Inflation Targeting or Nominal GDP Targeting: the Way Forward for the Developed Central Banks

Seyitan Mazino Teidi

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Prof. Dr. Serhan Çiftçioğlu
Acting Director

I certify that this thesis satisfies the requirement as a thesis for the degree of Master of Science in Economics.

Prof. Dr. Mehmet Balcılar
Chair, Department of Economics

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Economics

Asst. Prof. Dr. Kemal Bağzıbağlı
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Hasan Güngör
2. Assoc. Prof. Dr. Gülcay Tuna Payaslıoğlu
3. Asst. Prof. Dr. Kemal Bağzıbağlı

ABSTRACT

One of the after-effects of the Great Recession 2007-2009, asides slower recovery of economies, is the renaissance of the debate over monetary policy frameworks. In recent times, monetarists like Scott Sumner propose Nominal Gross Domestic Product (NGDP) Targeting as an alternative to the existing framework, i.e. inflation targeting. Automatically, researchers like ourselves hazard to question whether there is truly a need for an alternative framework, and whether or not a change in monetary policy framework may avoid another possible reoccurrence of future Recessions

The present study provides empirical comparisons for both frameworks. We evaluate and compare the stability power of monetary policy with respect to prices and output under both targeting regimes after the economy is exposed to an external shock, in particular, an oil shock. We make our analysis for a sample of developed economies within the domain of an Interacted Panel Vector Auto regression (IPVAR) technique. We identify how macroeconomic conditions vary with monetary policy responses when operating under different policy frameworks.

Our findings suggest that the stability performance of monetary policy is stronger when operating under NGDP targeting in and out of a recession.

Keywords: Monetary policy, Nominal Gross Domestic Product (NGDP) Targeting, Inflation Targeting, developed economies, Interacted Panel Vector Auto regression (IPVAR), recession, oil shock

ÖZ

2007-2009 Büyük Durgunluk artçı etkilerinden biri, ekonomilerin yavaş iyileşmesinden ayrı, para politikası çerçeveleri hakkında yapılan tartışmaların yeniden canlanmasıdır. Son zamanlarda, Scott Sumner gibi monetaristler mevcut enflasyon hedeflemesi çerçevesine bir alternatif olarak Nominal Gayri Safi Yurtiçi Hasıla (NGDP) Hedeflemesini önermektedirler. Otomatik olarak, bizim gibi araştırmacılar alternatif bir çerçeveye gerçekten ihtiyaç olup olmadığını ve para politikası çerçevesindeki bir değişikliğin durgunlukların ileride yeniden meydana gelmesini önleyip önleyemeyeceni sorgulamaktadır.

Bu çalışma, her iki çerçeve için ampirik karşılaştırmalar sağlamaktadır. Biz bu çalışmada, ekonominin özellikle petrol şoku gibi dışsal bir şoka maruz kalması durumunda her iki hedefleme rejimi altında para politikasının fiyatlar ve çıktı üzerinde istikrar sağlama gücünü değerlendirip karşılaştırmaktayız. Analizimizi Etkileşim Panel Vektör Otoregresyon (IPVAR) tekniğini kullanarak bir grup gelişmiş ekonomiler için uygulamaktayız. Makroekonomik koşulların farklı politika çerçeveleri altında çalışan para politikası tepkileri sonucu nasıl değiştiğini tespit etmekteyiz.

Bulgularımız para politikasının NGDP hedeflemesi altında çalışırken istikrar sağlama performansının durgunluk ve normal zamanlarda daha güçlü olduğunu göstermektedir.

Anahtar Kelimeler: Para politikası, Nominal Gayri Safi Yurtiçi Hasıla (NGDP) Hedeflemesi, enflasyon hedeflemesi, gelişmiş ekonomiler, Etkileşim Panel Vektör Otoregresyon (IPVAR), durgunluk, petrol şoku

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LIST OF ABBREVIATIONS

AD	Aggregate demand
ADF	Augmented Dickey-Fuller
AS	Aggregate supply
CBRT	Central bank of the Republic of Turkey
CPI	Consumer Price Index
DSGE	Dynamic stochastic general equilibrium
EIA	Energy Information Administration
Fed	Federal Reserve
GDP	Gross Domestic Product
IPS	Im, Peseran and Shin
IPVAR	Interacted Panel Vector Auto regression
LRAS	Long-Run Aggregate supply
NBER	National Bureau of Economic Research
NGDP	Nominal Gross Domestic Product
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
OPEC	Organization of Petroleum Exporting Countries
PP	Phillips-Perron
RGDP	Real Gross Domestic Product
SRAS	Short-Run Aggregate supply
U.S.	United States
VAR	Vector Auto regression

Chapter 1

INTRODUCTION

1.1 Background of study

“Trial and error”. This theme highlights the struggles of many central banks. Even historically, it has been a case of learning from experience for improving monetary policy conduct (Sumner, 2012). Transitions from one regime to another have been the main characteristics of monetary strategies thus far. From the gold standard to Bretton Woods followed by monetary targeting, we are now in the inflation-targeting era. However, central banks remain on a constant search for a better conduct of monetary policy. There remains an ongoing debate on the best way to conduct monetary policy, not only in emerging economies, but also in developed countries.

With the struggles of central banks amidst the Great Recession of 2007-2009, and the relatively slow recovery experienced by most advanced economies, one begs to question the accountability and effectiveness of the existing monetary framework, i.e. inflation targeting. Automatically, researchers raise the question whether there is a need for an alternative framework to be implemented by the central banks in order to better combat the shocks to the economies. The answer to this question is the motivation for a lot of recent studies thus far, including ours.

Many economists now advocate for an alternative monetary policy strategy of nominal gross domestic product (NGDP) targeting[1] (Sumner, 2011; Sumner, 2012; Eagle, 2012; amongst others). The argument is that, this framework is best for the economy to have a faster recovery from recessions. Another argument is based on the apparent advantage of the NGDP targeting in the face of adverse supply shocks, e.g. oil shock causing the oil prices to rise.

While all these findings and advocacies are directed towards developing nations (Bhandari and Frankel, 2014), and the Federal Reserve (Fed) we, in our study, broaden our horizon from the perspective of advanced economies[2]. Therefore, for our study we examine how cogent these arguments are. That is to say, we raise the research question that “which framework is best to achieve the goals of monetary policy with respect to advanced economies in the environment of adverse supply shocks; the existing inflation targeting or the alternative NGDP targeting, as postulated by the current literature?

1.2 Statement of the problem.

Since the Great Recession, there has been a deluge of studies that attempt to uncover the appropriate framework for monetary policy conduct. These studies have done so, to a large extent, by making comparisons between inflation targeting and NGDP targeting (Sumner 2011; 2012). Most of these studies have been both theoretical and empirical, with a paucity of studies with respect to the latter. Also, the few empirical studies done are directed towards the U.S. (McCallum, 2011) and developing nations

[1] We refer to NGDP growth targeting throughout the study, although, we continue with NGDP targeting for brevity.

[2] When we say advanced economies, we refer to a panel of advanced economies and not just the United States.

(Bhandari and Frankel, 2015). Yet, to our knowledge, we find no study done with respect to advanced economies other than the U.S. We find this remiss towards advanced economies troubling given their influence on the global market and their subservient role in the contagion of the recent global financial crisis.

1.3 Objective of the study

The main objective of this study is to provide theoretical and empirical bases for comparison between both inflation targeting and NGDP targeting frameworks. In doing so, we hope to evaluate whether there is substance to the recent fuss over the need for an alternative framework, and by extension, shed some light unto what the way forward is with respect to developed central banks and monetary policy.

Our study adopts the interacted panel vector auto regression (IPVAR) technique pioneered by Towbin and Weber (2013). Using the IPVAR technique, our study simulates a scenario of the effect of an adverse oil shock[3] on the economy, and tries to investigate how the impact on the economy changes with respect to the expected monetary response under an inflation targeting regime, and a counter factual response according to the demands of NGDP targeting. In particular, we use our results for an empirical comparison between the inflation targeting and the NGDP targeting strategies with respect to stability on prices and output.

The present study is organized onwards as follows: Chapter 2 comprises a literature review on the analysis and debate of both frameworks. Chapter 3 encapsulates our data

[3] We define the adverse oil shock as a 10% unexpected increase in crude oil Brent price.

and the methodology. Chapter 4 discusses our estimation and results. Chapter 5 concludes our findings with discussions and policy recommendation.

Chapter 2

LITERATURE REVIEW

To be able to compare and contrast inflation targeting and NGDP targeting, we first attempt to give a broad outline of how both frameworks operate. We carefully, following the literature, highlight their prerequisites, design and mode of operation. The main aim of this chapter is to have an objective outlook on our evaluation of recent literature arguments between these frameworks.

