inflation is bad for growth. However, there is less agreement about the effects of moderate inflation on economic growth. Souza et al. (2016) find that there is a positive effect of IT on economic growth especially for developing countries. They therefore argue that the adoption of IT implies gains in economic growth or at least non-sluggish economic growth.

These results are in line with those of Mollick et al. (2011), who find that IT adoption results in higher output per capita in both industrial and emerging market economies. Corbo et al. (2002) compare sacrifice ratios, (defined as percentage output losses per percentage unit of inflation reduction) for targeters and non-targeters. They concluded that "IT contributed to lowering output costs of inflation stabilization".

Although they find the impact of IT on economic growth to be minimal among developing countries, Ayres et al. (2014) also find that there is a statistically significant increase in real GDP among developing countries in certain regions only. However, in the case of Mexico, Carrasco (2011) notes that both the level and volatility of inflation began to fall before IT. He further notes that although lower volatility of economic growth is detected, growth itself has not been affected by the adoption of IT.

Stronger results along these lines are reported by Brito and Bystedt (2010), who find a significant negative effect of IT adoption on economic growth. Along similar lines, Argitis (2008) finds that any restrictive monetary policy directly or indirectly associated with inflation targeting tends to reduce aggregate demand and employment.

Gerlach and Tilliman (2012) also found that there is declining persistence of inflation in most IT countries in the Asia Pacific region although in differing degrees. However, they notice that despite these countries saying they are ITers, some of their central banks continue to attach great weights to the exchange rate.

Argitis (2008) after looking at 13 OECD observed that any restrictive monetary policy, directly or indirectly, associated with inflation targeting, tends to reduce aggregate demand and employment and therefore this will result in higher sacrifice ratio in terms of subdued growth rates and higher financial instability. Rowden (2010) also argues that IT is associated with big sacrifice ratios. He says International Monetary Fund sacrifices higher growth, employment, and public investment in health systems in order to keep inflation unnecessarily low.

There are studies that investigate the impact of IT on financial stability, largely prompted by the global financial crisis of 2008 (see for example Kim and Mehrotra, 2017). The question is whether IT helped to cope better with the financial crisis. Woodford (2012) has called for the modification of IT in the light of financial crisis so that IT includes marginal crisis risks. In fact, he calls for leaning against the wind in order to reduce the probability of a financial crisis.

In relation the stability of the banking systems, Fazio et al. (2015) argues that IT banking systems tended to be more stable and became less distressed during the global financial crisis compared to their non-IT counterparts.

This conclusion seems however to be inconsistent with the finding by Fouejieu (2017), who reports that the financial sector of IT economies appears to be more fragile, thereby challenging the view that IT supports financial stability. Indeed, Soyoung and Mehrota (2017) raise the possibility of a trade-off between financial stability and price stability objectives.

The existence of a trade-off between price stability and financial stability has been documented by Blot et al. (2015) for the case of the US and the Eurozone. In this context, Akram and Eitrheim (2008) find that financial stability can be advanced mainly through output stability and not through price stability.

Other authors have assessed whether the adoption of IT has an impact on inflation aversion by central banks. Dueker and Fischer (2006), ask the question whether IT imparts an aversion to inflation and inflation variability among inflation targeting countries above and beyond that displayed by non-inflation targeting countries? They conclude that the view that IT imparts more aversion to inflation and inflation variability in IT economies than in non-IT economies is not supported by empirical evidence in countries facing same circumstances.

Alders et al. (1996) say the behaviour of central bankers in taking inflation seriously explains aversion of high inflation. They are of the view that this applies for both ITers and non-ITers. Bleich et al. (2012) found that the introduction of IT changed the willingness of central banks to fight inflation. He found that the inflation coefficient in the Taylor rule is significantly larger than unity.

The ability of IT to cope with the challenges brought about by the global financial crisis of 2008 has also been a subject of discussion. Svensson (2010) argues for flexible inflation targeting, especially after the global financial crisis. He describes flexible inflation targeting as "the monetary policy that aims to stabilize both inflation around the inflation target and the real economy." The Assistant Governor of the Reserve Bank of Australia, Eday (2013) says, "one of the consequences of the recent financial crisis has been a rediscovery, or at least a renewed appreciation, of that role, (the stabilization of real economy)".

He continues to say that "this in many ways represents a return to the original rationale for central banking. It was only in recent decades that some came to see the role as being more narrowly confined to the inflation control function. What we are now seeing is better appreciation of the broader original role". We extensively quoted Eday because he is an assistant governor of one of the central banks that pioneered the adoption of IT.

Secondly, this shows that more targets may have been attributed to IT as a monetary policy framework, when in fact these targets could suitably be achieved using other complementary policy instruments.

The review of the literature shows that the conflicting results about the effectiveness of IT may be due to differences in samples and periods across studies (see Thornton (2016) and Goncalves and Salles (2006). Secondly the differences in results may be due to methodology. Studies which use

propensity score matching methods (e.g., Mendonca and Souza (2011) and Lin and Ye (2009)) tend to find results in favour of IT.

2.3. Methodology

2.3.1. Defining the degree of inflation targeting

How should we define inflation targeting? This is the question that was posed by Svensson (2002). In response, Svensson emphasizes three characteristics: a) the existence of a numerical target, b) the decision-making process of the central bank is inflation-forecast targeting, with the inflation forecast conditioned by the instrument setting that is consistent with the target, and c) there is a high degree of transparency and accountability by the central bank to achieve its target.

In the earlier seminal contributions by Svensson (1997,1998, 1999), variations of inflation targeting are explained in terms of the weight that the central bank attaches to inflation stabilization relative to other stabilization objectives in its loss function. Thus, with a central bank that has a numerical inflation target to achieve, Svensson (1997) interprets inflation targeting as implying that the central bank chooses a sequence of current and future interest rates to minimize its loss function—the loss function having a relatively large weight on inflation stabilization.

The variations of inflation targeting are strict and flexible inflation targeting. Strict inflation targeting is when the central bank is concerned only about inflation stabilization, whereas flexible inflation targeting includes concerns about other stabilization objectives—with the inflation objective carrying the greatest weight in the central bank's objective function. To illustrate, Svensson (1997, 1998, 1999) derives an optimal interest rate rule from a closed-economy model that is augmented with the central bank's loss function.

The model is composed of a Phillips curve to describe inflation dynamics and the IS curve to describe the dynamics of the output gap. The optimal interest rate rule closes the model by determining how the central bank adjusts the interest rate. Svensson's setup can be described as follows:

$$\pi_t = \pi_{t-1} + \alpha y_{t-1}, \tag{1}$$

$$y_t = \beta_y y_{t-1} - \beta_r \left(i_{t-1} - \pi_{t|t-1}\right) \tag{2}$$

$$L_t = \sum_{j=0}^{\infty} \frac{\delta^j}{2} \left(\left(\pi_{t+j} - \pi^*\right)^2 + \lambda y_{t+j}^2 \right), \tag{3}$$

where π_t is the inflation rate, $\pi_{t|t-1}$ is expected inflation at $t-1$, y_t is the output gap, i_t is the nominal interest rate, which in this set up is the instrument of monetary policy, L_t is the central bank's loss function, δ is the discount factor, π^* is the inflation target and λ is the relative weight that the central bank places on the output stabilization objective. Based on this model, Svensson (1997, 1999) shows, through a dynamic programming procedure, that the optimal interest rate rule, which minimizes the loss function, takes the following form:

$$i_t = \pi_t + f_\pi(\lambda)(\pi_t - \pi^*) + f_y(\lambda) y_t \tag{4}$$

where:

$$f_\pi(\lambda) = \frac{1 - c(\lambda)}{\alpha \beta_r}, f_y(\lambda) = \frac{\beta_y + 1 - c(\lambda)}{\beta_r}, c(\lambda) = \frac{\lambda}{\lambda + \delta \alpha^2 k(\lambda)}$$

$$k(\lambda) = \frac{1}{2}\left(\left(1 - \frac{\lambda(1-\delta)}{\delta \alpha^2}\right)^2 + \sqrt{\left(1 + \frac{\lambda(1-\delta)}{\delta \alpha^2}\right)^2 + \frac{4\lambda}{\alpha^2}} \right)$$

Note that as $\lambda \to 0$ we have that $k(\lambda) \to 1$ and this implies that $c(\lambda) \to 0$. We now construct a ratio IT which is the ratio of the reaction of the central bank to inflation to the reaction of the central bank to the output gap as follows:

$$IT = \frac{1-c(\lambda)}{\left(\beta_y+1-c(\lambda)\right)\alpha}. \quad (5)$$

We observe that as $\lambda \to 0$ we have that $IT \to \frac{1}{(1+\beta_y)\alpha}$, which is consistent with a shift towards strict inflation targeting. Therefore, the move towards strict inflation targeting leads to an increase in the reaction ratio. In other words, all else being the same, an increase in IT indicates an increase in inflation targeting while a decrease in IT indicates a decrease in inflation targeting.

This allows us to develop an empirical measure of inflation targeting. To determine the degree of IT, we use the Taylor rule approach. We argue that the degree to which the central bank responds to inflation relative to other target variables is a suitable approximate measure of IT. As in Taylor (2001), Mohanty and Klau (2004) and Froyen and Guender (2018) among others, we assume an emerging market central bank that sets a target for the nominal interest rate taking into account inflation, economic activity and exchange rate variability. Accordingly, we propose the following Taylor rule:

$$i_t^* = i_0 + \phi_{\pi,t}(\pi_t - \pi^*) + \phi_{y,t}y_t + \phi_{q,t}\Delta q_t \quad (6)$$

As derived by Svensson (1997) in the case of a closed economy, the parameters in eq. (6) are a combination of the central bank's preferences and the structure of the economy. We assume that these parameters are time-varying. The central bank adjusts the nominal interest rate as follows:

$$i_t = i_{t-1} + \phi_{i,t}(i_t^* - i_{t-1}) \quad (7)$$

Taking eq. (6) into eq. (7) we obtain the following interest rate rule:

$$i_t = \left(1 - \phi_{i,t}\right)i_{t-1} + \phi_{i,t}(i_0 + \phi_{\pi,t}(\pi_t - \pi^*) + \phi_{y,t}y_t + \phi_{q,t}\Delta q_t) \quad (8)$$

Based on eq. (6), we define the degree of IT to be the reaction ratio of the central bank to inflation, relative to total reaction to all variables. That is:

$$IT_t^* = \frac{\phi_{\pi,t}}{\phi_{\pi,t}+\phi_{y,t}+\phi_{q,t}} \quad (9)$$

The increase in $\phi_{\pi,t}$ relative to the other parameters implies that the central bank is increasing its degree of IT. The theoretical basis of this time-varying measure of IT is eq. (5), under the assumption that the model parameters are relatively stable over time.

Alternatively, we can use eq. (8) to define the degree of IT to be:

$$IT_t = \frac{\phi_{\pi,t}}{\phi_{i,t}(\phi_{\pi,t}+\phi_{y,t}+\phi_{q,t})+(1-\phi_{i,t})} \tag{10}$$

Existing literature, for example Goncalves and Salles (2006), follows Ball and Sheridan (2004) in using a difference-in-difference approach to investigate the macroeconomic effects of inflation targeting, which relies on the use of dummy variables. We use the measures of IT in eqs. (9) and (10) to test a relationship of the following form:

$$\Omega_t = \alpha_0 + \sum_{j=1}^{n} \theta_j \Omega_{t-j} + \sum_{i=0}^{m} \alpha_i IT_{t-i} + \sum_{k=0}^{q} \alpha_{z,k} Z_{t-k} + \epsilon_t \tag{11}$$

Where Ω_t is a macroeconomic variable (e.g., inflation, economic growth, the unemployment rate, or the long-term interest rate), Z_t is a vector of control variables that determine the macroeconomic variable and IT_t is the degree of inflation targeting. We use the examples of the inflation rate and the growth rate to illustrate the hypotheses to be tested. The hypothesis is that: inflation targeting reduces the inflation rate. Therefore, we expect that $\sum_{i=0}^{m} \alpha_i < 0$ and is statistically significant. Alternatively, inflation targeting does not reduce the inflation rate.

The second example is about the effects of inflation targeting on the growth rate. The hypothesis is that: inflation targeting increases the growth rate. Therefore, we expect $\sum_{i=0}^{m} \alpha_i > 0$ and statistically significant. Alternatively, inflation targeting does not increase the growth rate. In which case may be negative or even if positive, may not be statistically significant.

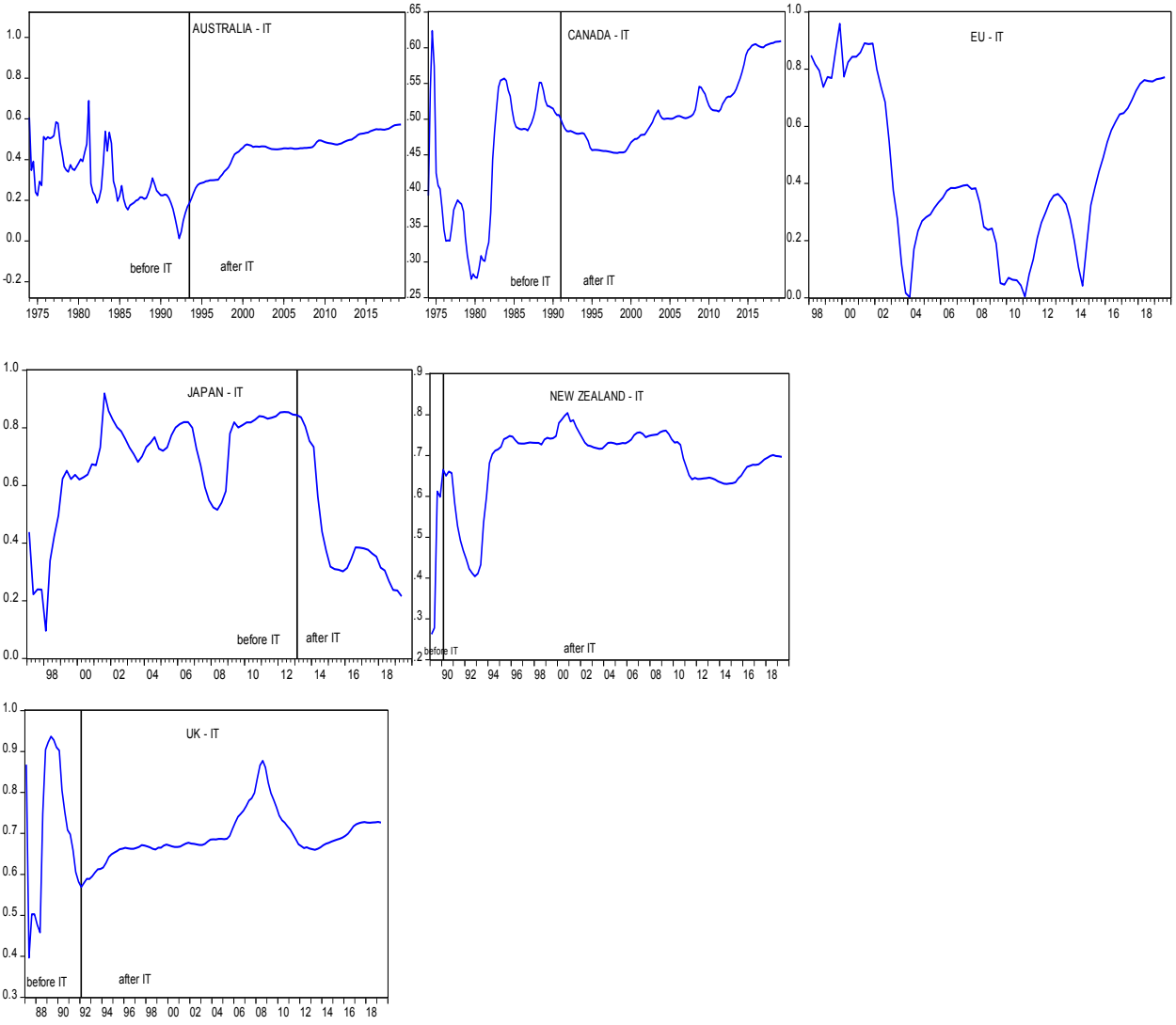
2.4. Empirical analysis

2.4.1. Data description

We sourced data from the FRED database. The sample sizes depend on the availability of data for each country. The frequency of the data is quarterly. For the inflation rate we used the CPI to calculate the annualized inflation rate so that $\pi_t = p_t - p_{t-4}$, where p_t is the natural log of CPI. We also calculated in a similar way the annualized growth rate by using real GDP. The long-term interest rate is proxied by the 10-year government bond yield. The short-term interest rate is

measured using the treasury bill rate. As the starting point of our analysis, we graphically present our measure of IT, also illustrating how this measure behaves before and after the adoption of inflation targeting as a monetary policy framework. Figure 2.1 illustrates the IT measure:

Advanced Economies



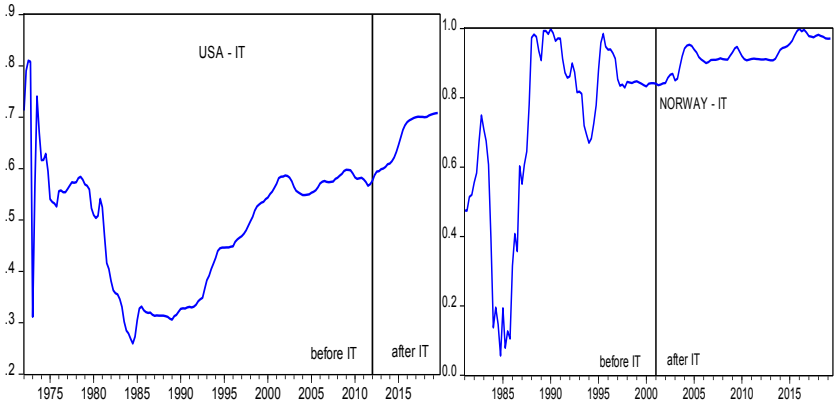


Figure 2.1 Evolution of IT Advanced economies

Emerging Markets

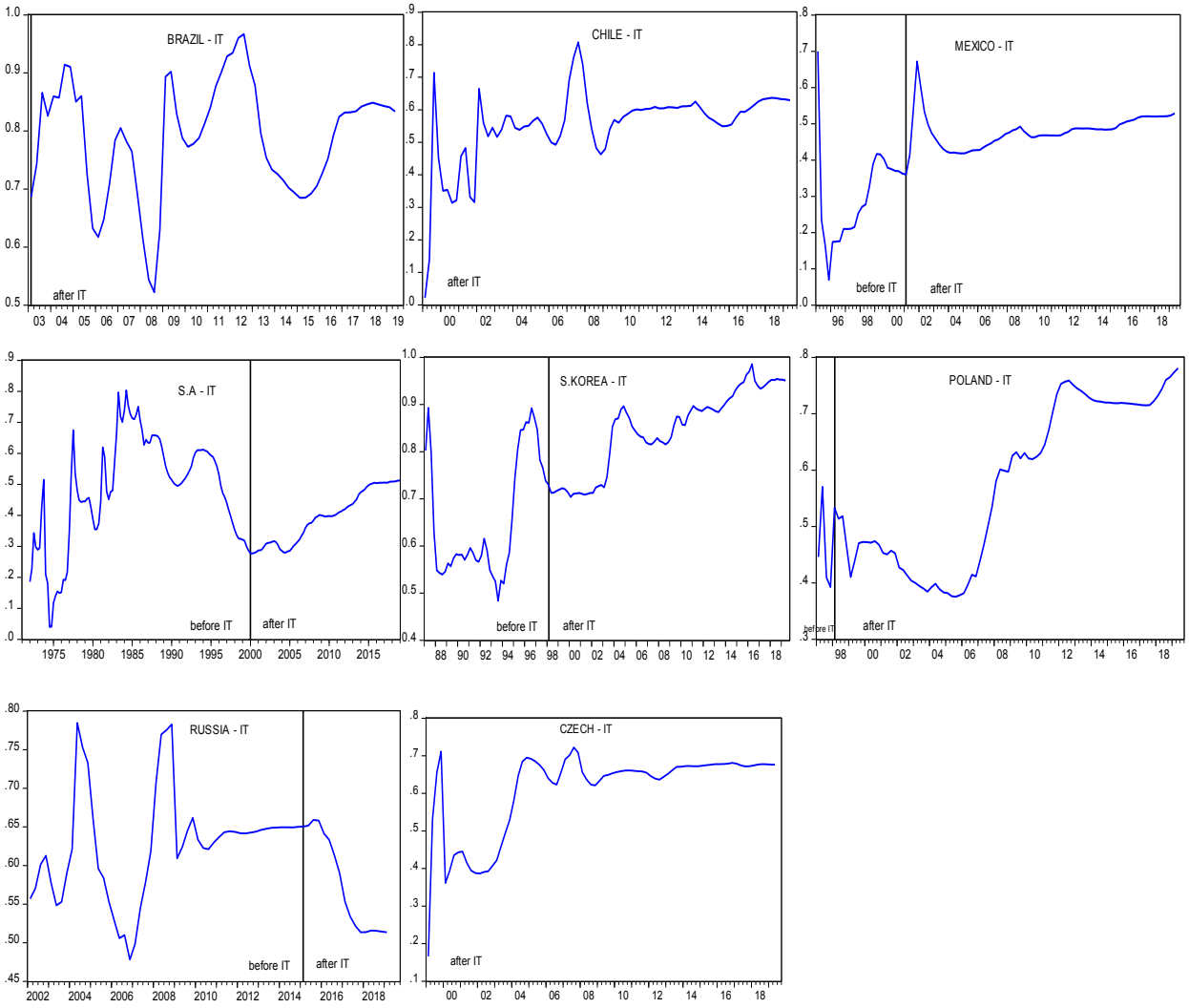


Figure 2.2 Evolution of IT Emerging Market

We next conduct unit root tests on the variables of interest, using the Augmented Dickey Fuller test. Table 2.1 reports that the key variables through which we measure macroeconomic performance: the short rate, the bond yield, inflation rate and the unemployment rate, are largely non-stationary, while the growth rate is stationary. Our measure of IT is also not stationary in most of the economies in our sample. However, in economies such as Australia, New Zealand, Brazil, Chile and Russia, IT is stationary.