2.1 What is Inflation Targeting?

The monetary policy strategy of explicit inflation targeting was pioneered by New Zealand in 1990. Canada later followed suit in 1991. Central banks of various countries, from the experiences of the aboriginals in inflation targeting, later adopted this framework for the governing of their monetary policy actions. Countries like Australia, Chile, Brazil, United Kingdom, New Zealand, Peru, Czech Republic, South Africa, Sweden, Thailand, Israel, South Korea, Mexico, Colombia, Poland, Canada, Switzerland; all were recorded as inflation targeters as at 2000 (Mishkin and Schimdt-Hebbel, 2001). More recently, Norway, Iceland, Hungary, The Philippines and Turkey have joined the league of inflation (See Table A.1 in Appendix A). Germany and Finland were inflation targeters in the 1990s. As a requirement for the adoption of the euro in 1999, both countries had to forgo the framework when giving up their respective monetary policies (Mishkin and Schmidt-Hebbel, 2001).

As highlighted by Bernanke and Mishkin (1997), the main aim of the inflation targeting framework is to establish a transparent, accountable and credible way for conducting monetary policy. Transparency, accountability and credibility are asides another key goal of price stability. Judging from the experiences so far, the execution and adoption of the framework differs across each country (Bernanke et al., 1999). Bernanke and Mishkin (1997) note various attempts to permit for the framework to achieve dual mandates of, for example, full employment and price stability. They also argue that inflation targeting should be viewed as a framework not a rule, thereby a framework of constrained discretion. The reverse is a misconception of the idea of inflation targeting, as noted by Bernanke and Mishkin (1997). Conversely, the likes of Milton Friedman see inflation targeting as more of a dogmatic rule.

Given the lags for the effect of monetary policy on inflation rate,[4] inflation targeting as a framework follows the forward guiding principle (Bogdanski et al., 2000). Bogdanski et al. (2000) argue that inflation targeting is inherently and implicitly de facto "inflation forecast targeting".

From the international experiences, let us outline what has been considered as the pillars for inflation targeting. Firstly, the adoption of inflation targeting as a framework must signify the intent of making price stability the overriding goal of monetary policy (Mishkin, 2000). Secondly, the adoption of inflation targeting as a framework demands independence of the central banks. The central banks are to be recognized as independent of the interventions of the governments, which would mostly have

[4] Ball (1999) and Svensson (1999) show the effect of monetary policy on both output and inflation. They highlight the differences in lags. See also Rudebusch (2002)

budgetary perspectives leading to monetary expansions and indirectly, inflationary pressures in the economy. Monetary policy actions are solely the responsibility of the central banks. They are to have absolute control over policy instrument without government interventions (Mishkin, 2000).

Besides having independence over monetary policy actions and instruments, central banks have to be transparent in the conduct of their monetary policies. The monetary policy has to be communicated to the general public. The central bank must be explicit in its plans, present and future. It should be able to state clearly its abilities and limitations (Bogdanski et al., 2000). It is a common ground of knowledge of monetary policy that, monetary policy conducted by the central banks can only establish price stability in the long run (Bernanke and Mishkin, 1997). As emphasized by Bogdanski et al. (2000, p. 27), “what [the central bank] cannot do is to raise economic growth through monetary expansion”. It will be prudent, on the side of the central banks, to also communicate with the public the presence of exogenous shocks and their result on forecasted inflation targets. A perfect example of such is the Deutsche Bundesbank. The Bundesbank announced clearly to the public, what it termed “unavoidable inflation”, after the 1979 oil shock (Bernanke and Mishkin, 1997).

Another key requirement for adopting inflation targeting framework is that, it mandates the explicit communication of the medium to long-term targets of inflation rates (See Table A.2 in Appendix A). The targets can either be in the form of ranges or point. The target may be set by either the central bank or/and the government[5]. In

[5] For example, Turkey’s inflation target of 5% with a corridor of +/- 2% is jointly set by the Central Bank of the Republic of Turkey, and the Turkish government. Also, the inflation target of 3% with a corridor of +/- 1% for The Philippines is solely set by the government.

addition, the measurement of the inflation target must be chosen by general consensus amongst the policy makers. The measurement must, and should be suitable as the best medium for calculating inflation. This measurement should also be easy to comprehend by the public. From experiences of inflation targeters, the preferred choice of measurement is the consumer price index (CPI, henceforth). Inflation targeting also necessitates explicit declarations of horizons for achieving the proposed targets. Mishkin (2000) argues that the success of inflation targeting hinges on the knowledge that overshooting and undershooting targets are equally dangerous. The central banks are expected to maintain credibility via monthly or quarterly reports of their activities.

Making an auspicious start to the adoption of inflation targeting hinges on a few prerequisites. The success of an inflation targeting framework is not only down to the effectiveness of the monetary policy. A sound financial system and cooperative fiscal policies or fiscal restraint, provide a good foundation for successful inflation targeting[6]. Mishkin (2000) emphasizes the regulation of the financial sectors, and the absence of huge fiscal deficits, for the success of inflation targeting in Chile. Conversely, Bogdanski et al., (2000) refuse to claim Brazil’s adoption of inflation targeting as a success, due to its grapples with large fiscal deficits.

2.2 What is NGDP targeting?

It is important to note that taking into consideration the lack of international experiences of NGDP targeting, our understanding of how NGDP targeting is expected

[6] See Bogdanski et al., 2000; Bernanke et al., 1999; and Mishkin, 2000 for the roles played by the government in order to achieve successful implementation of inflation targeting.

to operate is limited to the postulates of the literature. Therefore, the rest of this subsection presents the literature review of the NGDP targeting strategy.

NGDP targeting is not a new phenomenon as most would think. The idea of nominal income targeting has been in existence since the late 1970s and early 1980s. Aboriginal cases for this framework were made by the likes of Meade (1978), Tobin (1980), Bean (1981) and Hall (1984). Renewed interest in NGDP targeting began in the 1990s with McCallum (1997) and McCallum and Nelson (1999). Since the 1990s, the cases for NGDP targeting cooled off given the relative success stories of inflation targeting from the experiences of inflation targeters.

However, following the aftermath of the Great Recession, prominent economists like McCallum (2011), Eagle (2012), Sumner (2012), Woodford (2012), Frankel (2014), Bhandari and Frankel (2015), amongst others, have resurrected the interest in NGDP targeting once again. In recent times, one of the key motivations for this teeming interest is the supposed superiority of NGDP targeting in the face of adverse supply shocks (Bhandari and Frankel, 2015; Frankel, 2014). Bhandari and Frankel (2015) conclude that in India, considering the unrestrained deluge of supply shocks, NGDP targeting produces a smaller quadratic loss function value, as opposed to inflation targeting. Another key motivation is its supposititious ability to get economies to their pre-crisis state (Hassan and Loewald, 2013; Sumner, 2012; McCallum, 2011). Sumner (2012, p. 14) claims that "... we don't have data from actual NGDP targeters during the Great Recession. But we know that NGDP targeting would have called for much aggressive monetary stimulus in late 2008 and 2009". Furthermore, it is believed that

NGDP targeting has the propensity to be the panacea to the issue of liquidity trap[7] (Motyovszki, 2013; Hassan and Loewald, 2013; Eagle, 2012). This reoccurring interest has obviously driven our readers to this thesis, as it has also driven us to feel the need to explain the concept of NGDP targeting.

NGDP growth targeting is quite simply, setting up a NGDP (growth) target by summing up the designated RGDP (growth) target and inflation target (Hassan and Loewald, 2013). To illustrate, take your indicated rate of RGDP growth to be 4%, and your target inflation rate to be 2%, as implicitly followed by the Fed, you end up with an NGDP target of 6% growth rate. From here, one can easily see how NGDP targeting may appear to be the panacea to the problem of "killing two birds with one stone". The inflation target is expected to be similar to that of inflation targeting, also measured via the CPI. On the other hand, the RGDP target is suggested to be an estimate of the potential level of output (potential GDP) or perhaps the trend of RGDP growth rate (Hassan and Loewald, 2013).

Two approaches by which this NGDP targeting is expected to work was noted by Domac and Kandil (2002). In the first approach, the central bank sets a nominal income target, then uses this target to determine the targets of other financial instruments (e.g. interest rates) and monetary aggregates[8]. Basically this method still very much sets nominal income as the main target. All other financial instruments and monetary aggregates are only manipulated to end up achieving the nominal income target. For

[7] Liquidity trap was originally outlined during the Great Depression by John Maynard Keynes as simply a situation where the real interest rate can no longer stimulate growth either due to very low inflation expectations or/and the zero-lower-bound. See, for example, Keynes (1937), Eggerston and Woodford (2003), Hicks (1937), Krugman (2011), Woodword (2012) and also Motyovszki (2013).
[8] See Gordon (1985) for more detailed analysis on the first approach.

the second approach, the nominal income is used as an intermediate target by the central banks. The central bank simply sets a NGDP growth target for which they hope to use to achieve their rate of RGDP growth target and inflation rate target.[9] In this approach, nominal income targeting is more direct. If the nominal income is above its target, the central banks respond with a contractionary policy and vice-versa.

Sumner (2013) suggests that the NGDP targeting framework should operate via the creation of NGDP targeting futures market. A policy regime where the market, not the central bank, sets the short-term interest rate and monetary base for achieving the indicated target (Sumner, 2013). Another analysis sees NGDP targeting operating based on the quantity theory of money (Bean, 1983).