Table 2.1 Augmented Dickey-Fuller unit root tests

	Australia	Canada	Euro	Japan	N. Zealand	UK	US	Norway
Advanced								
Long rate	-0.58	-0.94	-0.47	-0.63	-1.01	-1.53	-1.29	-1.48
	(0.87)	(0.77)	(0.89)	(0.86)	(0.75)	(0.88)	(0.63)	(0.54)
Short rate	-1.76	-1.72	-1.67	-1.85	-1.87	-1.17	-1.72	-1.19
	(0.40)	(0.42)	(0.44)	(0.36)	(0.34)	(0.69)	(0.42)	(0.68)
Inflation rate	-2.10	-2.26	-3.18*	-1.66	-1.15	-1.32	-1.99	-1.55
	(0.24)	(0.19)	(0.02)	(0.45)	(0.70)	(0.62)	(0.29)	(0.51)
Output gap	-6.62*	-5.87*	-4.29*	-4.24*	-4.54*	-4.34*	-6.47*	-4.95*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Growth rate	-3.50*	-3.09*	-4.39*	-3.36*	-2.75**	-4.18*	-3.56*	-3.69*
	(0.01)	(0.03)	(0.00)	(0.01)	(0.07)	(0.00)	(0.01)	(0.01)
Unemp. rate	-2.21	-3.34*	-2.00*	-1.58	-2.02	-2.39	-3.37*	-2.25
	(0.20)	(0.01)	(0.04)	(0.49)	(0.28)	(0.15)	(0.01)	(0.19)
Real deprec.	-4.80*	-3.35*	-4.02*	-3.37*	-4.23*	-3.36*	-3.16*	-3.69*
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.02)	(0.01)
IT	-2.83**	-2.22	-1.82	-1.82	-4.95*	-2.41	-1.79	-2.03
	(0.06)	(0.20)	(0.37)	(0.37)	(0.00)	(0.14)	(0.38)	(0.27)
Emerging	Brazil	Chile	Czech	Mexico	S. Africa	S. Korea	Poland	Russia
Long rate	-3.99*	-0.47	-1.80	-2.21	-1.73	-1.48	-1.77	-8.59*

	(0.01)	(0.89)	(0.38)	(0.21)	(0.41)	(0.54)	(0.39)	(0.00)
Short rate	-2.82**	-2.12	-2.06	-3.01*	-2.83**	-1.19	-2.81**	-3.03*
	(0.06)	(0.24)	(0.26)	(0.04)	(0.06)	(0.68)	(0.06)	(0.03)
Inflation rate	-2.97*	-4.16*	-4.59*	-1.75*	-1.40	-1.55	-5.06*	-5.71*
	(0.04)	(0.00)	(0.00)	(0.00)	(0.58)	(0.51)	(0.00)	(0.00)
Output gap	-4.25*	-4.24*	-4.02*	-5.01*	-4.87*	-4.65*	-5.17*	-3.90*
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Growth rate	-2.58**	-3.32*	-4.28*	-5.02*	-3.36**	-3.69**	-4.72*	-2.61**
	(0.10)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.09)
Unemp. rate	-1.35	-2.44	-1.71	-2.56	-1.70	-2.24	-1.87	-2.89*
	(0.61)	(0.13)	(0.42)	(0.10)	(0.43)	(0.19)	(0.35)	(0.05)
Real deprec.	-3.68*	-2.86*	-3.38*	-5.59*	-4.33*	-4.01*	-3.35*	-7.21*
	(0.00)	(0.05)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
IT	-3.27*	-3.87*	-2.30	-3.04*	-2.30	-1.63	-0.03	-5.00*
	(0.02)	(0.00)	(0.17)	(0.03)	(0.17)	(0.46)	(0.95)	(0.00)

Note: Probability in parentheses, * significant at 5%, ** significant at 10%

Given that some variables may be non-stationary while others may be stationary within the same equation, the ARDL-type specifications in eq. (11) are appropriate.

2.4.2. Effect of IT on bond yields

The first test of the effect of IT on macroeconomic performance is on bond yields. We expect that IT will lead to a low inflation environment, which will anchor inflation expectations at a low and stable level. This in turn will deliver a low long-term interest rate environment. Our specification assumes that bond yields are persistent, and they are also determined by the inflation rate and the short rate. We tested the effect of the output gap on bond yields and found it to be largely insignificant across economies, and so we dropped the output gap from the specification. We use the following specification in our regressions:

$$R_t = \alpha_0 + \sum_{j=1}^{n} \theta_j R_{t-j} + \sum_{h=0}^{p} \alpha_{i,h} i_{t-h} + \sum_{k=0}^{q} \alpha_{\pi,k} \pi_{t-k} + \sum_{i=0}^{m} \alpha_i IT_{t-i} + \epsilon_t, \quad (12)$$

Our hypothesis is that $\sum_{i=0}^{m} \alpha_i < 0$, so that IT has a negative effect on bond yields. Table 2.2 reports the results for eq. (12). In relation to advanced economies, we find that IT tends to significantly reduce bond yields in five of the eight economies. In the case of Japan, IT does not have a significant effect on bond yields. For Canada and New Zealand, we find that IT has a positive effect on bond yields. Therefore, while for most of the advanced economies IT improves the performance of the bond market by reducing bond yields, there are some economies where such benefit does not exist.

Table 2.2 Effect of inflation targeting on bond yields

	Australia	Canada	Euro	Japan	N. Zealand	UK	US	Norway
Advanced								
Constant	0.003	-0.000	0.002	-0.001*	-0.002	-0.001	0.005**	0.003**
	(0.002)	(0.002)	(0.001)	(0.000)	(0.003)	(0.003)	(0.003)	(0.002)
R_{t-1}	0.906*	1.079*	1.329*	0.951*	1.112*	1.124*	1.000*	1.117*
	(0.029)	(0.058)	(0.087)	(0.025)	(0.090)	(0.080)	(0.061)	(0.093)
R_{t-2}	-	-0.147*	0.437*	-	-0.154*	-0.185*	-0.111**	-0.169**
	-	(0.053)	(0.090)	-	(0.087)	(0.080)	(0.058)	(0.082)
i_t	0.305*	0.299*	-	0.565*	0.340*	0.242*	0.400*	0.210*
	(0.035)	(0.043)	-	(0.134)	(0.067)	(0.049)	(0.040)	(0.038)
i_{t-1}	-0.250*	-0.232*	-0.090	-0.999*	-0.303*	-0.198*	-0.330*	-0.190*
	(0.040)	(0.047)	(0.082)	(0.224)	(0.064)	(0.052)	(0.046)	(0.048)
i_{t-2}	-	-	0.182*	0.422*	-	-	-	-
	-	-	(0.067)	(0.157)	-	-	-	-
π_t	0.038*	-	0.315*	0.000	-	-0.009	0.036*	-
	(0.010)	-	(0.067)	(0.010)	-	(0.026)	(0.017)	-
π_{t-1}	-	0.029*	0.307*	-	-0.188*	-	-	-0.050
	-	(0.011)	(0.067)	-	(0.064)	-	-	(0.039)

π_{t-2}	-	-	-	-	0.152*	-	-	0.085*
	-	-	-	-	(0.064)	-	-	(0.038)
IT_t	-0.024*	0.018*	0.006**	0.001	-	-	-	-
	(0.009)	(0.007)	(0.003)	(0.000)	-	-	-	-
IT_{t-1}	0.020*	0.016**	-0.010**	-	0.025*	-0.014*	-0.006**	-0.003*
	(0.010)	(0.009)	(0.006)	-	(0.009)	(0.006)	(0.004)	(0.001)
IT_{t-2}	-	-	-0.005	-	-0.021*	-0.017*	-	-
	-	-	(0.003)	-	(0.007)	(0.006)	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.004*	0.034	-0.009	0.001*	0.004*	-0.031*	-0.006**	-0.003*
R^2	0.90	0.85	0.77	0.83	0.88	0.90	0.92	0.93
Emerging	Brazil	Chile	Czech	Mexico	S. Africa	S. Korea	Poland	Russia
Constant	0.002*	0.008	-0.004	0.036*	0.003*	0.003	0.009*	0.004**
	(0.001)	(0.005)	(0.005)	(0.012)	(0.001)	(0.006)	(0.004)	(0.002)
R_{t-1}	0.934*	0.966*	1.140*	0.646*	0.918*	0.848*	0.764*	0.117*
	(0.028)	(0.042)	(0.083)	(0.085)	(0.023)	(0.046)	(0.078)	(0.093)
R_{t-2}	-	-	-0.303*	-	-	-	-	-0.169**
	-	-	(0.088)	-	-	-	-	(0.087)
i_t	-	0.271*	-	0.531*	0.344*	0.460*	0.376*	0.210*
	-	(0.065)	-	(0.091)	(0.053)	(0.145)	(0.071)	(0.038)
i_{t-1}	-0.004	-0.541*	-0.173**	-0.389*	-0.308*	-0.625*	-0.270*	-0.190*
	(0.019)	(0.098)	(0.101)	(0.080)	(0.049)	(0.173)	(0.075)	(0.048)
i_{t-2}	-	0.292*	0.392*	-	-	-0.217*	-	-
	-	(0.076)	(0.121)	-	-	(0.083)	-	-
π_t	0.206*	0.137*	-	0.020	0.063**	0.127**	0.230*	-

	(0.035)	(0.053)	-	(0.077)	(0.063)	(0.068)	(0.083)	-
π_{t-1}	-	-0.222*	0.149*	0.121	-0.135*	-0.625*	-0.192*	-0.050
	-	(0.061)	(0.043)	(0.099)	(0.062)	(0.173)	(0.081)	(0.039)
π_{t-2}	-	0.106*	-0.152*	-0.221*	0.095*	0.217*	-	0.085*
	-	(0.040)	(0.039)	(0.107)	(0.039)	(0.007)	-	(0.038)
IT_t				0.211*			0.093	
				(0.069)			(0.062)	
IT_{t-1}	-0.010*	-0.051*	0.054*	-0.188*	0.014*	0.021*	-0.200**	-
	(0.002)	(0.013)	(0.018)	(0.065)	(0.007)	(0.009)	(0.108)	-
IT_{t-2}	0.007*	0.037*	-0.047*	0.140*	-0.011**	-0.023*	0.102**	-0.003*
	(0.003)	(0.011)	(0.015)	(0.051)	(0.006)	(0.007)	(0.054)	(0.001)
$\sum_{i=0}^{m} \alpha_i$	-0.003*	-0.014*	0.004*	-0.048*	0.003*	-0.002*	-0.005**	-0.003*
R^2	0.74	0.85	0.72	0.30	0.77	0.85	0.94	0.71

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

The results for emerging markets also show that in most cases IT has beneficial effects on the bond market. This finding is consistent with the one by O'Sullivan and Tomljanovich (2012), although these authors focused on bond market volatility. Two economies exhibit opposite results—South Africa and the Czech Republic show that IT has the effect of increasing bond yields. Based on the above results, we conclude that IT tends to improve the performance of the bond market.

2.4.3. Effect of IT on bond yields POST IT

We also test the effect of IT on macroeconomic performance on bond yields, post IT adoption. The idea is that after the adoption of IT, bond markets should perform better in the sense that bond yields should decrease. The economies under consideration depend on the availability of data in the sample of the economies under study.

Table 2.3 provides a summary of the results.

Table 2.3 Effect of inflation targeting on bond yields

Advanced								Emerging
	Australia	Canada	Japan	N. Zealand	UK	US	Norway	S. Africa
Constant	0.023*	0.007	-0.001	-0.003	0.002	0.043*	0.024**	-0.001
	(0.006)	(0.005)	(0.000)	(0.003)	(0.003)	(0.008)	(0.014)	(0.004)
R_{t-1}	1.141*	0.940*	0.940**	1.084*	1.206*	0.771*	0.874*	0.087*
	(0.095)	(0.024)	(0.026)	(0.088)	(0.066)	(0.103)	(0.044)	(0.026)
R_{t-2}	-0.400*	-	-	-0157**	-0.247*	-0.146	-	-
	(0.096)	-	-	(0.086)	(0.063)	(0.151)	-	-
i_t	0.707*	0.433*	0.573*	0.414*	0.281*	1.632*	0.432*	0.341*
	(0.101)	(0.161)	(0.132)	(0.100)	(0.050)	(0.265)	(0.088)	(0.142)
i_{t-1}	-1.089*	0.694*	-0.085*	-0.606*	-0.578*	-1.447*	-0.687*	-0.471*
	(0.159)	(0.273)	(0.222)	(0.166)	(0.106)	(0.261)	(0.139)	(0.425)
i_{t-2}	0.472*	0.297*	0.399*	0.243*	0.309*	-	0.303*	0.519*
	(0.104)	(0.134)	(0.157)	(0.086)	(0.079)	-	(0.073)	(0.153)
π_t	0.128*	-0.062**	-0.002	0.101**	-0.001	-	-	0.121*
	(0.056)	(0.037)	(0.011)	(0.055)	(0.026)	-	-	(0.060)

π_{t-1}	-0.128**	-	-	-0.205*	-	-0.299*	-0.053	-0.1428
	(0.071)	-	-	(0.074)	-	(0.074)	(0.048)	(0.059)
π_{t-2}	0.099**	-	-	0.010**	-	-	0.085*	-
	(0.052)	-	-	(0.057)	-	-	(0.043)	-
IT_t	-0.035*	-	0.002*	0.006**	0.068*	0.162*	0.023**	0.020*
	(0.009)	-	(0.001)	(0.003)	(0.034)	(0.076)	(0.014)	(0.005)
IT_{t-1}	-	0.121**	-	-	-0.070**	-0.740*	-	-
	-	(0.065)	-	-	(0.036)	(0.184)	-	-
IT_{t-2}	-	0.113**	-	-	-	0.532*	-	-
	-	(0.064)	-	-	-	(0.131)	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.035*	0.234*	0.002*	0.006**	-0.002*	-0.046*	0.023**	0.020*
	(0.009)	-	(0.001)	(0.003)	-	-	(0.014)	(0.005)
R^2	0.97	0.98	0.96	0.99	0.99	0.85	0.98	0.94

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

For some of the advanced economies, e.g., Canada, Japan, New Zealand, and Norway, we find that IT does not improve bond market performance, post IT adoption. IT leads to higher bond yields in these economies. However, for Australia, UK and the USA, IT leads to lower bond yields, thus better bond market performance. For South Africa, an emerging market, we find that IT did not improve bond market performance.

2.4.4. Effect of IT on economic growth

We now test the effect of IT on economic growth. The channel of the effect of IT on economic growth is for example, through financial markets: IT is supposed to keep inflation low and stable, leading to stability of expectations of future short rates, which in turn stabilizes bond yields at low levels. Low levels of bond yields encourage investment and consumption by decreasing the cost of investment funding and increasing asset prices. Based on this channel, our null hypothesis is that IT will lead to higher economic growth.

Our specification assumes that economic growth is persistent and is also determined by the inflation rate and the short rate. We may think of this specification as the unrestricted IS curve expressed in growth terms, like the one found in Fair (2004: 66). We specify the growth rate as follows:

$$GR_t = \alpha_0 + \sum_{j=1}^{n} \theta_j GR_{t-j} + \sum_{h=0}^{p} \alpha_{i,h} i_{t-h} + \sum_{k=0}^{q} \alpha_{\pi,k} \pi_{t-k} + \sum_{i=0}^{m} \alpha_i IT_{t-i} + \epsilon_t, \qquad (13)$$

where GR_t denotes the growth rate of output and the rest of the variables are as defined in eq. (12). Table 2.4 reports the results from estimation of eq. (14). For advanced economies, the results are mixed. IT tends to reduce economic growth in Canada, UK, US and Norway. However, it raises economic growth in the other countries in the sample. For emerging markets, we find that IT tends to reduce economic growth in six of the eight economies in our sample. Russia and the Czech Republic are the only economies where IT tends to increase economic growth.

Table 2.4 Effect of inflation targeting on growth rate

	Australia	Canada	Euro	Japan	N. Zealand	UK	US	Norway
Advanced								
Constant	0.004	0.026	0.007	0.113**	0.175*	0.049	0.009*	0.573*
	(0.029)	(0.027)	(0.053)	(0.043)	(0.052)	(0.040)	(0.004)	(0.257)
GR_{t-1}	0.646*	1.006*	1.045*	0.614*	0.552*	1.145*	1.096*	0.256*
	(0.052)	(0.067)	(0.054)	(0.100)	(0.073)	(0.088)	(0.081)	(0.116)
GR_{t-2}	-	-0.295*	-0.337*	0.162**	-	-0.431*	-0.402*	-
	-	(0.057)	(0.049)	(0.097)	-	(0.095)	(0.079)	-
								-
i_t	0.024	-	1.133*	-	0.466*	0.370*	0.427*	-
	(0.037)	-	(0.188)	-	(0.216)	(0.128)	(0.090)	-
i_{t-1}	-	-0.032	-1.038*	-0.092	-0.549*	-0.312*	-0.400*	-0.251*
		(0.027)	(0.190)	(0.386)	(0.207)	(0.115)	(0.091)	(0.126)
i_{t-2}	-	-	-	-	-	-	-	-

	-	-	-	-	-	-	-	
π_t	-0.030	-	-0.284*	-	-0.611*	-0.170*	-	
	(0.044)	-	(0.056)	-	(0.148)	(0.048)	-	
π_{t-1}	-	-0.001	-	-0.629*	0.542*	-	-0.230*	-0.613*
		(0.035)	-	(0.166)	(0.164)	-	(0.081)	(0.177)
π_{t-2}	-	-	-	-	-	-	0.181**	
	-	-	-	-	-	-	(0.105)	
q_t	0.037	-	-	-	-	-0.005	-	-0.08**
	(0.023)	-	-	-	-	(0.008)	-	(0.047)
q_{t-1}	-0.038**	0.040**	0.049**	-0.022*	0.053*	-	-	-
	(0.022)	(0.024)	(0.025)	(0.008)	(0.029)	-	-	-
q_{t-2}	-	-0.042**	-0.049**	-	-0.088*	-	-	-
	-	(0.023)	(0.025)	-	(0.031)	-	-	-
IT_t	-	-	0.005**	-	0.190*	-0.028*	-0.006	-0.165*
	-	-	(0.003)	-	(0.094)	(0.011)	(0.009)	(0.069)
IT_{t-1}	0.034*	-0.023*	-	-0.035*	-0.187*	-	0.012**	-
	(0.017)	(0.009)	-	(0.017)	(0.083)	-	(0.007)	-
IT_{t-2}	-0.026**	-	-	0.044*	-	-	-0.012*	-
	(0.016)	-	-	(0.016)	-	-	(0.005)	-
$\sum_{i=0}^{m} \alpha_i$	0.008*	-0.023*	0.005	0.009*	0.003*	-0.028*	-0.006*	-0.165*
R^2	0.72	0.88	0.96	0.82	0.74	0.93	0.85	0.48
Emerging	Brazil	Chile	Czech	Mexico	S. Africa	S. Korea	Poland	Russia
Constant	0.003	0.759*	0.118*	0.031*	-0.040	0.114**	-0.043	0.034

	(0.008)	(0.193)	(0.052)	(0.011)	(0.025)	(0.059)	(0.089)	(0.033)
GR_{t-1}	1.225*	0.333*	1.262*	0.797*	1.130*	0.877*	0.439*	1.648*
	(0.087)	(0.089)	(0.094)	(0.085)	(0.064)	(0.058)	(0.086)	(0.101)
GR_{t-2}	-0.316*	-	-0.443*	-0.429*	-0.420*	-	-	-0.771*
	(0.086)	-	(0.088)	(0.072)	(0.062)	-	-	(0.090)
i_t	-	0.272*	0.890*	-	0.092	-	-	-
	-	(0.130)	(0.245)	-	(0.070)	-	-	-
i_{t-1}	-0.385*	-	-0.772*	-0.167*	-0.165*	-0.453*	-0.155*	-0.101*
	(0.153)	-	(0.198)	(0.033)	(0.069)	(0.089)	(0.057)	(0.050)
i_{t-2}	0.448*	-	-	-	-	0.471*	-	-
	(0.130)	-	-	-	-	(0.100)	-	-
π_t	-0.054	-0.118	-0.221*	-	-0.207*	-0.963*	0.545*	-
	(0.092)	(0.121)	(0.077)	-	(0.058)	(0.380)	(0.171)	-
π_{t-1}	-	-	-	0.163*	0.386*	0.537**	-0.376*	0.053*
	-	-	-	(0.049)	(0.091)	(0.321)	(0.165)	(0.023)
π_{t-2}	-	-	-	-	-0.200*	-	-	-
	-	-	-	-	(0.060)	-	-	-
q_t		-0.141*		0.036*	-0.025**	-0.015	-0.056**	
		(0.042)		(0.012)	(0.015)	(0.011)	(0.029)	
q_{t-1}			0.061**		0.038*		0.073*	0.034*
			(0.034)		(0.015)		(0.030)	(0.011)
q_{t-2}			-0.089*					-0.040*
			(0.034)					(0.011)
IT_t	-	-	-	-0.052*	-0.013*	-0.032*	0.054*	0.004

	-	-	-	(0.020)	(0.006)	(0.015)	(0.023)	(0.008)
IT_{t-1}	-0.034**	0.119*	0.012	-	-	-	-0.082*	-
	(0.018)	(0.047)	(0.008)	-	-	-	(0.027)	-
IT_{t-2}	0.028	-0.243*	0.016*	-	-	-	-	-
	(0.018)	(0.045)	(0.008)	-	-	-	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.006*	-0.124*	0.028*	-0.052*	-0.013*	-0.032*	-0.028*	0.004
R^2	0.90	0.73	0.95	0.89	0.86	0.87	0.67	0.98

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

From the results in Table 2.4, we can conclude that for advanced economies the impact of IT on economic growth is broadly mixed. In emerging economies, we find that IT tends to have a negative effect on economic growth. These results are not consistent with the ones by Goncalves and Salles (2006) and Souza et al. (2016) among others, who find beneficial effects of IT on economic growth.

2.4.5. Effect of IT on economic growth: POST IT

We are also interested in ascertaining whether the effect of IT on economic growth changed because of the adoption of IT. Table 2.5 shows the results on the effect of IT on economic growth after its adoption.

Table 2.5 Effect of inflation targeting on growth rate

	Australia	Canada	Japan	N. Zealand	UK	US	Norway
Advanced							
Constant	0.028	0.044	0.286**	0.108**	-0.023	-0.022	0.711*
	(0.033)	(0.029)	(0.149)	(0.062)	(0.026)	(0.022)	(0.202)
GR_{t-1}	0.364*	1.092*	1.021*	0.429*	1.162*	0.300	0.045

	(0.140)	(0.078)	(0.282)	(0.063)	(0.095)	(0.196)	(0.111)
GR_{t-2}	-	-0.387*	-0.707*	-	-0.539*	0.089	-
	-	(0.072)	(0.226)	-	(0.076)	(0.131)	-
i_t	0.208*	-	-	0.503*	0.355*	0.761	-
	(0.090)	-	-	(0.140)	(0.101)	(0.786)	-
i_{t-1}	-	-0.069	-9.273*	-0.547*	-0.348*	-0.758	-0.216*
	-	(0.047)	(2.725)	(0.125)	(0.099)	(0.633)	(0.107)
i_{t-2}	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
π_t	-0.314*	-	-	-0.532*	-	-	-
	(0.074)	-	-	(0.126)	-	-	-
π_{t-1}	-	-0.064	-0.715*	0.399*	-0.075	-0.078	-0.730*
	-	(0.045)	(0.303)	(0.184)	(0.062)	(0.155)	(0.164)
π_{t-2}	-	-	-	-	-	0.330**	-
	-	-	-	-	-	(0.182)	-
q_t	0.038*	-	-	-	0.014*	-	-0.110*
	(0.016)	-	-	-	(0.006)	-	(0.041)
q_{t-1}	-0.041*	0.044*	-0.059**	0.101*	-	-	-
	(0.018)	(0.022)	(0.033)	(0.031)	-	-	-

q_{t-2}	-	-0.049*	-	-0.123*	-	-	-
	-	(0.024)	-	(0.032)	-	-	-
IT_t	-	-	-	0.444*	-0.046*	1.40*	-0.178*
	-	-	-	(0.052)	(0.011)	(0.452)	(0.050)
IT_{t-1}	0.076	-0.039*	-0.212**	-0.429*	-	-	-
	(0.186)	(0.015)	(0.117)	(0.049)	-	2.484*	-
						(0.800)	
IT_{t-2}	-0.076	-	0.244*	-	-	1.118*	-
	(0.176)	-	(0.004)	-	-	(0.451)	-
$\sum_{i=0}^{m} \alpha_i$	0.000	-0.039*	0.032**	0.015*	-0.046*	0.034	-0.178*
	-	(0.015)	-	-	(0.011)	-	(0.050)
R^2	0.69	0.92	0.82	0.77	0.94	0.73	0.46
Emerging	Mexico	S.Africa	S.Korea	Poland			
Constant	0.030*	-0.035	0.391*	0.069			
	(0.015)	(0.040)	(0.127)	(0.062)			
GR(-1)	0.956*	0.926*	0.751*	0.429*			
	(0.085)	(0.095)	(0.069)	(0.110)			
GR(-2)	-0.524*	-0.258*	-	-			
	(0.088)	(0.087)	-	-			
SR	-	0.490*	-	-			
	-	(0.114)	-	-			
SR(-1)	-0.053	-0.555*	-0.223*	-0.131**			

	(0.064)	(0.101)	(0.099)	(0.074)
SR(-2)	-	-	0.318*	-
	-	-	(0.107)	-
π_t	-	-	-0.592*	0.123
	-	-	(0.224)	(0.114)
π_{t-1}	-0.046	0.020	-	-
	(0.090)	(0.035)	-	-
π_{t-2}	-	-	-	-
	-	-	-	-
LREER	-	0.015**	-0.054*	-0.007
	-	(0.008)	(0.020)	(0.014)
LREER(-1)	0.064*	-	-	-
	(0.022)	-	-	-
LREER(-2)	-0.064*	-	-	-
	(0.025)	-	-	-
IT_t	-	-0.056*	-0.135*	0.341*
	-	(0.013)	(0.043)	(0.089)
IT_{t-1}	-0.048**	-	-	-0.373*
	(0.026)	-	-	(0.086)
IT_{t-2}	-	-	-	-
	-	-	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.048**	-0.056*	-0.135*	-0.032*
	(0.026)	(0.013)	(0.043)	-
R^2	0.86	0.94	0.89	0.68

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

In relation to advanced economies, we find that IT tends to have negative or neutral effect on economic growth, post IT adoption. It is only in three out of eight economies where IT results in higher economic growth. As for emerging countries, there is no conclusive result. Two of the countries exhibit positive effect, while for South Africa and Poland IT resulted in the negative effect on economic growth.

2.4.6. Effect of IT on inflation

We now test the effect of IT on inflation rate. We expect that IT will lead to lower inflation rate. Our specification assumes that inflation rate is persistent, and it depends on the output gap and real exchange rate depreciation and IT. We thus estimate a Phillips curve, augmented with the IT variable as follows:

$$\pi_t = \alpha_0 + \sum_{j=1}^{n} \theta_j \pi_{t-j} + \sum_{h=0}^{p} \alpha_{y,h} y_{t-h} + \sum_{k=0}^{q} \alpha_{q,k} \Delta q_{t-k} + \sum_{i=0}^{m} \alpha_i IT_{t-i} + \epsilon_t \qquad (14)$$

where y_t is the output gap which is measured using the Hodrick-Prescott filter, Δq_t is the rate of real exchange rate depreciation. Our hypothesis is that $\sum_{i=0}^{m} \alpha_i < 0$ so that IT has a negative effect on inflation rate. Table 2.6 reports the results.

Table 2.6 Effect of inflation targeting on inflation

	Australia	Canada	Euro	Japan	N. Zealand	UK	US	Norway
Advanced								
Constant	0.001	0.011*	0.003*	0.005*	-0.002	-0.004**	-0.000	0.003
	(0.002)	(0.005)	(0.001)	(0.001)	(0.004)	(0.002)	(0.002)	(0.002)
π_{t-1}	1.110*	1.103*	1.009*	0.780*	1.031*	1.242*	1.279*	0.969*
	(0.098)	(0.053)	(0.116)	(0.094)	(0.064)	(0.087)	(0.063)	(0.079)
π_{t-2}	-0.041	-0.170**	-0.144	-0.066	-0.045	-0.295*	-0.411*	0.008
	(0.106)	(0.089)	(0.132)	(0.113)	(0.090)	(0.129)	(0.076)	(0.087)
π_{t-3}	0.089	0.126	0.040	0.112	-0.055	0.044	0.273*	0.020
	(0.085)	(0.081)	(0.095)	(0.105)	(0.111)	(0.112)	(0.082)	(0.105)

π_{t-4}	-0.423*	-0.462*	-0.342*	-0.450*	-0.334*	-0.239*	-0.391*	-0.468*
	(0.100)	(0.115)	(0.143)	(0.124)	(0.138)	(0.104)	(0.142)	(0.160)
π_{t-5}	0.255*	0.352*	0.300*	0.256*	0.247*	0.200*	0.232*	0.398*
	(0.075)	(0.081)	(0.109)	(0.102)	(0.089)	(0.080)	(0.084)	(0.115)
y_t	-	0.136*	0.152*	-	-	0.082*	0.160*	-
	-	(0.034)	(0.045)	-	-	(0.038)	(0.029)	-
y_{t-1}	0.101*	-	-	0.084**	0.042	-	-	0.093*
	(0.049)	-	-	(0.044)	(0.034)	-	-	(0.044)
Δq_t	-	-	-0.010	-	-0.001	-	-	0.024**
	-	-	(0.006)	-	(0.006)	-	-	(0.013)
Δq_{t-1}	-0.005	-0.008	-	-0.012**	-	-0.008*	-0.016*	-
	(0.006)	(0.007)	-	(0.006)	-	(0.004)	(0.007)	-
IT_t	-	-	-0.001	-0.029*	0.035*	0.007*	0.002	0.017*
	-	-	(0.001)	(0.008)	(0.017)	(0.003)	(0.003)	(0.007)
IT_{t-1}	-0.025*	-0.021*	-	0.021*	-0.027**	-	-	-0.018*
	(0.009)	(0.010)	-	(0.008)	(0.016)	-	-	(0.008)
IT_{t-2}	0.024*	-	-	-	-	-	-	-
	(0.010)	-	-	-	-	-	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.001*	-0.021*	-0.001	-0.008*	0.008**	0.007*	0.002	-0.001*
R	0.971	0.963	0.889	0.874	0.905	0.964	0.971	0.961
Emerging	Brazil	Chile	Czech	Mexico	S. Africa	S. Korea	Poland	Russia
Constant	0.006	-0.005	0.007	0.011	0.003	0.005	0.008*	-0.013**

	(0.004)	(0.005)	(0.006)	(0.008)	(0.003)	(0.005)	(0.004)	(0.007)
π_{t-1}	1.542*	1.377*	0.879*	1.310*	1.225*	0.962*	1.020*	1.213*
	(0.160)	(0.078)	(0.096)	(0.056)	(0.065)	(0.054)	(0.094)	(0.075)
π_{t-2}	-0.894*	-0.504*	-0.108	-0.477*	-0.327*	0.048	-0.161	-0.356*
	(0.294)	(0.081)	(0.155)	(0.083)	(0.083)	(0.078)	(0.148)	(0.108)
π_{t-3}	0.381**	-	-0.087	0.381*	0.241*	-0.077	0.133	0.192**
	(0.221)	-	(0.139)	(0.093)	(0.096)	(0.061)	(0.140)	(0.115)
π_{t-4}	-0.314*	-	-0.484*	-0.404*	-0.648*	-0.248*	-0.266**	-0.540*
	(0.124)	-	(0.120)	(0.132)	(0.116)	(0.118)	(0.140)	(0.180)
π_{t-5}	0.217*	-	0.363*	0.186*	0.504*	0.200*	0.196*	0.468*
	(0.069)	-	(0.069)	(0.089)	(0.070)	(0.082)	(0.072)	(0.140)
y_t	0.128*	-	0.143*	-0.814*	-	0.100*	0.247*	0.161*
	(0.046)	-	(0.056)	(0.139)	-	(0.039)	(0.065)	(0.055)
y_{t-1}	-	0.052	-	0.747*	0.152*	-	0.152*	-
	-	(0.066)	-	(0.123)	(0.050)	-	(0.065)	-
Δq_t	-0.019*	-	-	-0.056*	-0.031*	-	-	-0.030*
	(0.007)	-	-	(0.012)	(0.008)	-	-	(0.013)
Δq_{t-1}	-	-0.004	-0.017	-	-	0.001	-	-
	-	(0.010)	(0.014)	-	-	(0.003)	0.015*	-
							(0.008)	
IT_t	0.023**	-	-	-0.109*	-	-	-	-
	(0.013)	-	-	(0.022)	-	-	-	-
IT_{t-1}	-0.026*	0.002	-0.004	0.086*	0.003	-0.018*	-0.011*	0.021**

	(0.011)	(0.009)	(0.008)	(0.017)	(0.011)	(0.009)	(0.005)	(0.011)
IT_{t-2}	-	0.016*	-	-	-0.007	0.015*	-	-
	-	(0.005)	-	-	(0.010)	(0.007)	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.003**	0.018*	-0.004	-0.023*	-0.004	-0.003*	-0.011*	0.021*
R	0.93	0.91	0.91	0.99	0.95	0.92	0.99	0.96

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

In relation to advanced economies, we find that IT tends to significantly reduce inflation rate in four of the eight economies. For the remaining economies IT tends to increase inflation rate while it is not significant in one economy. It is thus true that, while for some of the advanced economies IT improves inflation performance, there are also some economies where this advantage is non-existent, or it is not significant. Similar results obtain for emerging markets. IT decreases the inflation rate in some of these economies, while in others IT does not improve inflation performance.

2.4.7. Effect of IT on inflation: Post IT

We now test the effect of IT on inflation rate, post IT adoption. We expect that the benefits of IT will be preserved over time, leading to low inflation rates.

Table 2.7 provides results for the effect of IT on the inflation rate after the adoption of IT.

Table 2.7 Effect of inflation targeting on inflation: Post IT

	Australia	Canada	Japan	N. Zealand	UK	US	Norway
Advanced							
Constant	0.008	0.001	0.001	-0.004	-0.007**	-0.009	-0.016
	(0.007)	(0.004)	(0.001)	(0.004)	(0.004)	(0.009)	(0.018)
π_{t-1}	1.002*	1.148*	-0.254*	1.037*	1.225*	0.800*	0.729*
	(0.122)	(0.111)	(0.089)	(0.069)	(0.147)	(0.175)	(0.128)
π_{t-2}	-0.019	-0.342*	0.154**	-0.090	-0.344**	-0.349**	0.100

	(0.149)	(0.129)	(0.081)	(0.100)	(0.191)	(0.203)	(0.155)
π_{t-3}	-0.133	-0.034	0.011	0.057	0.067	0.201	0.142
	(0.114)	(0.114)	(0.087)	(0.113)	(0.147)	(0.237)	(0.131)
π_{t-4}	-0.323**	-0.196	-0.260**	-0.509*	-0.305*	-0.027	-0.742*
	(0.180)	(0.164)	(0.135)	(0.146)	(0.111)	(0.280)	(0.098)
π_{t-5}	-0.256*	-0.267*	0.117	0.342*	0.247*	-0.006	0.300*
	(0.124)	(0.107)	(0.087)	(0.094)	(0.100)	(0.166)	(0.110)
y_t	-0.163	-	-	-	0.036	-0.485*	-
	(0.223)	-	-	-	(0.038)	(0.164)	-
y_{t-1}	-0.170	-0.106	0.232*	0.035	-	-	0.150*
	(0.218)	(0.104)	(0.098)	(0.039)	-	-	(0.075)
y_{t-2}	0.218	0.267*	-	-	-	-	0.018
	(0.142)	(0.115)	-	-	-	-	(0.067)
Δq_t	0.012	0.056*	0.019*	-0.001	-	-	0.069*
	(0.013)	(0.020)	(0.005)	(0.005)	-	-	(0.027)
Δq_{t-1}	-0.018	-0.085*	-	-	-0.009**	-0.035**	-
	(0.015)	(0.034)	-	-	(0.005)	(0.018)	-
Δq_{t-2}	0.014	0.058*	-	-	-	-	-
	(0.013)	(0.022)	-	-	-	-	-
IT_t	-0.735*	-	-0.208*	0.011**	0.013*	0.024**	-
	(0.352	-	(0.022)	(0.006)	(0.006)	(0.013)	-
IT_{t-1}	1.306*	-0.310**	0.210*	-	-	-	0.273**
	(0.643)	(0.160)	(0.022)	-	-	-	(0.143)
IT_{t-2}	-0.577**	0.314**	-	-	-	-	-0.245**

	(0.317)	(0.161)	-	-	-	-	(0.137)
$\sum_{i=0}^{m} \alpha_i$	-0.006*	0.004**	0.002*	0.011**	0.013*	0.024**	0.028*
	-	-	-	(0.006)	(0.006)	(0.013)	-
R	0.811	0.848	0.979	0.875	0.863	0.807	0.716
Emerging	S. Africa	S. Korea	Poland				
Constant	0.012*	0.014*	0.009*				
	(0.004)	(0.007)	(0.004)				
π_{t-1}	1.480*	0.953*	1.114*				
	(0.122)	(0.055)	(0.095)				
π_{t-2}	-0.704*	0.093	-0.379*				
	(0.172)	(0.094)	(0.115)				
π_{t-3}	0.296*	0.001	-0.305*				
	(0.099)	(0.084)	(0.142)				
π_{t-4}	-0.665*	-0.704*	-0.505*				
	(0.146)	(0.232)	(0.175)				
π_{t-5}	0.526*	0.519*	0.302*				
	(0.106)	(0.165)	(0.094)				
y_t	-	0.170*	0.294*				
	-	(0.034)	(0.100)				
y_{t-1}	0.272*	-	0.061				
	(0.100)	-	(0.087)				
y_{t-2}	-	-	-				
	-	-	-				
Δq_t	-0.010	0.002	-0.009				

	(0.014)	(0.002)	(0.008)
Δq_{t-1}	-0.021*	-	-
	(0.010)	-	-
IT_t	-0.021**	-	-
	(0.012)	-	-
IT_{t-1}	-	-0.013**	-0.010**
	-	(0.007)	(0.006)
IT_{t-2}	-	-	-
	-	-	-
$\sum_{i=0}^{m} \alpha_i$	-0.021**	0.013**	-0.010**
	(0.012)	(0.007)	(0.006)
R	0.957	0.904	0.948
	-		

Note: HAC std. errors in parentheses, * significant at 5%, ** significant at 10%.

In relation to advanced economies, post IT adoption, we find that IT tends to significantly increase inflation rate in these economies. It is only in Australia where IT reduces the inflation rate. Therefore, for most of these countries, IT is not beneficial as far as decreasing the inflation rate. The results for emerging markets also show that in two of the three economies for which there is data, IT tends to reduce inflation after the adoption of IT. It is only South Korea which exhibits a positive effect of IT on inflation post IT adoption.

2.5. Conclusion

This paper investigates the effect of IT on macroeconomic performance. Specifically, the paper focuses on the effect of IT on bond yields, the growth rate and the inflation rate. To conduct the study, we developed a measure of the degree of IT that is based on the relative strength of reaction of the central bank to inflation. Building on the theoretical models of IT, especially the seminal papers by Svensson (1997, 1999), we measure the degree of IT by the ratio of the reaction coefficient to inflation to the sum of the reaction coefficients in the Taylor rule.

The higher this ratio, the higher the degree of inflation targeting. Using recursive estimates, we managed to obtain time-variation in the Taylor rule coefficients, which then allows us to derive the degree of IT.

Our findings are as follows. In terms of its effects on bond yields, IT tends to decrease bond yields, and therefore IT improves bond market performance. This finding is in line with O'Sullivan and Tomljanovich (2012), who found that IT leads to a drop in conditional volatility in bond markets.

The implications are that IT tends to improve the performance of financial markets by decreasing the discount factor in asset pricing and thereby increasing asset prices. This is also in line with the finding by Dridi and Boughrara (2023) that IT helps contain stock market volatility. In terms of economic growth, IT produces mixed results for advanced economies. In some economies IT positively affects economic growth while in others it tends to reduce economic growth. For emerging markets, IT tends to reduce economic growth. In terms of inflation performance, there are also mixed results.

The implications of these findings suggest that IT is good for the performance of financial markets. However, the financial market benefits of IT do not get systematically transmitted to real economic performance. For instance, by anchoring inflation expectations at a low level, we expected that the resultant decline in bond yields would increase economic growth. We expected that the resultant low inflation expectations are supposed to decrease the inflation rate, so that IT has a negative effect on inflation as well.

In the light of the absence of these transmissions, we postulate that there could be some disconnect between financial markets and real economic activity in some the economies that are under consideration. This disconnect could be due to the dominant role played by retained earnings in financing real investment.

Secondly, the disconnect could be due to limited financial market access by many households who account for a large fraction of aggregate consumption. Blinder (1997), Nelson (2001) and more recently Haque and Magnusson (2023) among others, noted that the real interest rate has limited effect of aggregate expenditure, one of the key factors that may explain the disconnect.

On IT and economic growth, we find varied outcomes. There are generally different outcomes for advanced and emerging economies. In some of the advanced economies lT reduces economic growth, while in others it increases economic growth. This may be explained by the structure of their economies. However, for emerging markets, in most cases, IT tends to reduce economic growth.

On IT and inflation in advanced economies, we find that, while for some of the advanced economies IT improves inflation performance, there are also some economies where this advantage is non-existent, or it is not significant. Similar results obtain for emerging markets. IT decreases the inflation rate in some of these economies, while in others IT does not improve inflation performance.

3. Are Inflation Targets Optimal?

3.1. Introduction

Inflation targeting (IT) central banks believe that high inflation discourages savings because it erodes the value of money. They also believe that high inflation distorts the information which prices give to economic agents, and it therefore leads to sub-optimal allocation of resources.

However, in a two-asset economy in which agents have a choice to hold either capital or money, Tobin (1965) shows that inflation leads to a portfolio shift towards capital, thereby increasing capital accumulation. Other authors, e.g., Pattanaik and Nadhanael (2013), are of the view that inflation does not affect the level of investment, but only negatively affects the efficiency of investment.