According to the literature, NGDP targeting is expected to follow, analogous to inflation targeting, a forward guiding principle in practice (Sumner, 2012). Also similar to inflation targeting, the targets may be points, ranges or may be targeted at levels as advocated by Sumner (2012), Motyovszki (2013), among others. Sumner (2011) believes that NGDP targeting at levels will hold the Fed[10] accountable in its conduct. This is because, level targeting forces the Fed to account for its target misses in the subsequent years. For example, suppose the Fed sets its NGDP target rate at 3% but achieves a NGDP rate of 5% at the end of its designated horizon. In the subsequent year, the Fed would be expected to arrive at an NGDP rate of 1% to account for the 2% overshot from the previous year, before it returns to the original 3% target rate in the following year. This approach tends to market the accountability, transparency and

[9] See Hall (1983) for more detailed analysis on the second approach.
[10] In this case, central bank and Fed may be used interchangeably. Although, our use of any, is dependent on the focus of the Author of the literature being reviewed.

credibility of the Fed's monetary policy conduct, main functions of any monetary policy framework.

Analogous to inflation targeting, we also expect that a successful implementation of NGDP targeting will hinge on a sound financial sector and fiscal cooperation. Furthermore, NGDP targeting in its design is inherently built to render the government accountable in its fiscal policies (Sumner, 2012; Domac and Kandil, 2012).

2.2.1 The Cases for NGDP Targeting.

In recent times, cases for NGDP targeting have deluged the literature. Here, we analyze the literature on these recent cases for NGDP targeting in order to go further in our objective approach by arguing against or/and for some of these cases. Within the context, we also argue some cases for inflation targeting, given that arguments for inflation targeting are scarce in recent times. We aid our arguments by thorough parsing of the earlier literature on inflation targeting.

One of the prime cases for NGDP targeting is the advantage it provides in the face of recession threatening adverse supply shocks. Sumner (2011) argues that an economy operating under NGDP targeting would cushion the blow from this adverse supply shocks. The author claims that in the face of an oil shock, NGDP targeting will accommodate the shock by allowing for a little increase in inflation while simultaneously managing the decrease in output. Sumner (2011) also argues that a strict inflation targeting strategy, conversely, would not allow for any increase above its inflation target, and thus, would respond with a contractionary monetary policy that will end up pushing the full effect of the oil shock on the decrease in output. Hassan and Loewald (2012) support Sumner's claim suggesting that in an attempt to keep the inflation target, under inflation targeting, non-oil domestic product price will have to fall. Given the fall in the prices of these products in the presence of nominal rigidities (sticky wages), there will be devolution in profits. This reduced profitability further exacerbates unemployment woes (Hassan and Loewald, 2012).

In support of Sumner's (2011) point, Frankel (2014) uses a simple theoretical aggregate demand and supply approach to compare the NGDP and inflation targeting regimes for developing countries. Frankel (2014) posits the argument that the effect of adverse supply shocks under NGDP targeting will be split equally on both inflation and output. This is opposed to the full incidence on output that would occur under strict inflation targeting. Furthermore, Frankel (2014) claims that middle-income countries like Kazakhstan should embrace NGDP targeting due to their susceptibility to the supply shocks. Following a similar methodology as in Frankel (1995, 2014), Bhandari and Frankel (2014) estimate the effect of NGDP targeting in India. They argue a case for NGDP targeting in India as the best possible conduct for monetary policy given the Indian economy's historical evidence of supply shocks. Bhandari and Frankel (2015) argue for the adoption of NGDP targeting in developing countries for similar reasons, using same methodology of simple theoretical modeling as in Frankel (2014) and Bhandari and Frankel (2014). Frankel (2014) suggests that the adoption of NGDP targeting by developing nations is of crucial importance given their need to attain higher level of economic growth. In accordance to Frankel (2014), Eagle (2012) postulates NGDP targeting as the solution for faster economic recovery and growth. Eagle (2012) does so within a panel time-series framework of the excess of the unemployment rate over the pre-recession rate, and the percent deviation of NGDP from its pre-recession trend.

Adherents of the NGDP targeting strategy are not limited to those studying the developing economies. Hatzius et al. (2011), for instance, attempt to simulate the U.S. long-term growth outcomes, and propose NGDP targeting a solution for the achievement of the long-term employment and output targets for the U.S.

As highlighted by Hassan and Loewald (2012), another notified issue with inflation targeting is that it permits for housing bubbles and overheating. Because the Fed focuses on the CPI in inflation targeting, it unknowingly allows for the formation of asset bubbles (Sumner, 2011). Frankel (2012) claims that monetary policy, in a period where inflation is well within its target, tends to be over accommodative, ignoring signs of asset price bubbles.

Blanchard and Gali (2008) using a new-keynesian dynamic stochastic general equilibrium (DSGE) model, create a utility-based model of vacillations, with unemployment and nominal rigidities. Blanchard and Gali (2008) argue that strict inflation stabilization is not the right monetary policy conduct with regards to labor market stability. According to Blanchard and Gali (2007), strict inflation stabilization, in the presence of nominal rigidities, may result in large volatility in output and unemployment in the occurrence of productivity shocks.

As a remedy to these limitations of inflation targeting vis-à-vis the labor market, NGDP targeting has risen as an alternative framework. Sumner (2011) posits that stability in labor market can be further buttressed by the adoption of NGDP targeting. He argues strongly on the bases that stable wage growth is aided by stable NGDP growth. He argues that under inflation targeting, if average wages rises in the economy, labor market tightening may occur leading to huge disparity in wages. He further postulates the idea that with stable growth of NGDP, long run income will also increase, and this will culminate in higher wages in the long run. More or less, Sumner’s postulation heralds another remedy for long run economic growth and unemployment levels under NGDP targeting.

With regards to the implementation of NGDP targeting, Motyovszki (2013) suggests that NGDP level targeting helps to doubly ensure that the Fed remains accountable. Sumner (2012) agrees that NGDP targeting at levels promotes credibility and accountability. He argues that NGDP level targeting constrains the discretion of policy makers by coercing the Fed to stand by its declarations to the public. He also makes a strong notion that the austerity of the Great Recession would have been mitigated if the Fed operated under NGDP level targeting. In the words of Sumner (2012, p. 12), “NGDP level targeting (along a 5 percent trend growth rate) in the U.S. prior to 2008 would similarly have helped reduce the severity of the Great Recession”.

Moreover, Eagle (2013), in his study on minimizing the share risk and recessionary impacts with Quasi-Real Indexing and NGDP targeting, supports the adoption of NGDP targeting by the Fed. He constructs a panel data set on the U.S. spanning the period from the 1949 recession to the recent recession of 2007-2008. Although, Eagle omitted the recessionary periods of 1969-1970 and 1973-1975. He believed these recessionary periods were anomalous relative to the others that he observed. Eagle (2013) shows that the long-term level of unemployment resulting from recessions could have been eliminated by 75% under NGDP targeting. McCallum (2011) notes that one medium through which monetary policy conduct would capture both inflation and output outcomes is NGDP targeting. Given its design, NGDP targeting explicitly shows concerns of price stability and full employment (McCallum, 2011) which is expedient for economies with dual mandates.

As we mentioned earlier, another case for NGDP targeting is that it is a possible solution to liquidity trap. Motyovszki (2013) argues that NGDP targeting can provide latitude to monetary policy from liquidity traps. He claims that with NGDP level targeting, the public would expect the Fed to reach back to its NGDP pre-crisis target. With the expectation of future expansionary policy, the public implicitly also raise their inflation expectations. According to Motyovszki (2013), this anchored public expectation is expected to stimulate an increase in output at the zero-lower-bound by further lowered real interest rate. This process stimulation works on sheer expectation theory, precluding the need for unconventional monetary policies[11]. Motyovszki (2013) uses a Keynesian DSGE model to compare the effects of inflation targeting and NGDP targeting on volatility on output and prices. He concludes that NGDP produces more favorable results for both the output and the prices. That is, the volatility in output and prices under NGDP targeting is smaller relative to that of inflation targeting.

To conclude this section, Ball and Sheridan (2004) use a panel data set, containing twenty OECD countries as of 1990; with preclusions to Turkey, Iceland, Greece and Luxemborg[12]. Ball and Sheridan (2004) use dummy variables measuring the effect of adopting an inflation targeting framework, testing for differences in economic performances between inflation and non-inflation targeters. They come to a rather

[11] See also Evans (2011), and the references therein, for more proposed remedies to liquidity trap.
[12] In Ball and Sheridan (2004), the exempted countries were due to lack of independent currency prior to the Euro (Luxemborg); and an above annual inflation rate of 20% since 1984.

provocative conclusion that inflation targeting, ipso-facto, does not matter for better economic performance. They find no evidence of better economic performance from inflation targeters over non-inflation targeters[13].