The study by Bruno and Easterly (1995) reports that the problems that are associated with inflation become significant at high rates of inflation. In the light of these studies, it begs a question as to why central banks should make low inflation targets their overriding objective. This question is relevant because relationship between inflation and economic growth, and between inflation and unemployment in the long run remain an issue that divides economists, despite claims that there exists a consensus that low inflation is good for growth.

As pointed out by Debelle (1997), IT central banks accept the natural rate hypothesis first put forward by Friedman (1968), according to which there is only a short-run relationship between inflation and unemployment, however in the long run such a relationship does not exist.

Subsequent studies have questioned this hypothesis. Tobin (1980) argued that the natural rate of unemployment floats together with the actual rate, the natural rate does not exist. This was further confirmed by Blanchard and Summers (1986), who found that there is hysteresis in unemployment—the equilibrium unemployment rate depends on the history of the actual unemployment rate.

Fair (2000) also found that the inflation process in the US does not support the NAIRU hypothesis. Akerlof et al. (2000) found that the long run Phillips curve exhibits a negative relationship between inflation and unemployment. Snower (2002), Karanassou et al. (2005) and Vaona and Snower (2008) also find a positive relationship between inflation and economic activity in the long run.

However, Russell and Banerjee (2008) identified a slightly positive relationship between inflation and the unemployment rate in the long run. This is consistent with Ascari et al. (2022), who find that for the US, inflation negatively affects the output gap once it exceeds a threshold of 4%.

The above evidence, although conflicting, suggests that there is a level of inflation above which inflation negatively affects the performance of the economy and below which it does not. The question that this paper seeks to answer is: are existing inflation targets consistent with optimal economic performance? It is not clear how central banks around the world have set their inflation targets. Debelle (1997) suggests that the inflation targets should be set at low levels below which there would be no significant benefits from further lowering inflation.

However, there is no evidence that many IT central banks have conducted studies to determine these threshold levels. This point is underscored by Horvath and Matějů (2011), who found that some IT central banks simply state the inflation target and do not explain how they arrived at it. Some studies e.g., Debelle (1997) and Adam and Weber (2023) explain why inflation targets are positive, citing shifts in relative prices, errors in the calculation of price indices and downward nominal wage and price rigidity. However, these studies do not explain how the numerical targets have been arrived at.

The aim of this paper is to determine if the current inflation targets are consistent with maximum economic growth and minimum unemployment rates. We derive a simple model of long run economic growth based on the rate of capital accumulation. We then postulate that the rate of capital accumulation depends on the spread between the profit rate and the interest rate—the latter follows a simple IT rule in which the reaction coefficients vary non-linearly with the level of inflation.

The result is a cubic relationship between inflation and economic growth, potentially exhibiting two optimal inflation points. We then check if the actual inflation target is close to this optimal point or not and estimate the "unemployment costs" of the deviation of the inflation target from the optimal inflation rate.

The chapter is structured as follows: section 2 provides a literature review on the relationship between inflation and economic growth, section 3 derives a model that shows a non-linear relationship between inflation and economic growth and by extension, a non-linear relationship between the inflation rate and the unemployment rate, chapter 4 performs some empirical analysis on the relationship between inflation and economic activity and chapter 5 is the conclusion.

3.2. Literature review on the non-linear inflation-growth nexus

Almost all central banks contain within their mandates a requirement to maintain price stability. Central banks have operationalized such a requirement by implementing inflation targeting (IT). As Pollin and Zhu (2014) point out, these targets were mainly between 2 and 5 percent. Many central banks that have adopted IT hold the view that there is a negative relationship between inflation and economic growth, hence they believe that low and stable inflation provides the necessary macroeconomic environment to support higher economic growth.

One argument that is advanced by those who argue for low and stable inflation rates is that the consequence of high inflation is the danger of increasing speculative investments rather than productive investment. Empirical support for the view that inflation is detrimental to economic growth can also be found in Andres and Hernando (1997), Bittencourt (2012) and Baharumshah et al. (2016). However, there are authors who dissent from this view. For example, Faira and Carneiro (2001) conclude that no relationship exists between economic growth and inflation rates.

Other authors such as Fountas (2010) and Baharumshah et.al. (2016) find that inflation uncertainty has a positive effect on economic growth, while Jha and Dhang (2012) find no significant effects of inflation variability on growth. This finding is also supported by Vaona and Schiavo (2006) who state that "the importance of low inflation targeting may have been overstated". Ghosh (1998) found that at low levels of inflation rates (around 23% p.a. or lower), inflation and growth are positively correlated, otherwise they are negatively correlated.

This suggests the existence of a nonlinear relationship between inflation and economic growth. The question then is: what is the level of inflation that is consistent with maximum economic growth, all else being the same? A number of empirical papers have been written in an attempt to answer this question. Evidence from some advanced economies provided by Khan and Senhadji (2001) suggests that the threshold level is in the 1-3% range. Kremer et al. (2013) find that advanced economies have a threshold of 2%. Further evidence by Omay and Kan (2010) suggests that the threshold level of inflation for advanced economies is about 2.5%.

Although there is consensus, with few exceptions, that inflation targets should be low for industrialized countries, some economists believe that this estimate may be too low. Indeed, Wyplosz (2001) had already stated that the ECB target of 0 to 2% was too low. He argued that the threshold for ECB should be 5%. These estimates of the threshold inflation rate are consistent with those found by Ibara and Trupkin (2015). Using a Schumpeterian model with endogenous entry and a positive entry cost, Chu et al. (2017) estimate the growth-maximizing inflation rate to be 3% for the US.

These estimates led Palley (2008) to suggest that the US may attain the lowest rate of unemployment when inflation is in the 3 - 5% range, which is above the 2% inflation target of the Federal Reserve Board. From the perspective of emerging markets and developing economies, Vinayagathasan (2013) conducted a panel-data analysis for 32 Asian economies covering the period 1980- 2009. The study confirmed a non-linear relationship between economic growth and inflation.

The estimated threshold inflation rate is 5.43%. However, the study by Khan and Senhadji (2001) found that the threshold level for developing countries is in the 11 - 12% range. Other studies estimate the threshold inflation rate to be even higher. Baglan and Yoldas (2014) employ a semi-parametric panel data model for 92 developing economies and estimate the threshold level of

inflation to be 12%. Kremer et.al. (2013) estimate the threshold for developing countries to be 17%, which is close to the 17.5% estimate by Lopez-Villavincio and Mignon (2011), and the 19% estimate by Ibara and Trupkin (2015). Based on these estimates, Ibara and Trupkin argue that the developing countries have sacrificed significant economic growth in pursuance of low inflation.

Some studies on the inflation-growth nexus were conducted for individual countries. Mallik and Chowdhury (2001) found a positive relationship between inflation and economic growth for India, Sri Lanka, Bangladesh and Pakistan. Ayyoub et al. (2011) found that there was a threshold of 7% beyond which inflation had a negative impact on economic growth in Pakistan. Singh and Kalirajan (2003) do not specify the threshold inflation point for India.

They suggest that India should try and keep its inflation level at the rate of its trading partners like the USA, Japan, Germany, United Kingdom and France. This may be interpreted to mean that India should keep its inflation rate at low levels in the 1 - 5% range, since that is where the inflation targets of its trading partners are. This is close to the 6% suggested threshold for India by Pattanaik and Nadhanael (2013). However, there seems to be broad agreement that such low levels of inflation rates may be appropriate for advanced economies, but not necessarily for emerging markets.

In relation to selected Asian economies, Thanh (2015) finds that the threshold level for the ASEAN-5 to be 7.84%. Munir et al. (2009) found that there is non-linearity on the inflation-growth nexus for Malaysia and the threshold level is 3.89%. This estimate appears to be too low when compared to other studies on emerging market economies, e.g., Pollin and Zhu (2006) who estimate the threshold point to be in the 15 - 18% range and Burdekin et al. (2004), who find that emerging markets should worry about inflation in the 20 - 40% range. Evidence from transitional emerging market economies is provided by Aydin et al. (2016), who suggest a non-linear relationship between inflation and growth.

These authors find a positive relationship of inflation on economic growth up to almost 8% inflation rate, beyond which the relationship becomes negative. Ndoricimpa finds that African economies have thresholds that range between 6% - 9% and they emphasize the heterogeneity of countries within the African continent. This estimate is consistent with the 8.17% threshold found by da Veiga et al. (2016) for African economies. Ezako (2023) also finds, “significant negative

relationship between inflation and growth in the short run, which becomes insignificant in the long run". That inflexion point for Burundi was found to be 13 percent.

This estimate is indeed far lower than the one found by Seleteng et al. (2013) for the Southern African Development Community (SADC). Seleteng et al. find that SADC countries have a threshold inflation rate of 18.9%. This is also far above the inflation target of 3 - 6% that has been adopted by South Africa, which is the largest trading partner of many of the SADC countries, and it could induce macroeconomic imbalances in the region.

Galih and Safuan (2017) investigating this relationship using the Threshold Vector Autoregression model, concluded that, "the existence of a nonlinear relationship between the two, inflation and economic growth cannot be rejected". At low levels inflation was found to have a positive effect on economic growth which changes to negative at higher levels.

Much of the literature review above agrees that there exists a non-linear relationship between inflation and economic growth. The literature also agrees on the existence of a threshold level of inflation which is consistent with maximum economic growth. However, there is no consensus on the level of the threshold. This is most likely since the estimated equations used in most of the literature are of an empirical stylized nature, they are not derived theoretically.

This opens the possibility of diverse estimates arising from different specifications, not least the different sample sizes. In this paper, we attempt to close this gap in the literature by deriving a non-linear inflation-growth relationship theoretically and then estimate this relationship. Our approach aims to improve on the robustness of the results about the existence and level of the optimal level of inflation.

3.3. The non-linear growth-inflation relationship

Our derivation of the non-linear growth-inflation relationship and, consequently, the growth-maximizing inflation rate, proceeds from the basic capital accumulation rule, complemented by an investment function that is implied by classical authors such as Smith, Ricardo and Marx which has been used by post-Keynesian authors such as Robinson, Kalecki, Pasinetti and Kaldor. Ross and Clavijo (2015) compare China's and Mexico's economic growth rates in the last thirty years. They conclude China's growth rate was five times larger than Mexico's because capital accumulation, was more than two times higher in China. We therefore use capital accumulation as

a proxy for growth because it has been empirically proven that it is true. The capital accumulation rule is as follows:

$$K_t = (1 - \delta)K_{t-1} + I_t, \tag{1}$$

where K_t is the real capital stock, I_t is real investment and δ is the rate of depreciation of the capital stock. The classical investment function assumes that investment is driven by the spread between profits and interest payments on debt as follows.

$$I_t = \alpha\left(r_{t-1}K_{t-1} - \xi_t K_{t-1} - i_{t-1}\frac{D_{t-1}}{P_{t-1}}\right), \tag{2}$$

where r_t is the gross rate of profit, ξ_t is the time-varying risk premium, i_t is the nominal interest rate, D_t is corporate debt and P_t is the price level. We divide both sides of eq. (2) by K_{t-1} to obtain:

$$\frac{I_t}{K_{t-1}} = \alpha\left(r_{t-1} - \xi_t - i_{t-1}\frac{D_{t-1}}{P_{t-1}K_{t-1}}\right). \tag{3}$$

To simplify our analysis, we now assume that the debt-capital ratio is a constant θ. In addition, we assume that the nominal interest rate moves according to the following rule:

$$i_t = i_0 + \delta_t(\pi_t - \pi^T). \tag{4}$$

Note that in eq. (4) i_0 is the steady state nominal interest rate, π_t is the inflation rate and π^T is the inflation target. The reaction co-efficient δ_t of the nominal interest rate to the inflation is time varying. This equation is therefore a simple interest rate rule. We assume that the risk premium evolves according to $\xi_t = \xi_0 + \lambda(\pi_t - \pi^T)$.

This means that when the macroeconomic environment becomes inflationary, lenders to firms perceive that the environment is risky, especially if the loans are not inflation-linked. Inserting the nominal interest rate rule into eq. (3) we obtain the following equation and replace:

$$\frac{I_t}{K_{t-1}} = \alpha(r_{t-1} - \xi_0 - \lambda\pi^T - \lambda\pi_{t-1} - \theta(i_0 - \delta_t\pi^T) - \theta\delta_t\pi_{t-1}). \tag{5}$$

We are now in a position to introduce a non-linearity into the investment equation. To do this, we assume that the reaction co-efficient moves according to the following equation:

$$\delta_t = \delta_0 + \delta_\pi\pi_t + \delta_{\pi\pi}\pi_t^2. \tag{6}$$

This means that the interest rate reacts with greater strength the higher the inflation rate is. Therefore inserting eq. (6) into eq. (5) we obtain:

$$\frac{I_t}{K_{t-1}} = \alpha(r_{t-1} - \xi_0 - \lambda\pi^T + \lambda\pi_{t-1} - \theta(i_0 - \delta_0\pi^T - \delta_\pi\pi^T\pi_{t-1} - \delta_{\pi\pi}\pi^T\pi_{t-1}^2) - \theta\delta_0\pi_{t-1} - \theta\delta_\pi\pi_{t-1} - \theta\delta_{\pi\pi}\pi_{t-1}^3), \quad (7)$$

Collecting the like terms and consolidating the constants, we obtain:

$$\frac{I_t}{K_{t-1}} = \alpha(r_{t-1} - \mu_0 + \theta(\delta_\pi\pi^T + \lambda - \delta_0)\pi_{t-1} + \theta(\delta_{\pi\pi}\pi^T - \delta_\pi)\pi_{t-1}^2 - \theta\delta_{\pi\pi}\pi_{t-1}^3), \quad (8)$$

where $\mu_0 = \xi_0 + \lambda\pi^T + \theta(i_0 - \delta_0\pi^T)$. Consider now a simple production function, where output is determined by the level of the capital stock and the state of technology:

$$Y_t = A_t K_t^\beta, \quad (9)$$

where Y_t is output and A_t is the state of technology $\beta > 0$. From eq. (8) we observe that:

$$g_t = a_0 + \beta\frac{\Delta K_t}{K_{t-1}}, \quad (10)$$

where g_t is the growth rate of output and a_0 is the rate of technological innovation. From eq. (1) we have that:

$$g_t = (a_0 - \beta\delta) + \beta\alpha(r_{t-1} - \mu_0 + \theta(\delta_\pi\pi^T + \lambda - \delta_0)\pi_{t-1} + \theta(\delta_{\pi\pi}\pi^T - \delta_\pi)\pi_{t-1}^2 - \theta\delta_{\pi\pi}\pi_{t-1}^3). \quad (11)$$

Eq. (11) is the growth equation that shows the non-linear relationship between the growth rate and the rate of inflation. The optimal rate of inflation is that rate of inflation that corresponds to maximum or minimum economic growth, and it is given by the following quadratic equation:

$$\beta\alpha(r_{t-1} - \mu_0 + \theta(\delta_\pi\pi^T + \lambda - \delta_0) + 2\theta(\delta_{\pi\pi}\pi^T - \delta_\pi)\pi_{t-1} - 3\theta\delta_{\pi\pi}\pi_{t-1}^2) = 0 \quad (12)$$

Therefore, we have the following optimal inflation rates:

$$\pi^* = \frac{-2\theta(\delta_{\pi\pi}\pi^T - \delta_\pi) \pm \sqrt{4\theta^2(\delta_{\pi\pi}\pi^T - \delta_\pi)^2 - 12\theta\delta_{\pi\pi}}}{6\theta\delta_{\pi\pi}}. \quad (13)$$

Our aim is to test whether existing inflation targets are close, below or above the value that is consistent with maximum economic growth. If inflation targets are below this value, then we

conclude that such targets need to be raised in order to support higher rates of economic growth. If the targets are above this value, we conclude that such targets need to be reduced.

Note that eq. (9) contains the profit rate, whose data is not readily available. In order to overcome this problem, we assume that the profit rate is $r_t = r_{t-1} + \epsilon_t$, where ϵ_t is a persistent time-varying component of the rate of profit. We therefore specify eq. (23) as follows:

$$g_t = (a_0 - \beta\delta) - \beta\alpha\mu_0 + \beta\alpha\theta\big((\delta_\pi \pi^T + \lambda - \delta_0)\pi_{t-1} + (\delta_{\pi\pi}\pi^T - \delta_\pi)\pi_{t-1}^2 - \delta_{\pi\pi}\pi_{t-1}^3\big) + \varepsilon_t. \quad (14)$$

where ε_t contains an autoregressive component that comes from the dynamics of the profit rate. In terms of the unemployment rate, we use Okun's law and state the unemployment rate as follows:

$$u_t = \gamma + \psi u_{t-1} - \varphi\beta\alpha\theta\big((\delta_\pi \pi^T + \lambda - \delta_0)\pi_{t-1} + (\delta_{\pi\pi}\pi^T - \delta_\pi)\pi_{t-1}^2 - \delta_{\pi\pi}\pi_{t-1}^3\big) + \xi_t. \quad (15)$$

where $\gamma = \varphi g_0 - (a_0 - \beta\delta) + \beta\alpha\mu_0$ and $\xi_t = -\varphi\varepsilon_t$. Therefore, if the cubic form in eq. (15) holds, expect the following shapes of the growth-inflation and the unemployment-inflation relationship.

3.4. Empirical analysis

3.4.1. Optimal inflation and economic growth

Data is sourced from the Federal Reserve Bank of St. Louis database. We use quarterly data going back as far as possible for each country. The growth rate and the inflation rate are calculated using annualized growth rates of real GDP and CPI. To control for the effects of external factors on economic growth, we include the growth rate of the US in eq. (11).

Table 3.1 reports the results of the full-sample estimation of Eq. (11). Firstly, note that for both advanced and emerging market economies, the relationship between inflation and economic growth is non-linear. The results show that for most of the economies, the target rate of inflation π^T, is less than the optimal rate of inflation π^*. For example, for Australia, the optimal rate of inflation is 6.9%, yet the official inflation target is 2.5%. For the US and the UK, the optimal inflation rates are 4.6% and 4.9% respectively, whereas their inflation targets are at 2%. Norway's optimal inflation rate is 8.4%, yet its inflation target is 2%.

In terms of economic growth, we observe that the EU, could gain more economic growth than the target if it lowered its inflation target. The same result holds for Japan. However, for some economies, a higher inflation target is associated with marginally higher rates of economic growth. For example, Canada's optimal inflation rate is 6.7%, it delivers a 3.4% growth rate, which is higher than the target growth rate of 2.7%. The UK's optimal inflation rate is 4.9%, and it delivers a growth rate of 2.5%, which is higher than the target growth rate of 1.7%.

Table 3.1 Nonlinear relation between inflation and economic growth

Full Sample								
Advanced Markets								
	Aus.	Can.	EU.	Jap.	NZ	US	UK	Norway
Sample	`61-`19	`62-`19	`97-`19	`95-`19	`88-`19	`61-`19	`61-`19	`79-`19
c	0.04*	0.03*	0.01*	0.01*	0.01*	0.04*	0.00	0.03*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
y_{t-1}	-	-	0.89*†	-	0.72*†	-	0.81*†	-
	-	-	(0.06)	-	(0.07)	-	(0.06)	-
π_t	-0.44*†	-0.35*‡	-0.83*†	0.68**	-0.51*†	-0.50*‡	0.21*†	-0.65*
	(0.19)	(0.16)	(0.40)	(0.41)	(0.20)	(0.22)	(0.08)	(0.35)
π_t^2	5.60**	13.36*	51.60*	-36.66*	5.68*†	10.04*	-2.65*	15.56*
	(3.28)	(5.68)	(25.28)	(12.29)	(2.73)	(4.53)	(1.15)	(7.47)
π_t^3	-26.87**	-107.41*	-1215.97*	-526.25†	16.72**⁂	-72.58*	7.09**	-92.75*
	(15.39)	(47.99)	(494.07)	(361.80)	(10.07)	(29.84)	(4.03)	(44.84)
R^2	0.14	0.13	0.87	0.14	0.66	0.15	0.70	0.04
π_1^*	0.069	0.016	0.014	-0.054	-0.113	0.046	0.200	0.028
π_2^*	-	0.067	-	0.008	-	-	0.049	0.084
π_T	0.025	0.020	0.020	0.020	0.020	0.020	0.020	0.020
G_1^*	0.027	0.027	0.047	-0.048	0.423	0.031	-0.038	0.022
G_2^*	-	0.034	-	0.016	-	-	0.025	0.030
G_T	0.032	0.027	0.039	0.007	0.024	0.033	0.017	0.022
Emerging Markets								
	Bra.	Chile	Czech	S. Korea	Mexico	Poland	Russia	SA
Sample	`97-`19	`97-`19	`99-`19	`61-`21	`94-`19	`96-`19	`02-`19	`71-`19
c	-0.08**	0.01*	0.03*	0.01*	0.00	0.02*	-0.04**	0.04*
	(0.04)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.02)	(0.01)
y_{t-1}	-	0.63*†	-	0.85*†	-	0.58*†	-	-
	-	(0.11)	-	(0.03)	-	(0.1)	-	-
π	5.47*	-0.26*	-1.05*†	-0.12*†	0.56*	-0.29*†	1.90*†	-0.44*†
	(2.23)	(0.11)	(0.37)	(0.06)	(0.16)	(0.12)	(0.63)	(0.12)
π_t^2	-80.08*	12.63*	50.06*	1.76**⁂	-2.76*	4.78*	-10.55*†	5.34*

	(33.95)	(5.81)	(23.89)	(0.75)	(0.42)	(2.26)	(3.75)	(1.94)
π_t^3	317.86*	-142.98*	-538.1**	-4.70*⁂	3.23*†	-17.6**	6.65**◊	-25.09*
	(140.36)	(64.42)	(299.22)	(2.15)	(0.73)	(9.54)	(3.98)	(9.79)
R^2	0.22	0.52	0.16	0.73	0.41	0.45	0.47	0.15
π_1^*	0.120	0.013	0.013	0.035	0.435	0.039	0.958	0.071
π_2^*	0.048	0.046	0.049	1.641	0.133	0.143	0.099	-
π_T	0.035	0.030	0.020	0.020	0.030	0.025	0.040	0.045
G_1^*	-0.027	0.023	0.024	0.053	-0.008	0.036	-2.055	0.027
G_2^*	0.033	0.029	0.035	9.728	0.037	0.059	0.051	-
G_T	0.027	0.026	0.025	0.055	0.018	0.037	0.020	0.029

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%. †lag 1, ‡lag 2, ⁂lag 3, ◊lag 4.