2.3 In defense of Inflation Targeting: How compelling are the cases for NGDP Targeting?

Granted the lengthy cases for NGDP targeting, how significant are they? How cogent are these cases? To simplify our defense, we sum up all these cases to just a few major points. These points are: adverse supply shocks, liquidity trap, asset price bubbles, output and price performance, and labor market stability. We begin our argument from the last point.

Firstly, Sumner (2012) argues that NGDP targeting ensures labor market stability: Stable increase in NGDP growth results in steady increase in wages. Our argument in this thesis, however, is that the inflation targeting strategy does not inhibit stable NGDP growth. If anything, assuming immense credibility of central banks, the labor market is fully cognizant of the proposed inflation target. This awareness aids the facilitation of wage negotiations. With credibility of central banks over meeting inflation targets and well anchored inflation expectation, long-term stable increase in nominal income is equally attainable under inflation targeting.

A popular misconception is that inflation targeting is viewed as a rule, i.e. Friedman's (1996) "iron clad" rule. We argue in the same spirit as Bernanke and Mishkin (1997) that inflation targeting should be viewed as a framework. This concept permits for what is known as flexible inflation targeting. Flexible inflation targeting is simply a

[13] It is worth mentioning that their findings contradict a similar study by Neumann and Von Hagen (2002).

variation of inflation targeting framework. A variation that permits for lesser emphasis or weight on inflation. As opposed to strict inflation targeting, flexible inflation targeting may allow for misses in the inflation target over the indicated horizon, so as to accommodate shocks that would otherwise affect volatility of output largely. Just as NGDP targeting that accommodates supply shocks by splitting the effect on prices and output rather fairly, the same outcome may be possible under flexible inflation targeting. Besides, central banks may apply for clauses, allowing central banks to miss its target briefly in order to accommodate for the supply shock. The question now is, does such a strategy affect the credibility of central banks? The answer we believe, is no. We argue that if communicated to the public well, no credibility is lost. Well-communicated monetary policy actions eliminate the fear of loss in credibility. We argue that flexible inflation targeting achieves the same outcome in the presence of supply shocks. Even in the face of adverse productivity shocks as opposed to Blanchard and Gali (2008). Also, under strict inflation targeting, central banks are able to remiss the first round of inflationary effects by targeting the core inflation[14] (Hassan and Loewald, 2012). Although, this may not be a good idea given the usefulness of energy sources, amongst other reasons.

Moreover, Motyovszki (2013) made an arguably strong case for NGDP targeting in the face of liquidity trap. One hinged on expectation theories. He believes that expectations of monetary policy conduct of NGDP level targeting will help anchor inflation expectations. We argue that this expectation theory is a hyperbole. We believe

[14] A measurement of inflation designed to exclude, in most cases, the prices of food and energy from the CPI. This method is not generally advisable as the energy prices are reflected in the prices of many other goods given that energy is a general cost of production. Furthermore, ignoring the prices of food from the estimation of inflation could seem as lack of concern for public welfare.

the understanding of the public towards NGDP level targeting is overstated. Not everyone is economically fine-tuned. Besides, a similar method is possible under inflation targeting. Evans (2011) proffers the notion that central banks can ensure the public of low long-term interest rates, even still amidst increasing inflation and output. Assuming the declaration is seen to be credible, this should be expected to increase aggregate demand even at zero-lower-bound (Hassan and Loewald, 2012).

Furthermore, we agree that monetary policy under inflation targeting may permit for asset price bubbles. However, we argue that the current literature has remained tentative about how this can be tackled or prevented under NGDP targeting.

A further case in defense of inflation targeting is that it is arguably easier to understand and implement. Having said that, conversely, Sumner (2015) argues that Ben Bernanke's- the chairman of the Fed from 2006 to 2014- announcement to raise inflation in 2010, since it was below 2% (1% precisely), put the Fed under fire from the public. Sumner believes that this is due to lack of understanding of inflation targeting by the public.

Well, we argue that the same "fire" can occur under NGDP targeting as well. For example, let us assume the Fed is above its NGDP target. The Fed has to reduce NGDP growth to maintain its target. Janet Yellen – incumbent chairperson of the Fed - then makes an announcement to try and decrease nominal income (NGDP). How much "fire" do you think the media and public will create? We would like to think such an announcement will create even more "fire". In addition, NGDP targeting exudes operational difficulties. How it will work is not quite certain. What target range? How about unanchored inflation? How accurate are the estimates of potential GDP? Besides, measurement errors are also observed in inflation targeting. Because more revisions of its estimates due to uncertainty of data are needed for NGDP targeting (Hassan and Loewald, 2012), monetary policy under inflation targeting would seem easier to implement. Moreover, Svensson (1999) and Ball (1999)[15] show that output reacts faster to monetary policy than inflation. How then, will central banks be able to manage and monitor its NGDP target seeing that the NGDP targeting ignores these lag disparities (Hassan and Loewald, 2012)?

Finally, amidst the clamors for an alternative framework, Alp and Elakdag (2011) studied the role of monetary policy in Turkey during the Great Recession. Their study shows, quite interestingly, that the adoption of an inflation targeting framework and a flexible exchange rate regime by the Central Bank of the Republic of Turkey (CBRT), played a massive role during the recession. Using the Keynesian DSGE technique they conclude that, if not for the adoption of the aforementioned policies, Turkey would have suffered a more severe loss in output. They conclude from their study, that without the interest rate cuts implemented, output would have decreased to -6.2% from the actual realized -4.8%. Alp and Elakdag (2011) further note that if in the absence of the adopted inflation targeting regime[16], a fixed exchange rate regime governed the CBRT's monetary policy conduct; the output would have decreased to -8.0%. Their study is a clear indication of the possible impact inflation targeting regime may have on an emerging economy during a period of crisis converse to the recent popular belief.

[15] Svensson (1999) and Ball (1999) conclude that – under adaptive expectation – such ignorance of differences in transmission lags, leads to NGDP targeting being a perpetrator of economic instability.
[16] This inflation targeting regime adopted by CBRT, was also underpinned by the flexible exchange rate regime adopted.

2.4 IPVAR Literature

At this point, we note that the aim of our argument is not to advocate for inflation targeting as the better of the two frameworks. We only aim to create an objective level ground for empirical studies like ours to build on.

Building on our level ground and the lack of empirical evidences from NGDP targeting countries, if any; empirical comparisons between inflation targeting and NGDP targeting monetary policy frameworks appear scarce. So as to fill this gap, we employ the IPVAR technique outlined by Towbin and Weber (2013) in our study, as we mentioned earlier.

Towbin and Weber (2013), use this technique to investigate the limitations of a floating exchange rate regime in the presence of foreign currency debt and import structure. The technique enabled them to simulate different simulations of high and low foreign currency debt and import structure amidst a floating exchange rate regime. Also, Aastevit et al. (2013) adopted this same technique for estimating the effectiveness of monetary policy amidst levels of economic uncertainties. They controlled for the simulations of high and low economic uncertainty levels via this technique, and investigated the effect of monetary policy for the different simulations. Leroy and Lucotte (2014) also adopted the IPVAR technique to study structural and cyclical determinants of interest pass-through in the Eurozone.

We attempt to analyze, using the IPVAR technique, the effect of counterfactual monetary policy simulations on the macroeconomic activities of the U.S. in the presence of recessionary supply shocks. We explain in more detail in the methodology section of this thesis.

Chapter 3

DATA AND METHODOLOGY

3.1 Theory

To illustrate the mechanism behind how both inflation targeting and NGDP targeting work, we employ a classical aggregate demand and aggregate supply (AD-AS) framework. We make this illustration by outlining the disparities in the response of both targeting frameworks to recessionary shocks using an AD-AS analysis.

Firstly, when we consider recessionary shocks, we make reference to just AS shocks in our analysis. This is simply because of the fact that monetary policy reacts the same way to AD shocks whether under inflation targeting or NGDP targeting. To clarify why this is so, let us assume a simple case of a credit crunch. With banks being parsimonious towards loans, investment is discouraged, AD falls and shifts leftwards. As a result, both price level and real output fall. With inflation under its designated target, an inflation targeting framework would mandate a monetary stimulus in the economy, raising the AD, and in the process the price level, so as to meet its targeted inflation rate. The response, is analogous with NGDP targeting. Given that output level and inflation rate are below their targets, the NGDP growth rate is also below its proffered target. Thus, a NGDP targeting framework will, analogous to inflation targeting, necessitate an expansionary monetary policy to raise the AD, thereby increasing the real output and inflation rate to its desired level. Due to this fact of congruence in response to AD shocks between both frameworks, a clear distinction between these frameworks is best analyzed in the presence of an AS shock.

In the case of AS shocks, both inflation targeting and NGDP targeting posit incongruent reactions. This is regardless of whether the shock is adverse or positive. For our analysis, we consider an adverse AS shock as opposed to a positive one. This is simply because our methodology is focused on monetary response to recessionary shocks. With such a theoretical restriction, i.e. a positive AS shock, it would be more or less spurious to our purpose.

3.1.1 Inflation Targeting response to an adverse AS shock

In order to analyze the response of monetary policy - guided by an inflation targeting framework - to an adverse AS shock, we examine a scenario of disrupted oil supply. Given the disrupted supply of oil, that is, withheld or limited supply of oil; we expect that the nominal price of oil will increase following the basic law of demand and supply. With this increase in nominal price of crude oil, we expect the higher prices to translate to the real economy as an increase in the cost of production. Producers are not able to supply as much as they previously did. AS shift upwards (leftwards), raising the general price level and causing a fall in real output below the potential level of output. With price level being high, let us then assume this increase in price level raises inflation above the central bank's target rate. Under pure or strict inflation targeting, the central bank would be mandated to respond with a contractionary monetary policy, in order to lower AD, that is, shift AD downwards (leftwards) in response to the rising inflation rate. This decrease in AD, due to the contractionary monetary policy, lowers the price level up to a point where it gradually attains its inflation target. Albeit, the fall in AD is expected to further exacerbate the already declining output level.

Basically, in an attempt to restore inflation to its intended target, there is a trade-off between inflation and output level and hence, unemployment level. All this analysis is further explained graphically in Figure 1[17] below.

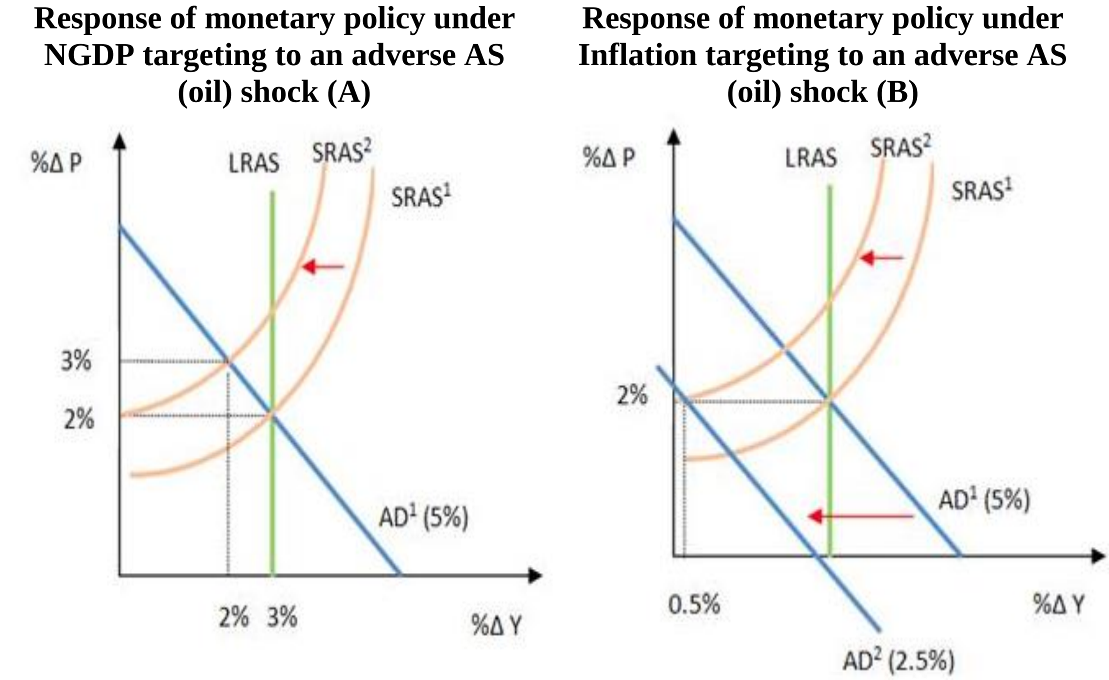

Figure 1. Inflation Targeting in Response to an Adverse AS Shock

As we can see from Figure 1 (part A), the adverse AS shock pushes inflation to 3%, above its target of 2%. In response to the oil shock, a contractionary monetary policy is employed to lower the AD (part B). As a result, inflation falls back to its target level of 2% at the expense of real output growth falling from 3% to 0.5%.

3.1.2 NGDP Targeting response to adverse AS shock

For the sake of brevity, we make our analysis of NGDP targeting with the same Figure 1 above. In the face of an adverse oil shock, monetary policy under a NGDP targeting tends to be more accommodating than that under an inflation targeting. This is due to

[17] Figure 1 is drafted from Beckworth (2010).

the fact that it splits the effect of the shock on both inflation and output. Basically, under NGDP targeting, the best reaction is to not react at all[18]. Why is this so?

If you recall from our elaborate explanation of NGDP targeting in the previous chapter, NGDP growth target is simply just the sum of the inflation and RGDP growth targets. In accordance with Figure 1 above, we consider the inflation target to be 2% and RGDP growth target to be 3%. Hence, NGDP growth target is de facto 5%. In the case of the disruption of oil supply, AS shifts leftwards. This adverse AS shock pushes inflation above its 2% target to 3%, and also reduces RGDP growth rate to 2% below its designated target rate of 3%. Regardless of these individual target misses, the NGDP growth target remains unchanged at 5%. This is simply due to the fact that in our example, the negative AS shock culminates in a proportionate rise and fall in both inflation rate and RGDP growth rate respectively. Therefore, the response of a central bank following a NGDP targeting strategy to a negative AS shock is illustrated on the left hand side of Figure 1. The response is actually no response at all as the NGDP growth rate remains constant at the target level of 5%.

3.2 Data

In order to make our empirical comparison between both inflation targeting and NGDP targeting, we evaluate the response of monetary policy under each framework to an adverse supply shock. To do so, we use a sample of quarterly data spanning the period 1986Q1-2014Q4 for seven advanced economies, i.e. Australia, euro area, Japan, New

[18] Do keep in my mind that this statement is only a fact when considering a simple scenario as outlined carefully in Figure 1. Nevertheless, it is not always the case. The response of central banks under NGDP targeting is partially determined by the proportion to which the adverse AS shock raises the price level and lowers the output level.

Zealand, Switzerland, Sweden and the United States[19]. We use a sample of 920 observations.

We use quarterly data for all our variables (described below) in order to attain uniformity as RGDP is estimated on quarterly basis. We prefer to use quarterly data as opposed to annually as it captures the changes in economic conditions that may occur within the yearly intervals. Using all other variables in quarterly form limits the probability of model misspecification. Therefore, we convert our other variables such as monetary policy benchmark interest rate from monthly observations to quarterly by taking the average of three months for each quarter[20]. Our data stems from various sources including Organization for Economic Co-operation and Development (OECD) statistics, Energy Information Administration (EIA), National Bureau of Economic Research (NBER) and the central banks of the economies we use, as derived using DataStream. We elucidate further on the sources of data later on when we analyze the variables of our model independently. Furthermore, more detailed description omitted in this chapter is available in the Appendix B Table B.1.

3.2.1 Economic growth

In this study, we measure output via the RGDP. Our RGDP observations are obtained in quarterly data from OECD statistics. Due to presence of policy benchmark rates as one of our variables, we were obliged to account for the discrepancies in scale and unit

[19] Our omission of some key advanced economies like Canada and United Kingdom is simply due to the fact that these economies are net oil exporters. Thus, given our external shock is an increase in nominal oil prices, including these economies would be ambiguous and counterproductive in observing the effect of this oil shock, as it is expected that the effect of an oil shock would differ for net exporters and importers.

[20] We prefer to estimate our data quarterly by taking the average as opposed to using the observation of the last period. This is simply due to the reasoning that taking the average tends to capture more accurately the fluctuation within the specified time period as opposed to taking the last period.

of measurement. We therefore estimate our RGDP variable in the first difference of the natural log form, hence converting into growth rates.

3.2.2 Inflation

For our estimation, we use the percentage change in the Consumer Price Index (CPI) as an indicator for inflation. We derive the data from OECD statistics. For the same reason stated above (sub-section 3.2.1), we transform CPI into the first difference of natural log form. Given the vast literature on the price puzzle[21], we prefer to use the CPI (all urban items) as our indicator as opposed to the GDP-Deflator. Sims (1992) as well as Rusnak et al. (2011) argue that the inclusion of Commodity Price Index in VAR estimations helps resolving the issue of this prize puzzle. This is simply due to its ability to engulf information that can aid the central bank in its inflation forecast (Hanson, 2004)[22], as well capturing the price changes of commodities like energy and gas. We believe that CPI estimated subsuming all items fulfills the same purpose, and the recommendation of Sims (1992), is due to the fact that prior to 1987, CPI values were calculated as core, that is, precluding oil and other energy prices from the index (Bernanke et al., 1999). Furthermore, considering our omission of output gap as an indicator in our study, including the CPI is our only way of limiting any possible occurrence of a price puzzle[23]. Nonetheless, because our study is not studying the direct effect of monetary policy on the economy per se, the issue of price puzzle is relatively less of a concern.

[21] The price puzzle explains the rather economically contradictory findings that plagued the studies that aimed at explaining the effect of monetary policies. Most studies showed previously inexplicable evidence of a rise in the general price level from an unprecedented contractionary monetary policy shock.
[22] See also Bernanke et al. (1997) for similar reason why the inclusion of commodity price index works.
[23] See Giordani (2003), for the inclusion of output gap as an alternative remedy to price puzzle.