Turning to emerging markets we observe widespread losses in terms of economic growth. This finding is in line with Ibara and Trupkin (2015) in relation to developing countries. The low inflation targets are not consistent with maximum economic growth. Brazil's optimal inflation rate is 4.8%, and it delivers an optimal growth rate of 3.3%, which is higher than the target growth rate of 2.7%. Chile's inflation target of 3% delivers a growth target of 1%, which is lower than the optimal growth rate of 2.9%.

Note that our estimates of the optimal inflation rate for some of the emerging market economies are in line with the estimates by Vinayagathasan (2013). Other emerging markets require double-digit inflation rates to achieve optimal economic growth, Poland for example, requires an optimal inflation rate of 14.3% in order to achieve a growth rate of 5.9%, which is far higher than the growth target of 1.5%. However, these double-digit optimal inflation rates are lower than the ones estimated by Pollin and Zhu (2006) and Burdekin et al. (2004).

Figure 3.1 illustrates the nonlinear inflation-growth relation that we have estimated in Table 3.1. We notice that for economies where there is an inflexion point, there is a negative relationship between the inflation rate and economic growth. Economies such as Canada, Norway, Brazil and Czech Republic have two clear extrema, where for Canada, Norway, and Czech Republic the higher growth rate obtains at a higher rate of inflation.

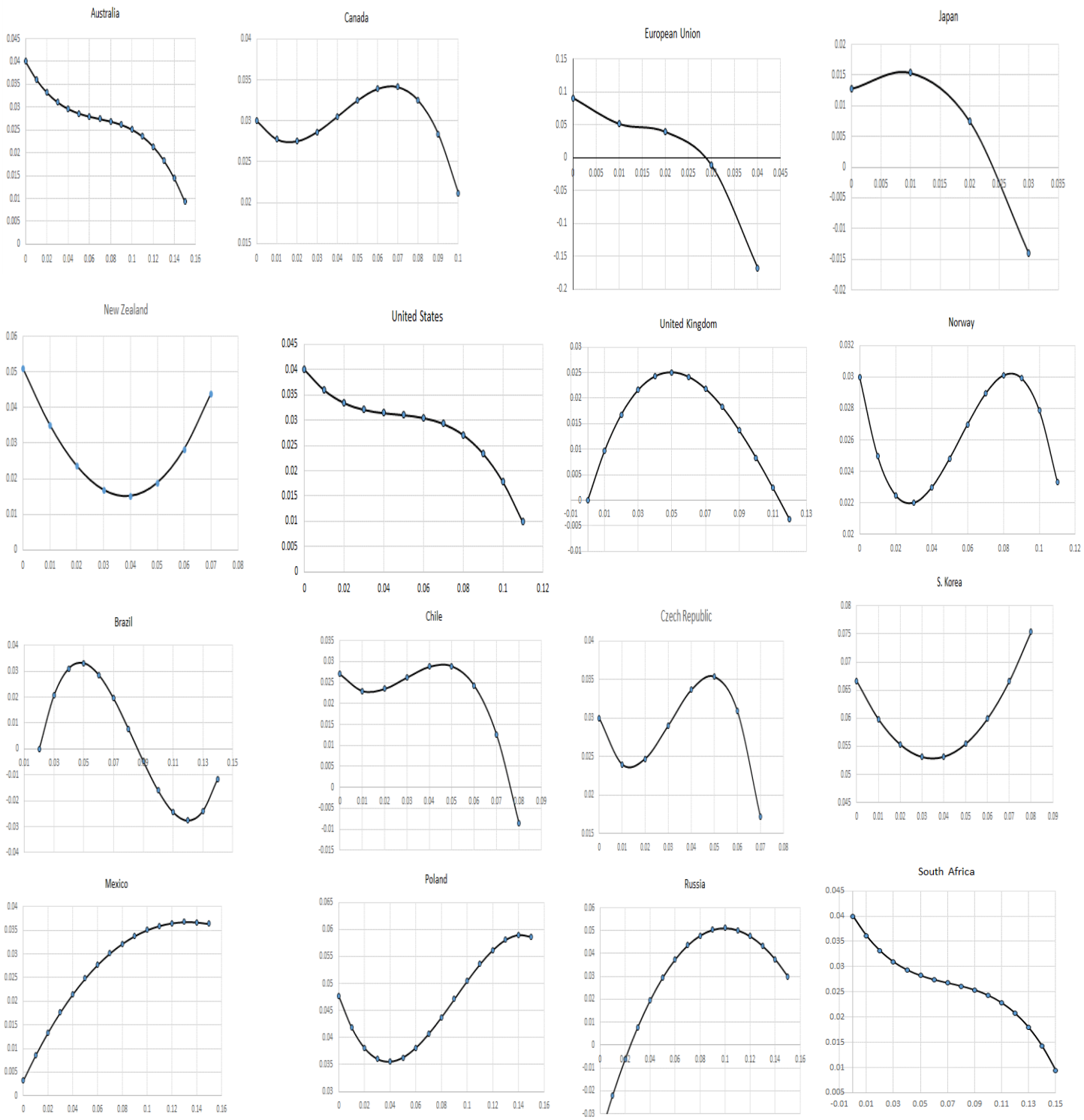


Figure 3.1 Inflation and economic growth ***(y-axis =inflation); (x-axis =economic growth)***

Overall, the results in Table 3.1 suggest that most of the emerging markets are sacrificing some economic growth in order to maintain low levels of inflation. While some advanced economies also face this problem, it is more widespread among emerging markets. The growth loss ranges from 0.5 percentage points to 3 percentage points across both advanced and emerging markets. Russia appears to sacrifice the most in terms of economic growth as it sacrificed 3.1 percentage points.

3.4.2. Optimal inflation and unemployment

We turn to the relationship between inflation and the unemployment rate. Table 3.2 reports the results, which show that Canada, Japan, and Norway appear to maintain low inflation targets at the expense of high rates of unemployment. Turning to emerging markets we observe that Brazil's optimal inflation rate is 4.7%, whereas its inflation target is 3.5%. The result is that the optimal unemployment rate is 7% compared to the 8.1% implied by the inflation target. Chile's optimal unemployment rate is 5.5% whereas its unemployment rate target is 8.2%. South Africa has its inflation target at 4.5%, yet its optimal inflation rate is 8.4%. The result is that the target rate of unemployment is 27.2, compared to the optimal rate of 22.8%.

Table 3.2 Nonlinear relation between inflation and unemployment

Full Sample								
Advanced Markets								
	Aus	Can.	EU.	Jap.	NZ	US	UK	Norway
Sample	`67-`19	`62-`19	`97-`19	`61-`19	`86-`19	`61-`19	`62-`19	`72-`19
c	0.00	0.00*	0.00	0.00**	0.00	0.00*	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
U_{t-1}	1.39*†	1.58*†	1.74*†	0.98*†	0.99*†	0.95*†	1.78*†	1.15*†
	(0.08)	(0.09)	(0.05)	(0.01)	(0.02)	(0.09)	(0.06)	(0.10)
U_{t-2}	-0.40*‡	-0.62*‡	-0.75*‡	-	-	-	-0.78*‡	-0.18**‡
	(0.08)	(0.08)	(0.05)	-	-	-	(0.06)	(0.10)
π_t	0.05*‡	0.04*	0.11*†	-0.01**	-0.05*†	-0.08**⁂	-0.01*◇	0.06**
	(0.02)	(0.02)	(0.05)	(0.01)	(0.02)	(0.02)	(0.00)	(0.03)
π_t^2	-0.52*†	-1.09*	-6.43*	0.04*⁂	2.04*‡	2.86*⁂	0.19*	-1.06**
	(0.16)	(0.51)	(3.15)	(0.01)	(0.66)	(0.35)	(0.07)	(0.55)
π_t^3	2.36*	8.98*	144.59*	0.25*	-10.41*‡	-16.02*⁂	-0.70*	5.37**
	(0.59)	(3.89)	(55.98)	(0.11)	(3.48)	(2.36)	(0.27)	(2.89)
R^2	0.99	0.98	0.99	0.99	0.97	0.98	1.00	0.97
π_1^*	0.074	0.059	0.015	0.080	0.014	0.016	0.022	0.093
π_2^*	-	0.023	-	-0.187	0.117	-	0.164	0.037
π_T	0.025	0.020	0.020	0.020	0.020	0.020	0.020	0.020

U_1^*	0.087	0.050	0.081	0.015	0.008	0.035	0.032	0.027
U_2^*	-	0.056	-	0.110	0.403	-	0.232	0.045
U_T	0.040	0.056	0.088	0.027	0.012	0.035	0.032	0.038
Emerging Markets								
	Bra.	Chile	Czech	S.Korea	Mexico	Poland	Russia	SA
Sample	`02-`19	`91-`19	`99-`19	`99-`21	`87-`19	`95-`19	`00-`19	`94-`19
c	0.02**	0.00**	0.00	0.01*	0.003*	0.00	0.00	0.02
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
U_{t-1}	1.08*†	1.20*†	1.70*†	0.75*†	1.32*†	1.84*†	0.95*†	0.76*†
	(0.08)	(0.11)	(0.08)	(0.05)	(0.18)	(0.05)	(0.03)	(0.07)
U_{t-2}	-0.16*‡	-0.27*‡	-0.72*‡	0.00**‡	-0.39*‡	-0.85*‡	-	0.14*‡
	(0.07)	(0.12)	(0.09)	(0.00)	(0.17)	(0.05)	-	(0.07)
π_t	-0.87**†	0.06**	-0.11**	-0.09*	-0.01*†	0.05*	0.00*‡‡	0.57*†
	(0.44)	(0.04)	(0.06)	(0.05)	(0.00)	(0.02)	(0.00)	(0.12)
π_t^2	12.81*†	-0.86**	5.30*	1.95*	0.01*†	-0.44*	0.21*	-12.50*†
	(5.35)	(0.48)	(2.43)	(0.90)	(0.00)	(0.22)	(0.07)	(3.95)
π_t^3	-50.57*†	2.81**	-57.79*	-8.06**‡‡	0.003*‡	1.00**	-0.82*	71.88*†
	(18.88)	(1.61)	(25.33)	(4.60)	(0.00)	(0.57)	(0.30)	(28.92)
R^2	0.93	0.90	0.99	0.82	0.93	0.99	0.98	0.83
π_1^*	0.047	0.158	0.013	0.030	0.513	0.217	0.004	0.084
π_2^*	0.122	0.046	0.048	0.132	1.937	0.073	0.164	0.032
π_T	0.035	0.030	0.020	0.020	0.030	0.025	0.040	0.045
U_1^*	0.070	0.055	0.038	0.035	0.019	-0.032	-0.003	0.228
U_2^*	0.199	0.083	0.094	0.052	0.081	0.107	0.029	0.280
U_T	0.081	0.082	0.044	0.036	0.045	0.051	0.002	0.272

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%. †lag 1, ‡lag 2, ‡‡lag 3, $^{\diamond}$lag 4.

Figure 3.2 presents the graphical view of Table 3.2. Notice that in all economies that exhibit the inflexion point, there is a positive relationship between inflation and the unemployment rate. The only exception is Mexico, where there is a negative relationship. Canada, Norway, Chile and South Africa show that the optimal inflation rate delivers the lowest unemployment rate at higher rates of inflation.

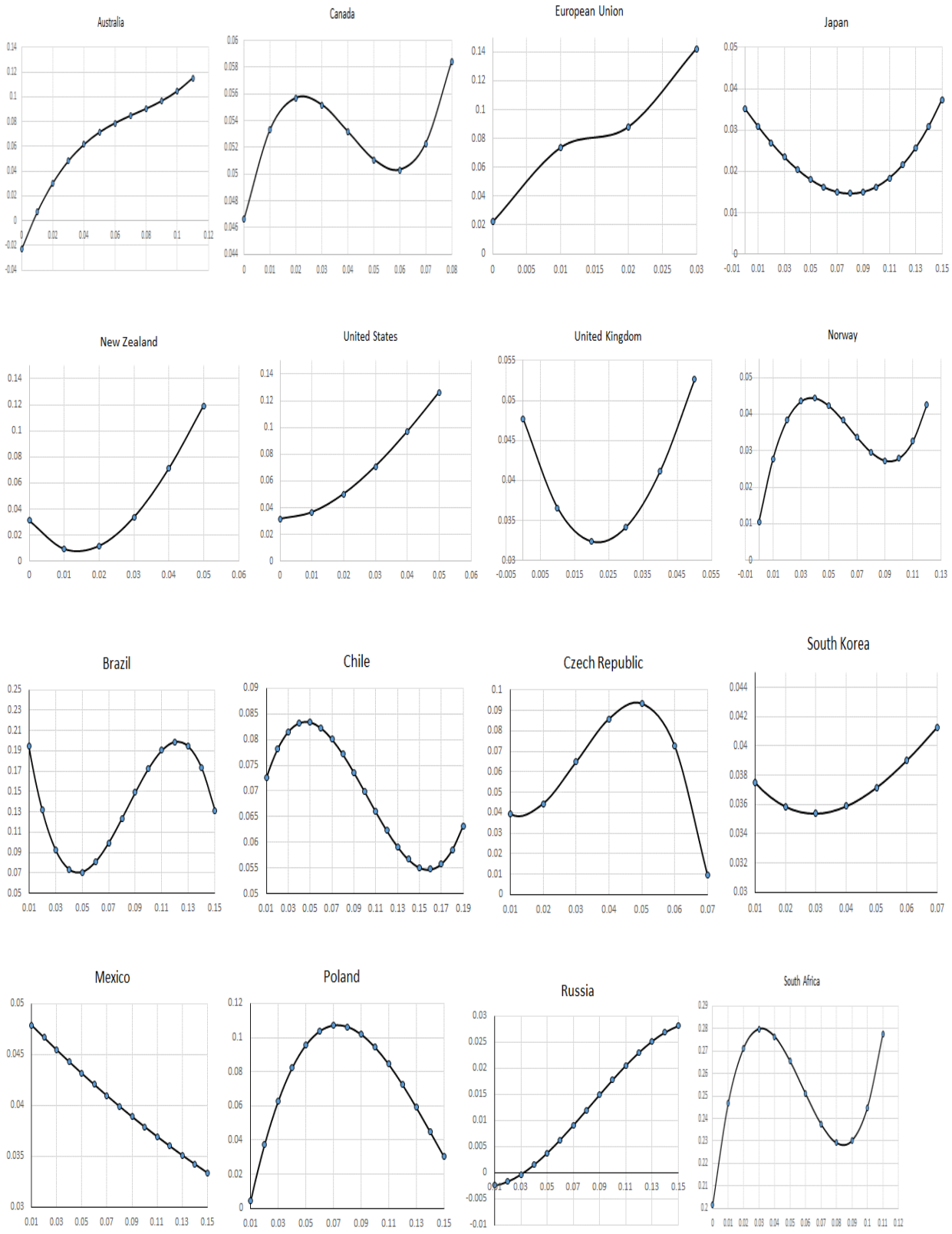


Figure 3.2 Nonlinear relation between inflation and unemployment ***(y-axis =inflation); (x-axis =unemployment)***

Overall, we find that most of the emerging markets appear to have sacrificed higher rates of unemployment in order to achieve low rates of inflation. There are also some advanced economies that face this challenge, although the phenomenon appears not to be as widespread as in emerging markets. Across economies, the sacrifice ranges from 0.5 percentage points of the unemployment rate to almost 4.5 percentage points. South Africa sacrifices the most in terms of the unemployment rate, as it bears an excess unemployment rate of 4.5 percentage points.

3.4.3. Post-inflation targeting estimations.

The full sample estimations in Table 3.1and Table 3.2 include a period where IT was not explicitly adopted by central banks. It is therefore important to investigate how the above results might have changed since the explicit announcement of IT. We treat the results in the following tables with caution, especially because, as pointed out by Stone (2003), Carare and Stone (2006) and Bhatt et al. (2017), many economies had already implicitly adopted IT before they announced adoption of the policy. As Dubey and Mishra (2023) show, formal adoption of IT served to lock in already low inflation in many economies.

Table 3.3 reports the results. Although the nonlinear relationship has changed because of changes in the coefficients, we observe that there are still advanced economies where the target is not consistent with optimal growth. This is the case for Canada, US and Norway. We also observe that the growth rate implied by the inflation target is, in some cases lower during the IT period than over the full sample.

There are several factors that may account for this, including the fact that the IT period includes the Great Recession. However, one could argue that there were a number of adverse shocks that also affected the pre-IT period, such as the large oil price shocks of the 1970s and the Volcker disinflation of 1979 - 1982.

Table 3.3 Inflation and economic growth

After IT								
Advanced Markets								
	Aus	Can.	EU.	Jap.	NZ	US	UK	Norway
Sample	`93-`19	`91-`19	`97-`19	`13-`19	`90-`19	`12-`19	`92-`19	`01-`19
c	0.04*	0.02*	0.01*	0.01*	0.02*	0.03*	0.00	0.01**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
y_{t-1}	-	-	0.89*†	-	0.72*†	-	0.86*†	0.37*†
	-	-	(0.06)	-	(0.06)	-	(0.07)	(0.12)
π	-1.34*	-0.36**	-0.83*†	0.92*	-0.62*†	-3.59*	1.02*†	-0.40*‡
	(0.32)	(0.21)	(0.40)	(0.34)	(0.20)	(0.52)	(0.33)	(0.17)
π_t^2	43.74*	38.40*	51.60*	-12.39**‡	13.29*†	252.89*	-32.04*†	53.90*⁂
	(17.98)	(13.81)	(25.28)	(6.32)	(3.64)	(52.75)	(9.97)	(11.67)
π_t^3	-480.74*	-557.64*	-1215.97*	-1170.12*	-123.39*	-4685.07*	81.85*⁂	-1197.72*⁂
	(220.65)	(175.13)	(494.07)	(236.76)	(32.06)	(1278.38)	(29.26)	(245.21)
R^2	0.15	0.26	0.87	0.59	0.60	0.50	0.86	0.33
π_1^*	0.030	0.005	0.014	-0.020	0.036	0.010	0.244	0.004
π_2^*	-	0.041	-	0.013	-	0.026	0.017	0.026
π_T	0.025	0.020	0.020	0.020	0.020	0.020	0.020	0.020
G_1^*	0.031	0.020	0.023	-0.001	0.016	0.017	-3.437	0.011
G_2^*	-	0.032	-	-	-	0.028	0.035	0.020
G_T	0.031	0.025	0.015	0.017	0.026	0.024	0.033	0.018
G_T^F	0.032	0.027	0.039	0.007	0.024	0.033	0.017	0.022
Emerging Markets								
	Bra.	Chile	Czech	S.Korea	Mexico	Poland	Russia	SA
Sample	`99-`19	`97-`19	`97-`19	`98-`21	`01-`19	`98-`19	-	`00-`19
c	-0.07	0.01*	0.03*	0.01	-0.20	0.02*	-	0.01*
	(0.06)	(0.01)	(0.01)	(0.02)	(0.12)	(0.00)	-	(0.00)
y_{t-1}	-	0.63*†	-	-	-	0.64*†	-	0.85*†
	-	(0.11)	-	-	-	(0.07)	-	(0.06)
π	5.31*	-0.26*	-0.74*†	4.20*	17.81**	-0.32*†	-	-0.11*‡
	(2.71)	(0.11)	(0.29)	(1.57)	(9.00)	(0.14)	-	(0.04)

π_t^2	-82.27*	12.63*	20.76*	-113.68*	-430.41*	7.15**	-	-2.03**
	(38.61)	(5.81)	(9.79)	(45.43)	(208.84)	(3.75)	-	(1.08)
π_t^3	336.18*	-142.98*	-153.47*	646.57**	3113.99*	-43.14**	-	16.80*
	(154.77)	(64.42)	(65.48)	(359.37)	(1488.03)	(23.75)	-	(7.51)
R^2	0.24	0.52	0.14	0.34	0.28	0.60	-	0.88
π_1^*	0.119	0.013	0.025	0.094	0.061	0.031	-	0.101
π_2^*	0.044	0.045	0.066	0.023	0.031	0.080	-	-0.021
π_T	0.035	0.030	0.020	0.020	0.030	0.025	-	0.045
G_1^*	-0.034	0.035	0.025	-0.066	-0.005	0.032	-	-0.015
G_2^*	0.036	0.041	0.031	0.051	0.034	0.040	-	0.087
G_T	0.031	0.014	0.026	0.050	0.034	0.012	-	0.004
G_T^F	0.027	0.026	0.025	0.055	0.018	0.037	-	0.029

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%. †lag 1, ‡lag 2, ⁂lag 3, ◊lag 4.

Turning to emerging markets, we observe that the loss in growth is more widespread. Brazil's growth target is at 3.1% whereas its optimal growth is 3.6%. Chile exhibits a loss of 2.7 percentage points by pursuing an inflation target that is 1 percentage point below its optimal level. Poland exhibits 2.8 percentage point loss to its growth rate with an optimal inflation rate of 8% compared to an inflation target of 2.5%. In the South African case, the IT period is characterized by a 0.4% growth rate, compared to the full sample growth rate of 2.9%, it appears that the inflation-growth curve has shifted to the left.

Table 3.4 reports the results for the inflation-unemployment relationship. We observe a shift upwards in the curve. In some economies this shift is only marginal, while in others it is substantial. For example, in New Zealand the shift is from 1.2% to 5.3%. For emerging markets, the shift was not significant. In the case of South Africa, the shift was downwards by 1.7 percentage points, while maintaining the inflation targets costs 0.002 percentage points of the unemployment.

Table 3.4 Inflation and unemployment

AFTER IT								
Advanced Markets								
	Aus	Can.	EU.	Jap.	NZ	US	UK	Norway
Sample	`93-`19	`91-`19	`97-`19	`13-`19	`90-`19	`12-`19	`92-`19	`01-`19
c	0.00**	0.00	0.00	0.00	0.00	0.00**	0.00*	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
U_{t-1}	1.24*†	1.69*†	1.74*†	0.64*†	0.98*†	0.95*†	1.42*†	1.43*†
	(0.08)	(0.14)	(0.05)	(0.17)	(0.02)	(0.01)	(0.10)	(0.12)
U_{t-2}	-0.27*‡	-0.71*‡	-0.75*‡	0.33**‡	-	-	-0.46*‡	-0.48*‡
	(0.08)	(0.14)	(0.05)	(0.17)	-	-	(0.10)	(0.12)

π_t	0.08**†	0.04*	0.11*†	0.06*†	-0.08**†	-0.11*⁂	-0.08*⁂	0.04*
	(0.04)	(0.01)	(0.05)	(0.02)	(0.04)	(0.04)	(0.04)	(0.02)
π_t^2	-3.79*	-0.38**	-6.43*	-8.00*‡	5.46*‡	3.94*⁂	2.10*⁂	-3.48*
	(1.35)	(0.21)	(3.15)	(3.54)	(2.15)	(1.40)	(0.50)	(1.46)
π_t^3	57.55*	2.34*⁂	144.59*	187.41**	-45.08**‡	-38.58*	51.66*	62.25**
	(16.77	(1.33)	(55.98)	(96.36)	(25.27)	(20.52)	(6.91)	(34.57)
R^2	0.99	0.99	0.99	0.98	0.98	1.00	0.99	0.93
π_1^*	0.029	0.054	0.015	0.024	0.009	0.020	0.012	0.030
π_2^*	0.015	-	-	0.005	0.072	0.048	-0.039	0.008
π_T	0.025	0.020	0.020	0.020	0.020	0.020	0.020	0.020
U_1^*	0.049	0.059	0.088	-0.013	0.053	0.018	0.045	0.039
U_2^*	0.051	-	-	0.006	0.347	0.026	0.130	0.042
U_T	0.049	0.059	0.088	-0.013	0.053	0.018	0.045	0.039
U_T^F	0.040	0.056	0.088	0.027	0.012	0.035	0.032	0.038

Emerging Markets

	Bra.	Chile	Czech	S.Korea	Mexico	Poland	Russia	SA
Sample	`99-`19	`91-`19	`99-`19	`99-`21	`01-`19	-	-	`00-`19
c	0.02*	0.00	0.00	0.01*	0.00	-	-	0.04*
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	-	-	(0.01)
U_{t-1}	1.07*†	1.24*†	1.66*†	0.75*†	0.98*†	-	-	0.83*†
	(0.05)	(0.10)	(0.10)	(0.05)	(0.04)	-	-	(0.06)
U_{t-2}	-0.17*‡	-0.30*‡	-0.69*‡	-	-	-	-	-
	(0.04)	(0.11)	(0.11)	-	-	-	-	-
π_t	-0.73**†	0.07**	-0.11**	-0.09**	0.20*‡	-	-	0.41*†
	(0.40)	(0.04)	(0.06)	(0.05)	(0.09)	-	-	(0.13)
π_t^2	10.99*†	-0.88**	5.08*	1.95*	-1.8**‡	-	-	-8.02*†
	(4.98)	(0.50)	(2.43)	(0.90)	(1.00)	-	-	(0.03)
π_t^3	-43.54*†	0.50**	-54.10*	-8.06**⁂	9.46	-	-	49.43*†
	(17.91)	(1.65)	(25.06)	(4.60)	(9.14)	-	-	(0.05)
R^2	0.89	0.90	0.99	0.82	0.94	-	-	0.72
π_1^*	0.046	1.143	0.014	0.030	0.066	-	-	**0.068**
π_2^*	0.123	0.039	0.049	0.132	-	-	-	0.041
π_T	0.035	0.030	0.020	0.020	0.030	-	-	0.045
U_1^*	0.077	-5.509	0.036	0.035	0.138	-	-	**0.252**
U_2^*	0.177	0.082	0.086	0.052	-	-	-	0.255
U_T	0.084	0.081	0.040	0.036	-0.007	-	-	0.255
U_T^F	0.081	0.082	0.044	0.036	0.045	-	-	0.272

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%. †lag 1, ‡lag 2, ⁂lag 3, ◊lag 4.

Although the results suggest that the losses due to the deviation of IT from optimal inflation appear to have decreased after the formal adoption of IT, there also appears to have been significant shifts in the inflation-growth and inflation-unemployment relationship. This creates significant uncertainty concerning the results, especially because many central banks adopted IT implicitly before formal adoption.

3.5. Conclusion

Many central banks have adopted IT as a monetary policy framework. A basic requirement for IT is an announcement of an explicit numerical target for inflation, which then allows economic agents to centre their inflation expectations and to contribute to the stability of the macroeconomic environment. While the institutional mechanisms and process towards formal adoption of IT are well documented, there is little research on how central banks arrived at their specific numerical targets.

This point is underscored by Horvath and Matějů (2011), who investigate how central banks set their inflation targets. Debelle (1997) provides a broad guide on how central banks set their targets—the target rate of inflation should be the level below which no additional significant gains in economic activity can be achieved. We argue that many central banks that have adopted IT have not conducted studies to determine this level of inflation.

In the light of this gap, we derived a simple growth model in which inflation is nonlinearly related to economic growth and by extension the unemployment rate. In this model, the reaction of the central bank to inflation changes with the level of inflation and the risk premium associated with real investment is endogenously determined by the level of inflation. This model shows that movements in the inflation-growth relationship are determined largely by fluctuations in the average rate of profit in the economy. We estimated this model for advanced and emerging market economies.

Our findings are that the nonlinear relationship between inflation and economic activity is heterogeneous across economies. There are some advanced economies that have slightly sacrificed economic growth in order to achieve a low inflation target. We find that this sacrifice is widespread among emerging market economies. The growth sacrifice ranges from 0.5 percentage points to 3 percentage points across both advanced and emerging markets.

While for some economies this may appear not significant, the cumulative output loss may be large. Turning to the unemployment rate, we again find widespread sacrifice among emerging markets compared to advanced economies. The sacrifice ranges from 0.5 percentage points of excess unemployment rate to almost 4.5 percentage points. Cumulatively and in absolute terms, this may imply that a significant number of people are kept out of employment in order to maintain a lower than optimal inflation target. In South Africa, where the highest sacrifice is observed, and where the unemployment rate is the highest in our sample of countries, this could amount to more than 960 000 people.

The policy implications of these findings are that policymakers need to consider revising their inflation targets by taking a long-term view of the data. Keeping people out of gainful employment in order to maintain a low inflation target poses serious normative questions. As a first step, detailed studies need to be conducted to ascertain the degree of alignment of inflation targets with optimal levels.

Secondly, the sensitivity of the degree of central bank credibility needs to be estimated in order to lay the foundation to align targets with optimality in a least cost manner. Thirdly communication of shifts in the way the targets are set are important and estimates of time-varying optimal levels of inflation need to made public so that agents understand the interest rate adjustment process.

4. The Behaviour of Fiscal Policy Under Inflation Targeting

4.1. Introduction

The advent of the Global Financial Crisis and the subsequent Covid-19 pandemic economies has opened policy space for consideration of fiscal policy interventions. As Taylor (2000) noted long before these major shocks, this moment arises because of the possibility of the decline in interest rates towards their zero lower bound.?????

In such situations, policymakers must consider the full range of policy options, including fiscal policy, even if quantitative monetary policies and non-interest rate channels may be available. A number of studies, e.g., Padoan (2009), Caldentey and Vernego (2010), Kollman et al. (2012), OECD (2020) document the sizes and effects of fiscal interventions in response to the crisis. Despite the widespread fiscal stimuli that were adopted in response to the two shocks, there are opposing views regarding the use of fiscal policy for macroeconomic stabilization, as pointed out by de Long and Tyson (2013).

One line of research argues that, with interest rates at the zero lower bound, the costs of fiscal policy are low. In addition, Reifschneider and Williams (2000) show that when interest rates are at their zero lower bound and the economy is in a deflationary trap, conventional open market operations are unable to restore equilibrium. However, stimulative fiscal policy can take the economy out of the downward spiral.

This finding is confirmed by Schmidt (2017), and it is in line with the finding by de Long and Summers (2012). Yet, Fatas and Mihov (2003) argue that aggressive use of discretionary fiscal policy brings about increased output volatility and lower economic growth, and therefore it must be constrained. In addition, Taylor (2010, 2012) casts doubt on the empirical effectiveness of fiscal stimuli in response to the crisis in the US economy.

Apeti, et al. (2024) agree with Scmidt, especially for developing countries about IT reducing fiscal volatility. They say, “our results suggest that reforms of the monetary policy management in the form of IT adoption may provide a useful policy for fighting fiscal discretion towards a reduction of fiscal policy volatility.”

In the light of the extensive use of fiscal interventions in response to the crisis and the Covid-19 pandemic, concerns over fiscal sustainability have arisen. Archibald and Greenridge (2003) attribute problems of fiscal sustainability to lack of discipline, requiring institutional reforms to constrain fiscal authorities, a view also held by Fatas and Mihov (2003). In the context of developing countries, Kia (2008) and Mendoza and Ostry (2008) point out that structural problems such as reliance on volatile commodity exports, insufficient development of domestic capital markets and dollarization add to fiscal instability.

As Bi (2011), Corsetti et al. (2012) and Bonam and Lukkezem (2018) show, the effect of rising public debt due to unsustainable fiscal policies is to raise the default risk premium on sovereign bonds, which then filter throughout financial markets, causing negative wealth effects.

In this chapter, we investigate whether the adoption of inflation targeting has affected the setting of fiscal policy. As pointed out by Woodford (2001) and Clarida et al. 1999, stability requires that a central bank adopts an activist monetary policy against inflation. In addition, Bonam and Lukkezem (2018), add that fiscal policy must be sustainable for macroeconomic stability to be achieved.

The question that arises from this is whether fiscal authorities consider the targets of monetary policy in their decision-making. Indeed, as pointed by Bernanke and Mishkin (1997), one of the key preconditions for inflation target is monetary policy dominance. Under inflation targeting, fiscal policy cannot be set in a way that undermines the ability of the central bank to achieve its inflation target (Sims, 2005). Therefore, hypothetically, we expect that the targets of monetary policy to form an important part of fiscal policy.

Understanding the behaviour of fiscal authorities in relation monetary policy targets is important for at least two reasons. Firstly, the extent to which fiscal authorities respond to monetary policy targets is important because it shows the degree of fiscal-monetary co-ordination. As Sims (2005) states, fiscal policy should not be set in a way that undermines monetary policy.

Secondly, as Fournier and Fall (2017) illustrate, lack of fiscal-monetary co-ordination can also undermine fiscal sustainability, causing debt explosion. Thirdly, with interest rates at the zero lower bound in many advanced economies, monetary authorities may have to be accommodative to allow policy makers to use all available, including fiscal policy, to prevent the economy from

entering a deflationary spiral. This can be achieved if monetary policy allows space for expansionary fiscal policy, as Reifschneider and Williams (2000) have shown.

The study is structured as follows: section 2 provides a literature review on the interaction between fiscal and monetary policy and implications of this interaction for fiscal sustainability, section 3 presents the theoretical framework that we use to derive simple fiscal policy rules that incorporate targets for monetary policy as normally specified in simple Taylor rules, section 4 conducts the empirical analysis to determine the behaviour of fiscal authorities under inflation targeting and section 5 concludes with some policy implications.

4.2. Literature review

The level of debt-GDP ratio differs across economies. Yun (2015) notes that there are countries that run very high debt to GDP ratio, e.g., Japan at 230%, and others with low ratios, e.g., at 35.9%. Whatever the levels of debt, there is broad consensus that such levels must engender sustainable fiscal policy.

For fiscal policy to be sustainable, as Blanchard et al. (1990) noted, public debt should not explode, government should not find itself in a position where it is forced to increase taxes, decrease expenditure, monetize fiscal deficits or default on debt repayment. It is because of these factors that Kalyoncu (2005) concluded that the debt of Mexico, Philippines and South Africa are not sustainable because they violate their intertemporal budget constraints.

Abdullah et al. (2012) argue that for fiscal sustainability to obtain the government must be solvent and be able to payback their debt in perpetuity without a possibility of defaulting in the future. This does not mean that government should run a balanced budget policy. Collignon (2012) agrees that sustainability does not mean budgets should always be balanced, but of critical importance is timeous correction of deviations from the sustainability path.

Hayes 2024 cites the advantages and disadvantages of over relying on fiscal policy or monetary policy to manage the economy. He argues that "a small amount of inflation is healthy for a growing economy as it encourages investment in the future. It also allows workers to expert higher wages. One big disadvantage of monetary policy, which these days means inflation targeting, the macro effects of monetary policy have a lag.

A balanced or surplus budget may have huge opportunity costs in terms of both social and physical infrastructure, especially for emerging economies which have developmental backlogs. In such situations, high debt-GDP ratios are unavoidable. As Archibald and Greenidge (2003) emphasized, debt is important for expansionary fiscal policy as long as it does not result in fiscal unsustainability.

Fiscal unsustainability is reflected in explosive debt dynamics. Breus (1998) mentions at least four consequences of fiscal unsustainability. Firstly, as also noted by de Castro Fernandez and Hernandez de Cos (2000), unsustainable fiscal policy may crowd out private sector investments by raising interest rates.

Secondly, as also pointed by Stoian and Campenau (2010), the overall efficiency of the economy may be lost, with negative implications for economic growth as entrepreneurs suspend or abandon economically viable projects that have been rendered unprofitable by high interest rates.

Thirdly, high debt today may negatively affect future generations as it will have to be repaid, especially because high debt has the adverse effect on the budget by raising interest payments (Armone et al. 2005). Fourthly, excessive deficits may endanger the solvency position of other countries as lenders restrict credit and engage in adverse selection. There are several factors that cause unsustainable fiscal policy. Firstly, according to Bartolini and Cattarelli (1994), the propensity to increase debt to unsustainable levels is higher in countries where government enjoys lower bond rates than market lending rates, and where there is a perception of lower default risk.

Secondly, the ability of fiscal policy to absorb external shocks is critical for sustainability. This point is mentioned by Buiter (2004) and emphasized by Huang and Xie (2008) who mention the susceptibility of developing economies to the external shocks like oil prices and exchange rates movements. Qin et al. (2005) also mention the same point in the case of the Philippines, where they show that domestic and external shocks can easily result in fiscal unsustainability.

Bankowski, et al. (2023) emphasize the need for better coordination between monetary policy and fiscal policy for better outcomes in the economy after investigating the conduct of these policies in the Euro area. They conclude that, “on average government measures mitigated about one quarter of euro area household income loss on account of inflation in 2022”. They say these measures have “temporarily lowered consumer prices.”

Cevic and Akitoby, 2023 find that the confluence of stimulus fiscal policies, both in advanced and emerging economies, and supply shocks, especially the Russia/Ukraine conflict has resulted in unprecedented inflation. This is both in the Euro area and emerging economies. Of the many conclusions they arrive at, the following are critical: (a) fiscal policy is a critical anchor of macroeconomic stability, (b) fiscal policy should be used with care in aggregate demand management as it has significant effects on inflation , which are highly dependent on fiscal space and economic conditions, and (c) flexible exchange rates and rule – based policymaking (inflation targeting for monetary policy and fiscal rules for fiscal policy) provide resilience to inflationary shocks. The importance of this coordination of the fiscal and monetary policies cannot be overemphasized. The silo approach can have very pernicious effect on the economy.

While it is accepted that on average debt defaulters usually have very high debt-GDP ratio, this is not always the case. However, low debt levels create fiscal space to deal with both internal and external shocks. The IMF (2003) found that some emerging market economies, e.g., India, Malaysia and Bulgaria, started with very high debt to GDP ratios but have never defaulted. One of the key factors that accounts for this outcome is the credibility of fiscal policy. A credible fiscal policy does not face severe and adverse market reaction in the light of deviations from a fiscally sustainable path because economic agents believe that corrective measures will be taken.

Thirdly, a major source of external shocks in many emerging and developing economies is the erratic behaviour of commodity prices. Many of the economies that have experienced debt crises are dependent on commodity exports as source of fiscal revenue. Ghatak and Sanchez-Fung (2007) cite the deteriorating oil prices in Venuezela in the 1990s as one of the reasons that increased its indebtedness. Nigeria also suffered the same fate as other oil-producing countries.

For commodity importing emerging markets, when commodity prices increase, they experience pressure on their finances, increasing debt, and thus making their default a real possibility. Dependence on primary commodities is also prone to volatility terms of trade for emerging economies. Cuadra and Sapriza (2006) observe that usually these commodity-dependent economies also depend on imports for their capital goods and intermediate inputs. The implication is that the volatility in commodity prices tends to create generalized economic volatility in these economies.

Fourthly, demographic shocks can also lead to debt explosion and thus fiscal unsustainability. Japan is a good example. Japan has very high life expectancy. Also birth rates are far below those of the OECD countries. The result of this is an aging population, which is not actively contributing to fiscal revenue.

Faruquee and Muhleisen (2003) note that the dependency ratio in Japan is the highest in the industrialized world. Doi et al. (2011) found that the accumulation of debt over the years has led to fiscal unsustainability in Japan. This finding is consistent with the one by Sakuragawa and Hosono (2011), who used a dynamic stochastic general equilibrium model for Japan. In such a situation, Auerbasch (2016) argues that fiscal measures such as debt-GDP and current budget deficit-GDP ratios do not properly capture the state fiscal policy because they do not factor in the responsibility of government to provide for the elderly.

The fifth factor which causes fiscal unsustainability in some of the emerging economies is debt dollarization, which also tends to create currency mismatch. In this situation revenues are largely collected in domestic currency, yet liabilities are denominated in foreign currency. In Argentina in 2001, most debt instruments were dollar denominated. When Argentina's currency collapsed, it led to debt explosion and default. Garber (1999) argues that it was liability dollarization that led to debt explosion and default in Argentina.

Thailand also experienced a similar problem although in this instance it was financial institutions that borrowed in dollars but lent in baht. Calvo and Mishkin (2003) noted that when the exchange rate worsened, Thai borrowers were unable to repay their dollar denominated loans, leading to default.

The sixth factor that causes fiscal unsustainability is the reaction of government after crisis. When investigating fiscal sustainability of South Korea between 1970 and 1999, Koo (2002) found that up to 1996 there was fiscal sustainability. From there, debt ratios, primary balance and tax gap deteriorated.

The primary deficit is big, indicating sustained expenditure increases but not enough tax increases, resulting in fiscal unsustainability. Fiscal policy reaction in the light of shocks is thus important. The correct response would have been either seignorage, consolidation, tax increase or the combination of the above. Failure to act appropriately by fiscal authorities led to unsustainable debt.

Linked to how fiscal authorities react, is the pro-cyclical stance, which was characteristic of many Latin American and Carribean economies. When GDP grows governments embarked on expansionary policies and vice versa. Fiscal policy, however, should be counter-cyclical to avoid too much volatility of the economy and smooth business cycles. As Serven (1998) points out, the volatility of the economy is not good for investment and growth.

According to Alberola et al. (2006), dependence on external credit, difficult access to international financial markets, negative impact on current accounts, leading to restrictive fiscal policies aggravate debt positions and fiscal unsustainability of the region. It is thus the pro-cyclicality of fiscal stance which may also lead to debt explosion.

The debt crisis problem was for a long time associated with only emerging and developing countries. However, from the early 1990s, the advanced OECD countries also realized the risk posed by high public debt. The Maastricht Treaty of 1992 enjoins member states to have sustainable public finances. Afonso and Rault (2010) emphasize that excessive deficits should be avoided, debt levels be kept below 60% of GDP. Member states are also expected to observe the conditions of stability and growth pact (SGP).

The developments that affected Portugal, Italy, Greece, Cyprus and Spain prove that developed economies are not immune, as pointed out by Beqiraj et al. (2018). Bohn (2007) showed that debt sustainability is a function of real interest rates, real growth rate and the primary balance. The deterioration of these economic variables may lead to debt explosion and fiscal unsustainability.

Related debate is what must be done with the indebtedness of these countries to return them to acceptable and sustainable debt levels. Burnside and Dollar (2000) are of the view that debt reduction, increased foreign aid should be accompanied by good governance and prudent macroeconomic policies. Thomas (2001) is sceptical of debt relief effectiveness because money may be misused. Arnone et al. (2005) are of the view that to deal with indebtedness of these countries, they must pursue prudent macroeconomic and competition policies to foster economic growth in developing countries.

Sachs (2002) believes that debt should be cancelled, and that action be accompanied by increased foreign aid to meet basic needs. However, there are concerns that the cancellation of the whole debt for countries may lead to the moral hazard problem, where governments may enter debt traps again believing that lenders will cancel the debt.