3.2.3 Adverse AS shock

Within our study, we use oil shock as our adverse AS shock. We acknowledge the tentativeness of the literature with respect to the apropos measurement of oil shocks. Therefore we investigate for two forms of measurement, which are changes in nominal oil prices and Hamilton's measurement of oil shocks[24] (net oil price increase). The changes in nominal prices of oil would appear to be the simplest and most holistic measurement for oil. Bernanke et al. (1997), however, find this measurement lacking in consistency vis-à-vis the relationship between oil shock and macroeconomic variables. Hamilton's measurement of oil shock appears to provide relatively more consistent and economically significant relationship between oil shock and macroeconomic variables (Bernanke et al., 1997).

Based on our empirical findings we, in the same spirit as Bernanke et al. (1997), opt for Hamilton's measurement of oil shock[25]. Our investigation shows that nominal oil price changes as a measurement for oil shock provides economically unsatisfactory outcomes[26]. Nonetheless, our study is not focused on solving the "oil shock measurement puzzle", but on being able to outline vacillations of oil prices that bode significant effect on the economy. We obtain our nominal spot oil prices from the EIA.

3.2.4 Inflation targeting regime

Within our sample spanning the period of 1986-2014, and consisting of a panel of seven advanced economies, it is imperative we take into consideration periods where monetary policy operates under explicit adoption of an inflation targeting regime. To do this, we use a dummy variable to accommodate the regime changes that may have

[24] For reference to Hamilton's measurement of oil shock, see Bernanke et al. (1997).
[25] We estimate our variation of Hamilton's measurement by the difference between the current logged nominal spot price from the maximum logged nominal spot price from the previous four quarters.
[26] We document our result of the investigation in the Estimation and Results chapter of this study.

occurred over our sample years. By doing so, we are able to control for our model, the periods where the monetary policy is dictated by an inflation targeting framework and where it is not. Furthermore, accounting for this dummy variable, in addition to our monetary policy variable, will allow us to investigate differences in monetary policy behaviors, as we will later elaborate within the inference section of this thesis. Within our appendix, appendix A Table A.1 precisely, we identify all countries under the inflation targeting framework and the year the framework was adopted as documented by each country's central bank.

3.2.4 Crisis

Within our sample spanning from 1986 to 2015, our macroeconomic variables may be subject to inconsistent behaviors amidst the presence of recessions that occurred within this time period. We control for these inconsistencies by the inclusion of a dummy variable as an indicator to capture the effect of the crisis episodes. In addition, controlling for the occurrence of economic crisis, which further aids our estimation, as we are able to compare between the effect of inflation targeting and NGDP targeting during and outside of crisis environments. The inclusion of this variable is also useful as an interaction term for our model[27]. We observe the occurrence of crisis within our time period according to recordings from the NBER. We control for the occurrence of the Great Recession of 2007-2009, the dot-com bubble of 2001 and the rather relatively mild recession of 1990-1991. For more detailed description, see Appendix B Table B.2.

[27] See below for details of the methodology employed in the thesis.

3.2.5 Monetary policy

As an indicator for monetary policy, we use the change of effective benchmark policy rates of each economy. We use the benchmark policy rate, as it is the rate the central banks have the most direct control over. We estimate our model using changes of benchmark policy rates in order to capture policy responses and their effectiveness following an adverse AS shock. We obtain our data from the central banks of each examined economy via DataStream in quarterly form, which we aggregate by taking the average of monthly observations within the particular quarters.

3.3 Pre-estimation tests

As a requirement for the estimation of time series models, it is imperative that our series be stationary (Gujarati et al., 2009). By stationary, we imply that the mean and variance of all our variables should be constant over time. This is mandated when using time-series modelling in order to avoid running a spurious regression. To check for stationarity, various conventional techniques may be employed, of which the Augmented Dickey-Fuller and Phillips-Perron tests are the most deployed.

3.3.1 Augmented Dickey-Fuller (ADF) test

As an enhancement over the original Dickey-Fuller technique, Dickey and Fuller (1981) postulate the ADF test in order to correct for the shortcomings of the Dickey-Fuller test. The expedience of the ADF test is that it accommodates for higher auto regressive processes (Greene, 2003).

3.3.2 Phillips-Perron (PP) test

As an auxiliary measure to the ADF test in the test for unit-root, Phillips (1987) and Phillips and Perron (1988) postulate the PP test. Asides serving as a supportive technique for conducting a unit-root test, it is very advantageous, as it accommodates the excesses of the ADF test. The PP test, being a non-parametric test, eliminates the quandary of high serial correlation in a series. The ADF test, unlike the PP test, is susceptible to this issue of serial correlation.

3.3.3 Im, Peseran and Shin (IPS) test

Howbeit, the ADF and PP tests delineated above are the prime conventional techniques used for testing for unit root within the time series domain. Given our study focuses on panel data analysis, there is a need for a more dynamic unit root technique. Also, it is well documented in the literature, that the ADF and PP are susceptible to the the issue of lower power (Kim et al., 2005). In order to resolve these issues, we deploy the second generation test, as formulated by Im, Pesaran and Shin (2003). This technique allows for a panel unit root test for an error term exhibiting a random walk within the domain of a dynamic model with fixed effects. The IPS unit root test is formulated as follows:

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{j=1}^{p} p_{ij} \Delta y_{it-j} +_i \varepsilon_{it}, i = 1,2,3,.....T, \tag{1}$$

The **ρ** is responsible for making the error term uncorrelated over time. Where $H_0 : \beta_i = 0$ for all i, and $H_1 : \beta_i < 0$ for some i. The ADF type t-statistics of IPS can be written as follows:

$$\hat{t}_{NT} = \frac{1}{N} \sum_{i}^{N} t_{iT}(P_i) \tag{2}$$

Where $t_{iT}(P_i)$ is the ADF t-statistic for country i. A modified form of the standardized t-bar statistic is formulated by IPS in the following form:

$$\bar{t} = \frac{\sqrt{N}\left\{\hat{t} - \frac{1}{N}\sum_{i=1}^{N} E[t_{iT}(P_{i,}0) : \beta_i = 0]\right\}}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} Var[t_{iT}(P_{i,}0) : \beta_i = 0]}} \tag{3}$$

Where, $\bar{t}$ represents the average of the individual ADF statistics. An assumption made by IPS suggests that *tiT* is independent and identically distributed (i.i.d), and has finite mean and variance as $T \rightarrow \infty$. Ergo, the following form:

$$t_{\alpha} = \frac{\sqrt{N}\left(\bar{t} - E[t_{iT} | P_i = 1]\right)}{\sqrt{Var[t_{iT} | P_i = 1]}} \Rightarrow N(0,1) \tag{4}$$

Another assumption is that $\bar{t}$ has a standard normal distribution, and following the central limit theorem, as $N \rightarrow \infty$, $\hat{t}_{IPS}$ follows a standard normal distribution with a variance of 1 and mean 0. This is formulated as follows:

$$\hat{t}_{IPS} \frac{\sqrt{N}\left(\bar{t} - E[t_{iT} | P_i = 1]\right)}{\sqrt{Var[t_{iT} | P_i = 1]}} \Rightarrow N(0,1) \tag{5}$$

Using this IPS technique, we observe that benchmark central bank rates are stationary at levels while all other variables are stationary at first difference, using a 1% significance level[28].

[28] For more detailed description of the IPS test, see Appendix C Table C.1

3.4 Empirical Model and Identification.

In our study, we attempt to control and evaluate the effects of simulations of systematic monetary responses to an adverse supply shock using the IPVAR technique. To elucidate further, we analyze the effect of an adverse AS shock on the economy, after which we simulate monetary policy responses to the prior effect according to the expected theory of both targeting frameworks. In this study we investigate the effect of these simulations on the stability of economic activities for a panel of advanced economies.

As part of our methodology, we first have to analyze the response of both inflation and RGDP to an AS shock (oil shock). To do so, we estimate our recursive panel VAR model in the following form similar to that used in Towbin and Weber (2013):

$$\begin{pmatrix} 1 & 0 & 0 \\ \gamma_{0,it}^{21} & 1 & 0 \\ \gamma_{0,it}^{31} & \gamma_{0,it}^{32} & 1 \end{pmatrix} \begin{pmatrix} \Delta Oil_{it} \\ \Delta CPI_{it} \\ \Delta RGDP_{it} \end{pmatrix} = \delta_i + \sum_{l=1}^{L} \begin{pmatrix} \gamma_{l}^{11} & 0 & 0 \\ \gamma_{l,it}^{21} & \gamma_{l,it}^{22} & \gamma_{l,it}^{23} \\ \gamma_{l,it}^{31} & \gamma_{l,it}^{32} & \gamma_{l,it}^{33} \end{pmatrix} \begin{pmatrix} \Delta Oil_{i,t-1} \\ \Delta CPI_{i,t-1} \\ \Delta RGDP_{i,t-1} \end{pmatrix} + u_{it} \quad (6)$$

Where Oil_{it} represents our external variable, log of nominal price of crude oil; CPI_{it} denotes our inflation measure, the log of CPI and $RGDP_{it}$ delineates the log of RGDP at time period *t*. $\gamma_{l,it}^{ab}$ refers to the deterministically time-varying coefficients. δ_i is a vector of intercepts specific to each economy, u_{it} is also a vector of i.i.d uncorrelated shocks, and *L* represents the lag length.