The dominant view is that fiscal adjustment by concerned governments remains the most viable option. However, some adjustments have failed. Baldacci et al. (2006) concluded that for fiscal adjustment to be successful, it should be back-loaded (adjustments that seek to spread out the path of adjustment), IMF supported and there should be large adjustments. Spanish debt was sustainable until it joined European Union.

Before joining the EU, Mahdavi and Westerlund (2011) and Escario et al. (2012), argue that fiscal policy was sustainable in Spain because it had also financed its deficit through monetization. The discarding of seignorage resulted in the debt-GDP ratio ballooning. The situation worsened after global economic crisis. Portugal, Italy and Greece had a similar problem.

Although the above review highlights the various factors that cause unsustainable fiscal policy, the factor that is of our concern in this paper is the response of fiscal authorities under inflation targeting. If inflation targeting brings about credibility of monetary policy, there should be an incentive for fiscal authorities to also adopt reaction functions similar to Taylor rules as a guide to setting their fiscal stances. It is this type of behaviour that is the subject of our investigation.

4.3. Theoretical framework

4.3.1. The government's budget constraint and the Taylor rule

To investigate the impact of inflation targeting on the sustainability of fiscal policy and debt, we use the following intertemporal budget constraint.

$$\frac{\Delta B_t}{P_t} = G_t - T_t + i_{n,t}\frac{B_{t-1}}{P_t} \qquad (1)$$

where ΔB_t is the change in nominal government debt, T_t is revenue, $G_t - T_t$ is the primary deficit, $i_{n,t-1}$ is the average nominal interest rate on government debt, P_t is the price level. Normalizing eq. (1) by output we get:

$$\frac{\Delta B_t}{P_t Y_t} = \frac{G_t - T_t}{Y_t} + i_{n,t}\frac{B_{t-1}}{P_t Y_t} \quad (2)$$

Let b_t be the real debt-GDP ratio and d_t be the deficit-GDP ratio. It follows that:

$$\Delta b_t = d_t + (i_{n,t} - \pi_t - g_t)b_{t-1} \quad (3)$$

In the next step, we reformulate the intertemporal budget constraint by introducing foreign-currency denominated debt. Therefore, we now have:

$$\frac{B_t}{P_t Y_t} = d_t + (1 + i_{n,t})\left(\frac{B_{t-1}^d}{P_t Y_t} + \frac{E_t B_{t-1}^f}{P_t Y_t}\right) \quad (4)$$

where B_t^d is government debt that is denominated in domestic currency, E_t is the nominal exchange rate and B_t^f is government debt that is denominated in foreign currency. Eq. (4) can be re-written as follows:

$$b_t = d_t + (1 + i_{n,t})\left(\frac{1}{(1+\pi_t)(1+g_t)} \cdot \frac{B_{t-1}^d}{P_t Y_t} + \frac{E_{t-1}B_{t-1}^f}{P_{t-1}Y_{t-1}} \cdot \frac{E_t}{E_{t-1}} \cdot \frac{1}{(1+\pi_t)(1+g_t)}\right) \quad (5)$$

We can further write eq. (5) as follows:

$$b_t = d_t + (1 + i_{n,t})\left(\frac{b_{t-1}^d}{(1+\pi_t)(1+g_t)} + (1+\Delta e_t) \cdot \frac{b_{t-1}^f}{(1+\pi_t)(1+g_t)}\right), \quad (6)$$

where b_t^d is the domestic currency denominated debt-GDP ratio and b_t^f is the foreign currency denominated debt-GDP ratio expressed in domestic currency. We assume, for simplicity that

$$b_t^d = (1-\gamma)b_t \text{ and } b_t^f = \gamma b_t.$$

$$\Delta b_t = d_t + (i_{n,t} - \pi_t - g_t + \gamma \Delta e_t)b_{t-1} \quad (7)$$

We assume that $\tilde{y}_t^p = \tilde{y}_{t-1}^p + \eta_t$, where $\tilde{y}_t^p$ is the natural log of potential output. Letting the natural log of actual output to be $\tilde{y}_t$, we can write $g_t = \Delta y_t + \eta_t$, where $y_t = \tilde{y}_t - \tilde{y}_t^p$ is the output gap. We linearize eq. (7) to obtain:

$$\Delta b_t = d_t - \delta + b_0\left(i_{n,t} - i_0\right) - b_0(\pi_t - \pi_0) - b_0\Delta y_t + \gamma b_0 \Delta e_t + \alpha(b_{t-1} - b_0) + \xi_t, \quad (8)$$

where $\alpha = (i_0 - \pi_0 - g_0)$ and $\xi_t = -b_0\eta_t$ Lastly, we introduce a Taylor rule in eq. (8) through $i_{n,t}$ as follows:

$$i_{n,t} = i_0 + \phi_\pi(\pi_t - \pi_0) + \phi_y y_t + \phi_y \Delta q_t \quad (9)$$

Substituting $\left(i_{n,t} - i_0\right)$ from eq. (8) using eq. (9) we obtain:

$$\Delta b_t = d_t - \delta + b_0(\phi_\pi - 1)(\pi_t - \pi_0) + b_0\phi_y y_t + b_0\phi_y\Delta q_t - b_0\Delta y_t + \gamma b_0\Delta e_t + \alpha(b_{t-1} - b_0) + \xi_t \quad (10)$$

Eq. (10) states that, as long as $(\phi_\pi - 1) > 0$ the increase in inflation above target will cause the central bank to raise the interest rate with the result that the public debt-GDP will increase. Similarly, an increase in the other targets of monetary policy will tend to raise public debt-GDP ratio. To prevent public debt from rising permanently, government will have to adjust the deficit-GDP ratio. This brings us to the question of fiscal policy rules.

4.3.2. Fiscal policy rules

Our approach to fiscal rules uses the stationarity of the debt-GDP ratio as the benchmark. This means that, although empirical fiscal rules can differ in how they prescribe the degree of reaction of authorities to endogenous variables, they should nevertheless qualitatively follow the sign structure implied by benchmark rule. The benchmark fiscal policy rule therefore sets $\Delta b_t = 0$. This means that the debt-GDP ratio should be stationery if fiscal policy is sustainable. From eq. (10) this means that the primary deficit-GDP ratio is:

$$d_t^* = \delta - b_0(\phi_\pi - 1)(\pi_t - \pi_0) - b_0\phi_y y_t - b_0\phi_q\Delta q_t + b_0\Delta y_t - \gamma b_0\Delta e_t - \alpha(b_{t-1} - b_0) \quad (11)$$

This equation established a negative relationship between the fiscal deficit-ratio and the debt-ratio, which is the basis of the tests for fiscal sustainability (e.g., Bohn, 1998). In the case where there is deficit smoothing, we have:

$$d_t = \delta\lambda + (1-\lambda)d_{t-1} - \lambda b_0(\phi_\pi - 1)(\pi_t - \pi_0) - \lambda b_0\phi_y y_t - \lambda b_0\phi_q\Delta q_t + \lambda b_0\Delta y_t - \lambda\gamma b_0\Delta e_t - \lambda\alpha(b_{t-1} - b_0) \quad (12)$$

An alternative fiscal rule is to state eq. (11) in terms of the government spending ratio. To do this, we assume that:

$$\frac{T_t}{Y_t} = \frac{T_0}{Y_t} + \tau, \tag{13}$$

where T_0 denotes autonomous government revenue and τ is the average tax rate. A linearization of eq. (13) gives the following relationship:

$$\frac{T_t}{Y_t} = -\tau_y y_t, \tag{14}$$

where τ_y is the steady state ratio of autonomous revenue to output. The expenditure fiscal rule that is consistent with a stable debt-GDP ratio is therefore given by:

$$\frac{G_t}{Y_t} = \delta - b_0(\phi_\pi - 1)(\pi_t - \pi_0) + (\tau_y - b_0\phi_y)y_t - b_0\phi_q\Delta q_t + b_0\Delta y_t - \gamma b_0\Delta e_t - \alpha(b_{t-1} - b_0) \tag{15}$$

The only modification to the fiscal deficit rule is the co-efficient on the output gap, which is now ambiguous.

4.4. Empirical analysis

4.4.1. Estimating the basic fiscal rules

The data for this study is sourced largely from the FRED database. Primary deficits are sourced from the OECD database, whereas for South Africa it is sourced from the South African Reserve Bank. For the EU and New Zealand public debt is sourced from the IMF. The fiscal variables are annual, so we interpolated them using the quadratic approximation so that the quarterly estimates match the annual average. Inflation is based on annualized changes in the natural log of the consumer price index, while the output gap is calculated using the HP filter.

Table 4.1 presents unit root tests for the key variables: the primary deficit-GDP ratio, inflation and the public debt-GDP ratio. Generally, the results suggest that these variables are not stationary, except for Poland where only the debt-GDP ratio is not stationary. Bohn (1998) argues that if both the primary balance and public debt are not stationary, but the error term of their regression is stationary, then such a regression can be interpreted as a co-integrating relationship. Burger and

Marinkov (2012), also proceed under the assumption that the key variables are stationary, also citing Favero and Marcellino (2005). Given the results in Table 4.2, which generally support the view that the basic fiscal rules are co-integrating relationships, we will proceed to estimate the fiscal ratios in levels.

Table 4.1 Augmented Dickey-Fuller test

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	81'-19'	02'-21'	87'-19'	66'-19'	87'-19'	95'-19'
d_t	-2.42	-0.67	-2.80**	-1.43	-2.07	-2.82**	-0.46
	(0.13)	(0.45)	(0.06)	(0.56)	(0.26)	(0.06)	(0.89)
π_t	-2.08	-1.57	-2.30	-3.57*	-1.62	-1.50	-2.76**
	(0.25)	(0.50)	(0.17)	(0.01)	(0.47)	(0.53)	(0.07)
b_t	-0.16	-1.56	-0.16	2.10	1.39	1.08	-3.50
	(0.94)	(0.50)	(0.94)	(0.24)	(1.00)	(1.00)	0.01)
Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	10'-20'	96'-20'	08'-20'	95'-20'	00'-20'	80'-20'	98'-20'
d_t	0.88	-2.50	-0.50	-3.14*	-0.27	-3.45*	-1.18
	(0.78)	(0.12)	(0.88)	(0.03)	(0.92)	(0.01)	(0.68)
π_t	-1.99	-2.67**	-1.11	-4.10*	-1.56	-1.52	-2.46
	(0.29)	(0.08)	(0.71)	(0.00)	(0.50)	(0.52)	(0.13)
b_t	-0.73	-1.68	-0.56	-0.68	-0.34	0.53	-2.74**
	(0.83)	(0.44)	(0.87)	(0.85)	(0.91)	(0.99)	(0.07)

Note: Probability in parentheses.

Our estimation of the fiscal deficit rule begins with the most basic specification, where the central bank does not react to real exchange rate changes and there is no foreign currency denominated debt. This specification differs with the one by Bohn (1998, 2005) only because Bohn includes temporary government outlays while in our case, we have the inflation rate arising from the Taylor rule.

Table 4.1 reports the results. We find that almost all the economies display a counter-cyclical fiscal rule. The only exceptions in this case are South Africa, which exhibits a pro-cyclical fiscal rule, which supports the finding by Burger (2012) and the EU, a finding that is supported by Gootjes and de Haan (2022).

However, in terms of the reaction to the level of the debt ratio, we find mixed results. Bohn's requirement for a fiscally sustainable rule is that it should react negatively to the debt-GDP ratio, in line with the theoretically derived benchmark rules. Australia, the EU, UK and Norway violate this requirement of fiscal sustainability. Our finding regarding the EU does not support the one by

Afonso and Rault (2010), which is based on cointegration tests between government expenditures and revenues.

In relation to Australia, our findings are in line with Miyazaki (2014), who finds that although there is cointegration between government expenditures and revenues, revenues did not grow faster than expenditure. Among emerging markets, Brazil, Poland and South Korea violate the requirement for fiscal sustainability.

Of particular interest is the reaction of fiscal policy to inflation. If inflation rises above target, we expect that fiscal authorities will be constrained from running fiscal deficits in order to assist the central bank in the achievement of its target. We therefore expect a negative relationship between inflation and the fiscal deficit.

Once again, we find mixed results. Among advanced economies only Canada is significantly constrained by inflation targeting. The rest of the economies are not constrained to reduce deficits when inflation increases. Among emerging markets, Mexico, South Africa and Turkey exhibit a significant constraint imposed by inflation targeting on fiscal policy.

Table 4.2 Estimation of the basic deficit fiscal rule (eq. 11, $\phi_q = \gamma = 0$)

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	81'-19'	02'-21'	87'-19'	66'-19'	87'-19'	95'-19'
c	0.06*	0.39*	-0.06*	0.24*	0.17*	0.07*	0.13*
	(0.01)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
y_t	-0.22*	-0.67*	0.37*	-0.32**	-0.22*	-0.55**	-0.67*
	(0.11)	(0.13)	(0.10)	(0.18)	(0.07)	(0.30)	(0.21)
π_t	-0.00	-0.28*	0.42*	0.16*	-0.09	0.28*	0.23
	(0.07)	(0.13)	(0.20)	(0.05)	(0.06)	(0.14)	(0.50)
b_t	0.07*	-0.08*	0.04*	-0.04*	-0.05*	0.43*	0.04
	(0.01)	(0.03)	(0.02)	(0.02)	(0.01)	(0.11)	(0.05)
$\bar{R}^2$	0.57	0.75	0.78	0.15	0.52	0.34	0.12

Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	10'-20'	96'-20'	08'-20'	95'-20'	00'-20'	80'-20'	98'-20'
c	0.16*	0.13*	0.27*	0.03*	0.13*	0.01	0.06*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
y_t	-0.08**	-0.34*	-0.33*	-0.26*	-0.25**	0.28*	-0.22*
	(0.05)	(0.07)	(0.05)	(0.04)	(0.13)	(0.11)	(0.07)
π_t	0.10*	0.10	-0.30*	0.02	0.33**	-0.12*	-0.02*
	(0.04)	(0.09)	(0.06)	(0.02)	(0.17)	(0.05)	(0.01)
b_t	0.04*	-0.02*	-0.03*	0.07*	0.17*	-0.06*	-0.06**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.03)

$\bar{R}^2$	0.87	0.45	0.95	0.60	0.78	0.46	0.31

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Table 4.3 provides estimations of a basic expenditure fiscal rule along the lines of eq. (15). As can be observed, in both advanced and emerging market economies, fiscal policy does not react in a sustainable way to public debt. The exceptions are the Czech Republic and the US. In relation to the response to the output gap, fiscal policy is largely counter cyclical in line with the finding by Jalles (2022), except for the EU.

In emerging market economies South Africa and South Korea exhibit a-cyclical behaviour. For a number of advanced economies, fiscal authorities do not react to inflation whereas they do so in a number of emerging markets, especially Brazil, Czech Republic, Mexico and Turkey. Note that the results for South Africa are not comparable to those in Table 4.2 because of the change in the sample period due to data unavailability on government expenditure.

Table 4.3 Estimation of the basic expenditure fiscal rule (eq. 15, $\phi_q = \gamma = 0$)

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	80'-19'	97'-20'	90'-19'	66'-19'	80'-19'	84'-19'
c	0.37*	0.18*	-0.16*	0.18*	0.19*	0.15*	0.22*
	(0.00)	(0.01)	(0.04)	(0.01)	(0.01)	(0.00)	(0.01)
y_t	-0.49*	-0.28*	0.75*	-0.25*	-0.23*	-0.25*	-0.42*
	(0.10)	(0.07)	(0.23)	(0.12)	(0.06)	(0.09)	(0.12)
π_t	0.02	0.22*	1.14*	0.13	-0.12*	0.15*	-0.23*
	(0.07)	(0.06)	(0.42)	(0.12)	(0.04)	(0.03)	(0.11)
b_t	0.10*	0.03*	0.48*	-0.01	-0.04*	0.04*	-0.01
	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)	(0.04)	(0.02)
$\bar{R}^2$	0.74	0.68	0.79	0.18	0.71	0.77	0.25

Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	00'-20'	96'-20'	96'-20'	95'-20'	98'-20'	93'-20'	00'-20'
c	0.16*	0.22*	0.07*	0.19*	0.07*	0.03*	0.15*
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
y_t	-0.10*	-0.23*	-0.14*	-0.14*	0.04	0.01	-0.13*
	(0.02)	(0.05)	(0.04)	(0.03)	(0.04)	(0.01)	(0.02)
π_t	-0.07*	-0.22*	-0.13*	0.01	0.23*	0.00	-0.04*
	(0.03)	(0.08)	(0.01)	(0.01)	(0.08)	(0.01)	(0.01)
b_t	0.05*	-0.02*	0.09*	-0.01	0.20*	0.02*	-0.01
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
$\bar{R}^2$	0.77	0.47	0.94	0.36	0.93	0.94	0.66

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Our conclusion is that there are mixed results when it comes to fiscal sustainability, i.e., fiscal reactions to the debt-GDP ratio. In some economies, e.g., the US, there is consistent fiscal sustainability as found by Aldama and Creel (2019). In other economies we find that fiscal policy is not sustainable.

In terms of cyclicality, we find that almost all economies exhibit counter-cyclical fiscal policy, except for South Africa and the EU, in line with Jalles (2022). Interestingly, we find that in some of the economies in our sample, inflation is not a significant consideration of fiscal authorities, while in others it is. South Africa stands out among these economies: its fiscal policy is pro-cyclical, a result that is consistent with Burger and Maronkov (2012) and Amra et al. (2019). Fiscal authorities respond in a restrained manner to inflation in South Africa and fiscal policy is sustainable by the Bohn standard. While the EU shares some of these characteristics, fiscal authorities here do not respond to inflation.

4.4.2. The role of the exchange rate in basic fiscal rules

In order to test the robustness of the above results, we now include some of the variables that could be targets for policy. The first variable we consider is the real effective exchange rate. We expect that an appreciation of the real effective exchange rate would negatively affect net exports and thereby reduce aggregate demand. In response authorities may embark on expansionary fiscal policy in order to stabilize output. Alternatively, authorities may be concerned about the external balance, so that an appreciation of the real effective exchange rate cause a trade deficit, to authorities may respond by reducing the deficits. Therefore, we expect an ambiguous relationship between the changes in the real effective exchange rate and the primary deficit. A positive relationship implies that authorities are concerned about overall stability of aggregate demand whereas a negative relationship implies that authorities are concerned primarily about the external balance.

Table 4.4 shows that the inclusion of changes in the real exchange rate does not alter the results in section 4.1. In many of the advanced economies, except for Canada, inflation is not a constraint to fiscal policy. Czech Republic, Mexico and South Africa exhibit a negative and significant co-efficient on inflation, suggesting that inflation targeting is a consideration.

Although fiscal authorities appear not to react to changes in the real effective exchange, for those that significantly react, the results suggest that an appreciation of the real effective exchange rate causes authorities to tighten fiscal policy. This implies that authorities in these economies are primarily concerned about the external balance. In Brazil and the Czech Republic, authorities are concerned about the stability of the overall aggregate demand.

Table 4.4 Deficit rule with the real effective exchange rate

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	81'-19'	02'-20'	87'-19'	66'-19'	87'-19	95'-19'
c	0.06*	0.35*	-0.05*	0.24*	0.16*	0.07*	0.14*
	(0.00)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
y_t	-0.26*	-0.71*	0.36*	-0.26	-0.25*	-0.28	-0.74*
	(0.11)	(0.11)	(0.10)	(0.17)	(0.08)	(0.29)	(0.20)
π_t	0.03	-0.20**	0.40*	0.19*	-0.06	0.30*	-0.02
	(0.06)	(0.11)	(0.20)	(0.07)	(0.07)	(0.13)	(0.44)
b_t	0.06*	-0.03	0.04*	-0.03*	-0.05*	0.04*	0.03
	(0.01)	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)	(0.04)
Δq_t	-0.02	0.00	-0.02	-0.03	-0.03**	-0.11*	-0.12**
	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.01)	(0.07)
$\bar{R}^2$	0.61	0.80	0.78	0.20	0.52	0.36	0.26

Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	10'-20'	96'-20'	08'-20'	95'-20'	00'-20'	80'-20'	98'-20'
c	0.15*	0.14*	0.28*	0.03*	0.14*	0.01	0.06*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
y_t	-0.05	-0.41*	-0.11*	-0.27*	-0.28*	0.26*	-0.15*
	(0.05)	(0.07)	(0.04)	(0.04)	(0.11)	(0.11)	(0.07)
π_t	0.12*	-0.19**	-0.17*	0.02	0.27**	-0.11*	-0.00
	(0.05)	(0.10)	(0.07)	(0.02)	(0.14)	(0.04)	(0.01)
b_t	0.05*	-0.02*	-0.34*	0.07*	0.15*	-0.05*	-0.07*
	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.01)	(0.03)
Δq_t	0.01*	0.06*	-0.04*	0.00	-0.03*	0.00	-0.08*
	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
$\bar{R}^2$	0.87	0.46	0.92	0.61	0.89	0.40	0.38

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Table 4.5 report the results for the expenditure rule. The results still show that many of the economies follow a countercyclical rule. There also appears to be little consideration of fiscal sustainability since the expenditure ratio positively responds to the debt ratio in many of the

economies. Fiscal authorities in advanced economies are concerned about the external balance, as shown by the negative response of expenditure to real exchange rate appreciation.

In relation to inflation, advanced economy fiscal authorities, except for Norway, do not restrain spending when inflation increases. This contrasts with fiscal authorities in emerging markets, except for South Korea, where an increase in inflation causes fiscal authorities to restrain spending.