Within this VAR model, we identify our adverse AS shock as an oil shock. This oil shock is identified by an unexpected increase in the nominal price of crude oil. Unlike the case of small economies, it is much more difficult to find an exogenous variable for a large economy. Within our methodology, we assume the nominal prices of crude oil as an external variable and this assumption serves to imply strict exogeneity.

Therefore, we set $\gamma^{12}_{l,it} = \gamma^{13}_{l,it} = 0$. Following our VAR setup, we imply that our external variable (oil shock) has a one way effect on economic conditions. That is, crude oil prices affect inflation and output, but not vice-versa. Our usage of oil shock as a recessionary shock carries weight given its primary role in the induction of past recessions. Hamilton (1983) finds evidence to support the negative effect of an adverse oil shock on output. Furthermore, our assumption of strict exogeneity is realistic and arguably valid given that crude oil prices are largely determined by the production quotas set by the Organization of the Petroleum Exporting Countries (OPEC), and dealings in the crude oil futures market. Bernanke et al. (1997) argue that there is a strong case of exogeneity for major oil shocks.

At this point, we carefully point out the fact that given the major aim in Eq. (1) is to identify and evaluate the effect of an external shock, the partial identification described above ($\gamma^{12}_{l,it} = \gamma^{13}_{l,it} = 0$) is sufficient, making the ordering of CPI_{it} and $RGDP_{it}$ of little or no significance.[29]

3.4.1 Interaction Terms

Within our methodological framework, we evaluate variations in macroeconomic conditions as a result of changes in monetary policy in response to an external shock. In order to do this, we set our benchmark policy rate as an interaction term. We also account amongst our interaction term, crisis and none crisis periods, and inflation targeting periods and non-inflation targeting periods. Ergo, we set our interaction terms in the following form:

$$\gamma^{ab}_{l,it} = \beta^{ab}_{l,1} + \beta^{ab}_{l,2}.BPR_{it} + \beta^{ab}_{l,3}.Infl_{it} + \beta^{ab}_{l,4}.Crisis_{it} \quad (7)$$

[29] See Towbin and Weber (2013) for further details.

Where, $\gamma_{l,it}^{ab}$ denotes the deterministically time-varying coefficients from Eq. (6). BPR_{it} represents benchmark policy rates and $Infl_{it}$ depicts our dummy for periods under inflation targeting, where $Infl_{it}$ = 1 for periods under the guidance of an explicit inflationary framework, and $Infl_{it}$= 0 for the periods not under an inflationary framework. $Crisis_t$ depicts our dummy for the occurrence of crisis period, where $Crisis_t$ = 1 for crisis period, and $Crisis_t$= 0 for period of relative economic stability at time period *t*. $\beta_{l,1}^{ab}$ is an intercept, and $\beta_{l,2}^{ab}$, $\beta_{l,3}^{ab}$ and $\beta_{l,4}^{ab}$ represent the coefficients of our interaction terms BPR_{it}, $Infl_{it}$ and $Crisis_{it}$ respectively.

Although our empirical model is very similar to that of Towbin and Weber (2013), ours is differentiated with regards to the purpose we aim to achieve from the model.

We believe that estimating the effect of monetary policy by setting it as an interaction term using the IPVAR technique is a novelty in the literature. By using this technique, we are able to control for the changes in the benchmark policy rate, thereby consciously simulating the response of monetary policy to changes in the economic condition. Therefore, we postulate the notion that asides us using this technique as an alternative measure of the effect of monetary policy, this technique does - ipso-facto - capture the effect of systematic monetary policy responses within a guiding targeting framework. Because we actually select the values for benchmark policy rates in our estimation, we believe the effect we measure is not as a result of an unsystematic monetary policy response, but of a systematic one. In our study, by controlling for benchmark policy rates within the focus of this thesis, that is, by consciously simulating monetary policy response under the theoretical assumptions of inflation and NGDP targeting, we account for the difference in what is considered optimum economic policy according to the theoretical expectations of both frameworks. Thus, we believe we are to an extent arguably exempt from the Lucas critique (1976)[30].

[30] Robert Lucas (1976) postulates the notion of naiveté in the prediction of optimum economic policy based on historical data within large-scale econometric frameworks. He argues that these frameworks are not structural and do not account for the fact that the historical data of these policies change significantly with changes in monetary policy regimes and therefore a prediction of optimum economic policy is outright baseless.

Chapter 4

ESTIMATION AND RESULTS

The estimation of the IPVAR model is done within the domain of ordinary least squares (OLS). We estimate the model opting for a lag length of two in accordance to Schwartz Criterion. We further investigate our choice to opt for two lags. We find that choosing beyond a lag length of two distorts our impulse responses due to the premise that going beyond a lag length of two causes the model to allow for too much dynamics.

Taking into consideration that our study focuses on panel data analysis, our model is no exception to the perils of unobserved heterogeneity. As a solution to this problem, we estimate our model allowing for country specific fixed effects. By doing so, we allow differences in slope coefficients to vary with country specific characteristics. Also, the use of interaction terms achieves the same purpose (Towbin and Weber, 2013). We investigate our decision to use fixed effects as opposed to random effect using the Hausman specification test as proposed by Hausman (1978). In order to run this test, we set up our panel VAR model as in Eq. (6). in two simplified OLS regression equations as follow:

$$\Delta CPI_{it} = \beta_0 + \beta_1 \Delta CPI_{it-1} + \beta_2 \Delta Oil_{it-1} + \beta_3 \Delta RGDP_{it-1} + \mu_{it} + \varepsilon_{it} \quad (8)$$

$$\Delta RGDP_{it} = \beta_0 + \beta_1 \Delta CPI_{it-1} + \beta_2 \Delta Oil_{it-1} + \beta_3 \Delta RGDP_{it-1} + \mu_{it} + \varepsilon_{it} \quad (9)$$

Where μ_{it} refers to the country specific characteristic effect.

For fixed effect, μ_{it} is considered fixed and independent of time, while also being an unknown constant that differs across countries. Therefore, slope coefficients are determined and estimated after taking into account discrepancies from the means. Hence transforming both Eq. (8). and (9) into the following forms:

$$\Delta CPI_{it} - \overline{\Delta CPI_i} = \beta_0 + \beta_1 \Delta CPI_{it-1} - \overline{\Delta CPI_i} + \beta_2 \Delta Oil_{it-1} - \overline{\Delta Oil_i} + \beta_3 \Delta RGDP_{it-1} - \overline{\Delta RGDP_i} + \mu_{it} - \overline{\mu_i} + \varepsilon_{it} - \overline{\varepsilon_i} \quad (10)$$

$$\Delta RGDP_{it} - \overline{\Delta RGDP_i} = \beta_0 + \beta_1 \Delta CPI_{it-1} - \overline{\Delta CPI_i} + \beta_2 \Delta Oil_{it-1} - \overline{\Delta Oil_i} + \beta_3 \Delta RGDP_{it-1} - \overline{\Delta RGDP_i} + \mu_{it} - \overline{\mu_i} + \varepsilon_{it} - \overline{\varepsilon_i} \quad (11)$$

Where $\mu_{it} = \overline{\mu}_i$, we can now re-write both equations in a final form as follows:

$$\widetilde{\Delta CPI}_{it} = \beta_0 + \beta_1 \widetilde{\Delta CPI}_{it-1} + \beta_2 \widetilde{\Delta Oil}_{it-1} + \beta_3 \Delta \widetilde{RGD}P_{it-1} + \tilde{\varepsilon}_{it} \quad (12)$$

$$\Delta \widetilde{RGD}P_{it} = \beta_0 + \beta_1 \widetilde{\Delta CPI}_{it-1} + \beta_2 \widetilde{\Delta Oil}_{it-1} + \beta_3 \Delta \widetilde{RGD}P_{it-1} + \tilde{\varepsilon}_{it} \quad (13)$$

Where $\widetilde{\Delta CPI}_{it}, \widetilde{\Delta CPI}_{it-1}$, $\widetilde{\Delta Oil}_{it-1}$, $\Delta \widetilde{RGD}P_{it-1}$, $\Delta \widetilde{RGD}P_{it}$ and $\tilde{\varepsilon}_{it}$ all refer to the deviations from the mean as seen in Eq. (10) and (11). Whereas, for random effect, μ_{it} is assumed to be i.i.d, and cov($\mu_{it}, \varepsilon_{it}$)=0. Also, μ_{it} is assumed to be uncorrelated with the independent variables. Therefore, our original OLS regression models can be written as follows:

$$\Delta CPI_{it} = \beta_0 + \beta_1 \Delta CPI_{it-1} + \beta_2 \Delta Oil_{it-1} + \beta_3 \Delta RGDP_{it-1} + \eta_{it} \quad (14)$$

$$\Delta RGDP_{it} = \beta_0 + \beta_1 \Delta CPI_{it-1} + \beta_2 \Delta Oil_{it-1} + \beta_3 \Delta RGDP_{it-1} + \eta_{it} \quad (15)$$

Where $\eta_{it} = \mu_{it} + \varepsilon_{it}$.