Table 4.5 Expenditure rule with the real effective exchange rate

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	80'-19'	97'-20'	90'-19'	66'-19'	80'-19'	95'-19'
c	0.37*	0.17*	-0.17*	0.18*	0.17*	0.16*	0.22*
	(0.00)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)
y_t	-0.48*	-0.31*	0.84*	-0.17	-0.27*	-0.24	-0.47*
	(0.12)	(0.11)	(0.21)	(0.13)	(0.07)	(0.19)	(0.11)
π_t	0.01	0.37*	1.19*	0.15	0.01	0.07	-0.24*
	(0.07)	(0.08)	(0.33)	(0.11)	(0.05)	(0.05)	(0.10)
b_t	0.10*	0.04*	0.49*	0.00	-0.03*	0.05*	-0.01
	(0.01)	(0.02)	(0.04)	(0.01)	(0.01)	(0.01)	(0.02)
Δq_t	-0.02**	-0.06*	0.10*	-0.02	-0.04*	-0.05**	-0.07**
	(0.01)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.04)
$\bar{R}^2$	0.73	0.47	0.84	0.18	0.51	0.42	0.32

Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	00'-20'	96'-20'	96'-20'	95'-20'	98'-20'	93'-20'	00'-20'
c	0.17*	0.21*	0.08*	0.18*	0.08*	0.03*	0.16*
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
y_t	-0.14*	-0.23*	-0.21*	-0.10*	0.07**	0.01	-0.15*
	(0.05)	(0.05)	(0.04)	(0.03)	(0.04)	(0.01)	(0.03)
π_t	-0.07*	-0.16*	-0.14*	0.01	0.18**	0.00	-0.04*
	(0.03)	(0.07)	(0.01)	(0.01)	(0.09)	(0.01)	(0.01)
b_t	0.04*	-0.01*	0.10*	0.00	0.19*	0.02*	-0.03**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)
Δq_t	0.00	0.03**	0.01	-0.01	-0.02*	0.00	-0.02**
	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
$\bar{R}^2$	0.63	0.51	0.89	0.48	0.94	0.94	0.51

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Although the results show a mixed response of fiscal authorities to variables that are targets in the Taylor rule from the deficit rule perspective, it appears that when considering expenditure rules, authorities in advanced economies do not restrain spending in the light of inflationary pressures. On the other hand, authorities in emerging market economies, tend to restrain spending in the face of inflationary pressures. A key finding that also emerges is that in making expenditure decisions,

authorities appear not to consider sustainability because of the positive response of expenditure to the debt-output ratio.

4.4.3. The growth effect in basic fiscal rules

Table 4.6 report the results for a deficit rule when growth effects are included in the specification, which gives the full specification of eq. (11). The results largely remain unaltered, except that now in Canada fiscal authorities do not tighten policy in the face of inflationary pressures. Czech Republic and South Africa consistently exhibit a negative and significant co-efficient on inflation, suggesting that inflation remains a robust constraint to fiscal policy in these economies.

While in the Czech Republic authorities are concerned about the stability of overall aggregate demand in response to real effective exchange rate shocks, in South Africa fiscal authorities are neither concerned about the stability of aggregate demand in response to real effective exchange rate shocks, nor are they concerned about the external balance. Note that eq. (11) suggests that fiscal deficits should positively respond to economic growth, there is no economy where this is the case in a significant way, where it is significant, fiscal authorities respond negatively.

Table 4.6 Deficit rule with the real effective exchange rate and economic growth

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	81'-19'	02'-20'	90'-19'	66'-19'	87'-19'	95'-19'
c	0.06*	0.35*	-0.07*	0.24*	0.16*	0.07*	0.13*
	(0.00)	(0.04)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
y_t	-0.23	-0.72*	0.40*	-0.37	-0.15	-0.25	-1.01*
	(0.15)	(0.30)	(0.09)	(0.28)	(0.11)	(0.32)	(0.26)
π_t	0.01	0.08	0.47*	0.17	-0.09	0.29**	0.39
	(0.08)	(0.23)	(0.22)	(0.20)	(0.08)	(0.16)	(0.56)
b_t	0.07*	-0.08	0.06*	-0.01*	-0.05*	0.04*	0.04
	(0.01)	(0.04)	(0.02)	(0.03)	(0.01)	(0.01)	(0.04)
Δq_t	-0.02	-0.08	-0.01	-0.01	-0.04**	-0.11*	-0.08
	(0.01)	(0.06)	(0.01)	(0.04)	(0.01)	(0.04)	(0.07)
Δy_t	-0.02	-0.06	-0.23*	-0.05	-0.13	-0.01	0.37
	(0.12)	(0.19)	(0.09)	(0.16)	(0.10)	(0.28)	(0.23)
$\bar{R}^2$	0.58	0.26	0.82	0.21	0.52	0.34	0.18
Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	10'-20'	97'-20'	96'-20'	96'-20'	00'-20'	80'-20'	00'-20'
c	0.14*	0.15*	0.17*	0.03*	0.14*	0.01	0.06*
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.02)
y_t	0.00	-0.20*	-0.80*	-0.13**	0.01	0.53*	-0.10
	(0.04)	(0.06)	(0.16)	(0.07)	(0.21)	(0.02)	(0.08)
π_t	0.22*	-0.29*	-0.01	0.01	0.13	-0.14*	-0.02
	(0.07)	(0.10)	(0.04)	(0.02)	(0.22)	(0.05)	(0.01)

b_t	0.06*	-0.02*	-0.52*	0.07*	0.15*	-0.05*	-0.07*
	(0.01)	(0.01)	(0.05)	(0.02)	(0.01)	(0.01)	(0.03)
Δq_t	0.00	0.05*	-0.04	0.00	-0.04*	0.01	-0.07*
	(0.01)	(0.02)	(0.04)	(0.01)	(0.02)	(0.01)	(0.03)
Δy_t	0.06	-0.22*	0.20	-0.11**	-0.09	-0.33*	-0.06
	(0.06)	(0.08)	(0.14)	(0.06)	(0.12)	(0.12)	(0.06)
$\bar{R}^2$	0.85	0.52	0.75	0.57	0.82	0.43	0.44

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Table 4.7 is the expenditure version of the rule. It shows that still many of the advanced economies do not restrain their spending in the face of inflation pressures, their spending is countercyclical and there is generally no consideration of debt sustainability, except for the US. The results for emerging markets also remain unchanged—generally in these economies fiscal authorities restrain spending in the face of inflation pressure and there is no systematic consideration of debt sustainability.

Table 4.7 Expenditure rule with the real effective exchange rate and economic growth

Advanced markets							
	Aus.	Can.	EU.	NZ	US	UK	Norway
Sample	89'-19'	80'-19'	97'-20'	90'-19'	66'-19'	80'-19'	84'-19'
c	0.37*	0.16*	-0.16*	0.18*	0.17*	0.16*	0.22*
	(0.00)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)
y_t	-0.43*	-0.44*	1.09*	-0.21	-0.27*	-0.24	-0.30**
	(0.12)	(0.16)	(0.21)	(0.17)	(0.08)	(0.22)	(0.16)
π_t	-0.01	0.41*	0.83*	0.14	0.01	0.07	-0.29*
	(0.06)	(0.08)	(0.36)	(0.12)	(0.06)	(0.05)	(0.10)
b_t	0.10*	0.04*	0.48*	0.00	-0.03*	0.05*	-0.01
	(0.01)	(0.02)	(0.04)	(0.01)	(0.01)	(0.01)	(0.02)
Δq_t	-0.01	-0.06*	0.11*	-0.02	-0.04*	-0.05**	-0.06
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.04)
Δy_t	-0.04	0.19**	-0.33**	0.03	-0.01	0.00	-0.20
	(0.10)	(0.11)	(0.19)	(0.09)	(0.07)	(0.14)	(0.13)
$\bar{R}^2$	0.77	0.50	0.85	0.18	0.51	0.42	0.30
Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	00'-20'	97'-20'	96'-20'	96'-20'	98'-20'	93'-20'	00'-20'
c	0.16*	0.22*	0.08*	0.19*	0.08*	0.03*	0.16*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
y_t	-0.06	-0.15*	-0.23*	-0.08**	0.08	0.02	-0.17*
	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)	(0.02)	(0.04)
π_t	-0.06**	-0.26*	-0.15*	0.00	0.17**	0.00	-0.04*
	(0.03)	(0.08)	(0.01)	(0.02)	(0.10)	(0.01)	(0.01)
b_t	0.05*	-0.01*	0.09*	-0.01	0.19*	0.02*	-0.03**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)
Δq_t	0.00	0.03*	0.01	-0.01	-0.02*	0.00	-0.02**
	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Δy_t	-0.05	-0.16*	0.06**	-0.06	0.00	-0.02	0.02
	(0.04)	(0.06)	(0.03)	(0.05)	(0.03)	(0.01)	(0.03)

$\bar{R}^2$	0.67	0.48	0.88	0.41	0.95	0.94	0.51

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

Lastly, many of the emerging markets have dollarized foreign debt. Therefore, besides a response to real exchange rate changes brought about by the interaction with monetary policy, fiscal authorities may react to nominal exchange rate changes. Table 4.8 shows the results for a deficit rule, considering the possible effects of debt dollarization. The results largely show that fiscal authorities do not tighten policy in the face of depreciation.

Table 4.8 Deficit rule with dollarized debt

Emerging markets							
	Bra.	Czech	Mexico	Poland	S. Kor.	SA	Turkey
Sample	80'-20'	97'-19'	96'-20'	96'-20'	00'-20'	80'-20'	01'-20'
c	0.01	0.14*	0.18*	0.03*	0.15*	0.01	0.06*
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.02)
y_t	0.54*	-0.23*	-0.62*	-0.18*	-0.10	0.54*	-0.06
	(0.19)	(0.07)	(0.18)	(0.04)	(0.12)	(0.19)	(0.08)
π_t	-0.11*	-0.12	0.08	-0.01	0.01	-0.11*	-0.03
	(0.05)	(0.09)	(0.06)	(0.03)	(0.22)	(0.05)	(0.03)
b_t	-0.05*	-0.02*	-0.54*	0.07*	0.14*	-0.05*	-0.07*
	(0.01)	(0.00)	(0.06)	(0.02)	(0.01)	(0.01)	(0.04)
Δq_t	-0.03	-0.03	-0.13	0.02*	-0.09*	-0.03	-0.04
	(0.04)	(0.04)	(0.09)	(0.01)	(0.03)	(0.04)	(0.04)
Δx_t	-0.03	-0.04*	-0.09	0.02*	-0.04	-0.03	0.03
	(0.03)	(0.02)	(0.08)	(0.01)	(0.03)	(0.03)	(0.02)
Δy_t	-0.29*	-0.11	0.04	-0.13*	-0.11**	-0.29*	-0.08*
	(0.11)	(0.07)	(0.10)	(0.03)	(0.07)	(0.11)	(0.04)
$\bar{R}^2$	0.40	0.57	0.72	0.70	0.82	0.40	044

Note: HAC std. errors in parentheses, *significant at 5%, ** significant at 10%.

The results above can be summarized as follows. Consideration for debt sustainability is not uniform across economies. A substantial number of economies do not meet Bohn's (1998) principle in that their deficits are negatively related to the debt ratios. The violation of Bohn's principle appears to be more severe when expenditure rules are considered.

Secondly, although many economies exhibit counter-cyclical fiscal policies, there are some who are consistently pro-cyclical—South Africa and the EU are cases in point. Thirdly, there is no systematic response to real exchange rate depreciation across economies. Lastly, fiscal authorities in advanced economies tend not to restrain policy in the face of inflation pressures.

However, fiscal authorities in emerging markets they tend to restrain fiscal policy in the face of inflation pressure. The implication of this behaviour is that the monetary policy mandate of central banks to restrain inflation within target also finds expression in how fiscal policy is set in emerging market economies.

4.5. Conclusion

Fiscal authorities are expected to support central banks in their mandates. This is the essence of monetary policy dominance over fiscal policy. Accordingly, fiscal authorities are expected to respond to the targets of monetary policy in a way that supports central banks. In this regard, the quotes by Kumhof et al. (2010) from Sims (2005) and Woodford (2001) are relevant. Woodford (2001) states that, "A central bank charged with maintaining price stability cannot be indifferent as to how fiscal policy is determined".

Sims (2005) says, "Ideally, where fiscal policy that undermines central bank control of inflation is a real possibility, this should be accounted for, discussed in inflation reports, and reflected in central bank projections". These statements emerge out of findings that fiscal authorities that do not use fiscal instruments to maintain solvency make it difficult, if not impossible, for central banks to achieve price stability.

In this chapter we investigated whether the adoption of inflation targeting in particular, has affected the setting of fiscal policy. We find that, save for South Africa and the EU, overall fiscal authorities set fiscal policy in a counter-cyclical manner. This assists in stabilizing inflation. Secondly, fiscal authorities in advanced economies tend not to respond to inflation and if they do, they fiscal deficits positively react to inflation. In emerging markets, we find the opposite result.

Fiscal authorities here tend to react to inflation in a negative way. This suggests that in emerging markets, a commitment to inflation targeting does constrain fiscal authorities. Thirdly, we do not find a uniform adherence to fiscal sustainability as expressed by Bohn's (1998) principle across economies.

We suspect that the lack of response to inflation in advanced economies could be explained by the increased anchoring of inflation expectations. Indeed, Mishkin (2007), Williams (2009), Watson (2014), Blanchard (2015) and Ball and Mazumder (2018) find that there has been increased anchoring of inflation expectations, at least in the US. Our argument is that with anchored inflation

expectations on the inflation target, there is no need for fiscal authorities to react to inflation since "price stability" would have been achieved.

Logically, if this is correct, our results imply that emerging market economies may have to go some way towards anchoring inflation expectations. If inflation expectations are anchored in emerging markets, then it would mean that fiscal authorities are overly conservative in their approach to inflation control.

The policy implications of our results are as follows. Firstly, fiscal authorities should maintain their counter-cyclical stances. This aligns with price stability concerns even if Phillips curves have flattened. Secondly, there may be a need to consistently monitor and enhance the degree of inflation expectations anchoring.

Kumhof et al. (2010) argue that this can be achieved by following the Taylor principle. We argue that such a policy prescription assumes that agents have very high capacity to process information, to the extent that they can link the Taylor principle to inflation stability. We would encourage policymakers to find ways to stabilize core inflation through carefully designed industrial policy interventions.

By so doing, upward pressure on inflation would be mitigated and fiscal policy may have leeway to support output stability. Lastly, we do not find uniform adherence to Bohn's principle of fiscal sustainability, this could pose a challenge for fiscal authorities in the future.

5. Conclusion

In this research we investigated the effect of IT on macroeconomic performance. The research proceeded from the premise that there is no consensus on the effects of IT on macroeconomic performance.

In Chapter 2, we investigated the effect of IT on macroeconomic performance. Specifically, in this chapter we developed a measure of the degree of IT that is closely related to the degree of policy activism that was proposed by Leeper (1991). We then used this measure to investigate the effect of IT on bond yields, the growth rate and the inflation rate. In order to conduct the study, we developed a measure of the degree of IT that is based on the relative strength of reaction of the central bank to inflation.

Building on the theoretical models of IT, especially the seminal papers by Svensson (1997, 1999), we measure the degree of IT by the ratio of the reaction coefficient to inflation to the sum of the reaction coefficients in the Taylor rule. The higher this ratio, the higher the degree of inflation targeting. Using recursive estimates, we managed to obtain time-variation in the Taylor rule coefficients, which then allows us to derive the degree of IT.

Our findings are as follows. In terms of its effects on bond yields, IT tends to decrease bond yields, and therefore IT improves bond market performance. This finding is in line with O'Sullivan and Tomljanovich (2012), who found that IT leads to a drop in conditional volatility in bond markets. The implications are that IT tends to improve the performance of financial markets by decreasing the discount factor in asset pricing and thereby increasing asset prices.

This is also in line with the finding by Dridi and Boughrara (2023), that IT helps contain stock market volatility. In terms of economic growth, IT produces mixed results for advanced economies. In some economies IT positively affects economic growth while in others it tends to reduce economic growth. For emerging markets, IT tends to reduce economic growth. In terms of inflation performance, there are also mixed results.

The implications of these findings suggest that IT is good for the performance of financial markets. However, the financial market benefits of IT do not get systematically transmitted to real economic performance. For instance, by anchoring inflation expectations at a low level, we expected that the resultant decline in bond yields would increase economic growth.

We expected that the resultant low inflation expectations are supposed to decrease the inflation rate, so that IT has a negative effect on inflation as well. In the light of the absence of these transmissions, we postulate that there could be some disconnect between financial markets and real economic activity in some of the economies that are under consideration. This disconnect could be due to the dominant role played by retained earnings in financing real investment.

Secondly, the disconnect could be due to limited financial market access by many households who account for a large fraction of aggregate consumption. Blinder (1997), Nelson (2001) and more recently Haque and Magnusson (2023) among others, noted that the real interest rate has limited effect of aggregate expenditure, one of the key factors that may explain the disconnect.

In Chapter 3, we derived a simple growth model in which inflation is nonlinearly related to economic growth and by extension the unemployment rate. In this model, the reaction of the central bank to inflation changes with the level of inflation and the risk premium associated with real investment is endogenously determined by the level of inflation. This model shows that movements in the inflation-growth relationship are determined largely by fluctuations in the average rate of profit in the economy. We estimated this model for advanced and emerging market economies.

Our findings are that the nonlinear relationship between inflation and economic activity is heterogeneous across economies. There are some advanced economies that have slightly sacrificed economic growth in order to achieve a low inflation target. We find that this sacrifice is widespread among emerging market economies. The growth sacrifice ranges from 0.5 percentage points to 3 percentage points across both advanced and emerging markets.

While for some economies this may appear not significant, the cumulative output loss may be large. Turning to the unemployment rate, we again find widespread sacrifice among emerging markets compared to advanced economies. The sacrifice ranges from 0.5 percentage points of excess unemployment rate to almost 4.5 percentage points.

Cumulatively and in absolute terms, this may imply that a significant number of people are kept out of employment in order to maintain a lower than optimal inflation target. In South Africa, where the highest sacrifice is observed, and where the unemployment rate is the highest in our sample of countries, this could amount to more than 960 000 people.

The policy implications of these findings are that policymakers need to consider revising their inflation targets by taking a long-term view of the data. Keeping people out of gainful employment in order to maintain a low inflation target poses serious normative questions. As a first step, detailed studies need to be conducted to ascertain the degree of alignment of inflation targets with optimal levels.

Secondly, the sensitivity of the degree of central bank credibility needs to be estimated in order to lay the foundation to align targets with optimality in a least cost manner. Thirdly communication of shifts in the way the targets are set are important and estimates of time-varying optimal levels of inflation need to made public so that agents understand the interest rate adjustment process.

In Chapter 4 we investigated whether the adoption of inflation targeting, has affected the setting of fiscal policy. We find that, save for South Africa and the EU, overall fiscal authorities set fiscal policy in a counter-cyclical manner. This assists in stabilizing inflation.

Secondly, fiscal authorities in advanced economies tend not to respond to inflation and if they do, their fiscal deficits positively react to inflation. In emerging markets, we find the opposite result. Fiscal authorities here tend to react to inflation in a negative way. This suggests that in emerging markets, a commitment to inflation targeting does constrain fiscal authorities. Thirdly, we do not find a uniform adherence to fiscal sustainability as expressed by Bohn's (1998) principle across economies.

We suspect that the lack of response to inflation in advanced economies could be explained by the increased anchoring of inflation expectations. Indeed, Mishkin (2007), Williams (2009), Watson (2014), Blanchard (2015) and Ball and Mazumder (2018) find that there has been increased anchoring of inflation expectations, at least in the US. Our argument is that with anchored inflation expectations on the inflation target, there is no need for fiscal authorities to react to inflation since "price stability" would have been achieved.

Logically, if this is correct, our results imply that emerging market economies may have to go some way towards anchoring inflation expectations. If inflation expectations are anchored in emerging markets, then it would mean that fiscal authorities are overly conservative in their approach to inflation control.

The policy implications of our results are as follows. Firstly, fiscal authorities should maintain their counter-cyclical stances. This aligns with price stability concerns even if Phillips curves have flattened. Secondly, there may be a need to consistently monitor and enhance the degree of inflation expectations anchoring. Kumhof et al. (2010) argue that this can be achieved by following the Taylor principle.

We argue that such a policy prescription assumes that agents have very high capacity to process information, to the extent that they can link the Taylor principle to inflation stability. Rather we would encourage policymakers to find ways to stabilize core inflation through carefully designed industrial policy interventions. By so doing, upward pressure on inflation would be mitigated and fiscal policy may have leeway to support output stability. Lastly, we do not find uniform adherence to Bohn's principle of fiscal sustainability, this could pose a challenge for fiscal authorities in the future.

What comes out from our research is that economies are not the same, and have different challenges, especially between the developed and emerging economies. However, countries continue to adopt inflation targeting at very low levels despite different structures of their economies. They are in different levels of development, especially the financial services sector.

Countries experience different levels of economic growth and unemployment rates. Poverty levels are also different. We observed that the sacrifice, in terms of economic growth and employment, especially in many of the emerging countries under consideration, is proportionally greater than the developed economies.

We therefore argue that in these economies, the blanket approach of, "one size fits all", in imposing low levels of inflation as targets of monetary policy is harmful to economic and social welfare. This is consistent with Levin et al. (2004), who found that the adoption of IT is not associated with a fall in inflation expectations over longer horizons.

We therefore propose that each country conducts detailed research to establish an optimal level with least sacrifice ratios. This will also assist to deal with the concern raised by Krugman (2014) when he argues that "there is evidence that, this level, 2 percent, was not arrived at scientifically, except to say it made both economic and political sense".

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