After formulating the above equations, we compare between using the fixed effects and random effects specifications. We do so estimating the Hausman specification test where H_0 = Random effect, and H_1 = Fixed effect. In comparing between Eq. (12) and (14), and between (13) and (14), we obtain the following respective result:

Table 1. Hausman Specification Test comparing Eq. (12) and (14).

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	25.778055	3	0.0000

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
CPI_ALL_ITEMS(-1)	0.985108	0.983868	0.000003	0.4398
OIL_PRICE(-1)	0.002269	0.003576	0.000000	0.0014
RGDP(-1)	0.000000	0.000000	0.000000	0.0181

Source: Author's computation via EViews 9

Table 2. Hausman Specification Test comparing Eq. (13) and (15).

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	41.113177	3	0.0000

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
CPI_ALL_ITEMS(-1)	228.917487	-201.974757	14830.938518	0.0004
OIL_PRICE(-1)	-204.150281	-182.671490	958.310290	0.4878
RGDP(-1)	0.997959	1.004953	0.000003	0.0000

Source: Author's computation via EViews 9

From the above tabulated results, we observe a p-value of 0.0000 on both occasions following the test summary of the above tables. We thus can reject the H_0 = Random effect. Therefore, the results from the Hausman test categorically buttresses and confirms the appropriateness of our decision to specify our model allowing for fixed effects.

As it is a well-documented issue within the VAR literature on the interpretation of slope coefficients, we estimate impulse response functions in order to interpret our findings. In the simulation of our impulse responses, we use a confidence interval of 90% for the simulated standard error bandwidths. Furthermore, while estimating our impulse responses, we akin to the caveats of inaccurate standard errors that are reliant on first order asymptotics, as pointed out by Towbin and Weber (2013). They believe this inaccuracy is simply due to the non-linearity of the impulse responses of the OLS estimates. Thus, to remedy this issue, we employ the bootstrapped standard errors postulated by Runkle (1987). Importantly, we alter the bootstrapped standard error technique to accommodate for the panel nature of our model, and the inclusion of interaction terms[31], also done by Towbin and Weber (2013). We use this adjusted bootstrapped standard error technique in accordance to Towbin and Weber (2013)[32].

4.1 Identification of Oil Shock

In estimating our empirical model, we impose an oil shock to the system and evaluate the effect on economic conditions. We identify the oil shock as a permanent 10% increase in Hamilton's net oil prices.

Since we are evaluating stability of the system based on the deviations of impulse responses from the zero baseline, using a permanent shock causes the impulse

[31] For a detailed description of the process for estimating the bootstrapped standard error, see Towbin and Weber (2013)

[32] At this point, we would like to acknowledge and appreciate Pascal Towbin and Sebastian Weber, for their support, and also for promptly enabling access to their estimation programs.

responses to be relatively linear as opposed to a temporary shock which will show a dying out effect. This makes it easier for interpretation with respect to stability as allowing for a dying out effect causes obvious variations on the deviations of impulse responses from the zero baseline. Hence, interpretation with respect to stability becomes ambiguous when using a temporary shock as opposed to using a permanent shock.

4.2 Identification of monetary policy responses

We make our estimations allowing for different simulations of monetary policy responses in accordance to our theoretical expectations of how different targeting regimes operate, and the different economic scenarios we investigate. We identify a contractionary policy response as a 100 basis points (bps) increase in benchmark central bank policy rates. Conversely, an expansionary policy response is identified as a 100 bps decrease in benchmark central bank policy rates. We also make simulations for when there is no monetary response by central banks. This is denoted by no change in benchmark central bank rates.

4.3 Results

4.3.1 Hamilton's measurement vs. Changes in logged nominal prices

So as to identify an economically significant relationship between oil shock and macroeconomic variables, our choice of oil shock measurement is of huge importance, as we have elaborated on earlier in the methodology section of this study. Therefore, we estimate the recursive VAR model in Eq. (6) using both Hamilton's measurement and changes in logged nominal oil prices. To this end we obtain the following results:

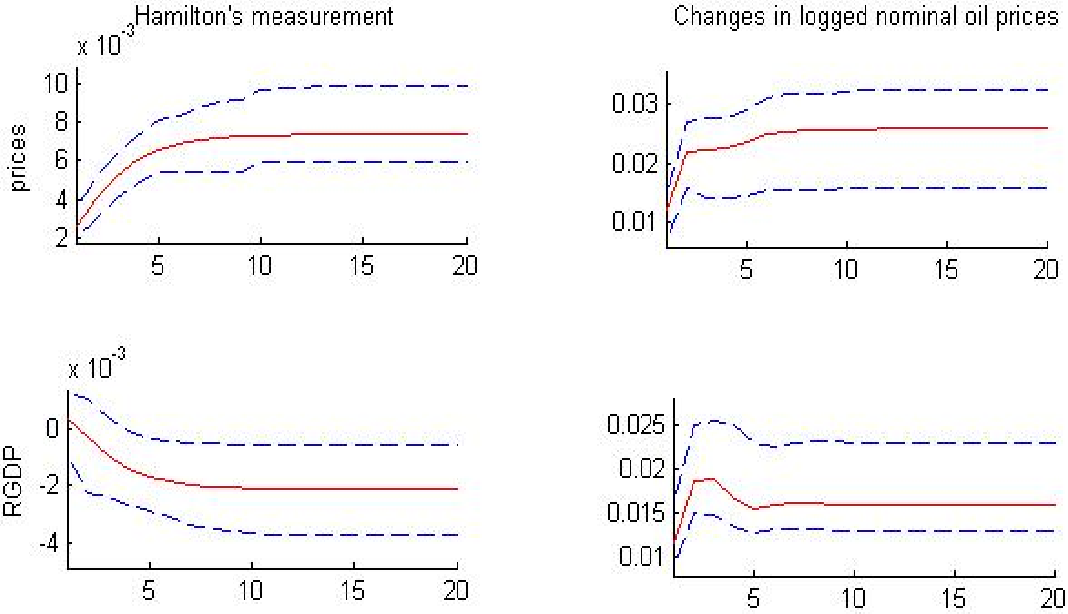

Figure 2: Impulse response for a 10% unexpected increase in oil prices

From Figure 2, we immediately see the problem posed when using changes in logged nominal oil prices with respect to RGDP. We see that RGDP (output)[33] rises to about 0.019% after three quarters, before reaching 0.016% from the 5th quarter. This result is very unsatisfactory as it does not give the economically expected theory of a negative relationship between oil shocks and output. Conversely, we see under Hamilton's measurement, a more economically consistent and statistically significant relationship between oil shock and our macroeconomic variables. To an initial 10% increase in oil prices, output falls to -0.002% after eight quarters.

4.3.2 Inflation Targeting[34] vs. NGDP Targeting

In order to evaluate the comparison between both monetary frameworks for all the scenarios we investigate, we estimate Eq. (6) while allowing for the interactions of all

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[33] From here on we choose to use RGDP and output interchangeably as we acknowledge that output may improve the clarity of results

[34] Within the results section, when we use inflation targeting, we make reference to strict inflation targeting. That is, seeing inflation targeting as a strict decision. For more detailed explanation, please revisit the literature review chapter of this thesis.

interaction terms in Eq. (7). We make our simulation of monetary policy response under inflation targeting and NGDP targeting based on the following assumptions:

Assumption 1: According to our explained theory in the methodology section, under strict inflation targeting, a shock increase in oil price will necessitate the central bank to authorize a contractionary response for fear of possible rise in inflation.

Assumption 2: According to our explained theory in the methodology section, under NGDP targeting, the oil shock will affect growth rate of output and inflation proportionately in opposite directions. Thereby, leaving the growth rate of NGDP unchanged. Hence no response at all will be mandated of the central bank.

We believe our assumption 1 to be realistic and consistent with the literature and central bank behaviors under inflation targeting. A typical example is the Fed. Bernanke et al. (1997) report findings that suggest that the contractionary behavior of the Fed is perhaps more responsible for recessions than the oil shock itself. Although, there is no realistic epitome of NGDP targeting, we believe assumption 2 to be consistent with the literature.

Thus, following these assumptions, we identify strict inflation targeting within our empirical framework by setting $Infl_{it} = 1$ to signify monetary policy under the the guidance of the regime. We then simulate a contractionary policy of an increase in benchmark policy rate by 100 bps while keeping $Crisis_{it} = 0$ indicating the absence of crisis period. On the other hand, NGDP targeting is identified by setting $Infl_{it} = 0$ showing that monetary policy does not operate under inflation targeting framework.

The no response of monetary policy is then simulated by a no change in benchmark policy rates while also keeping $Crisis_{it} = 0$.

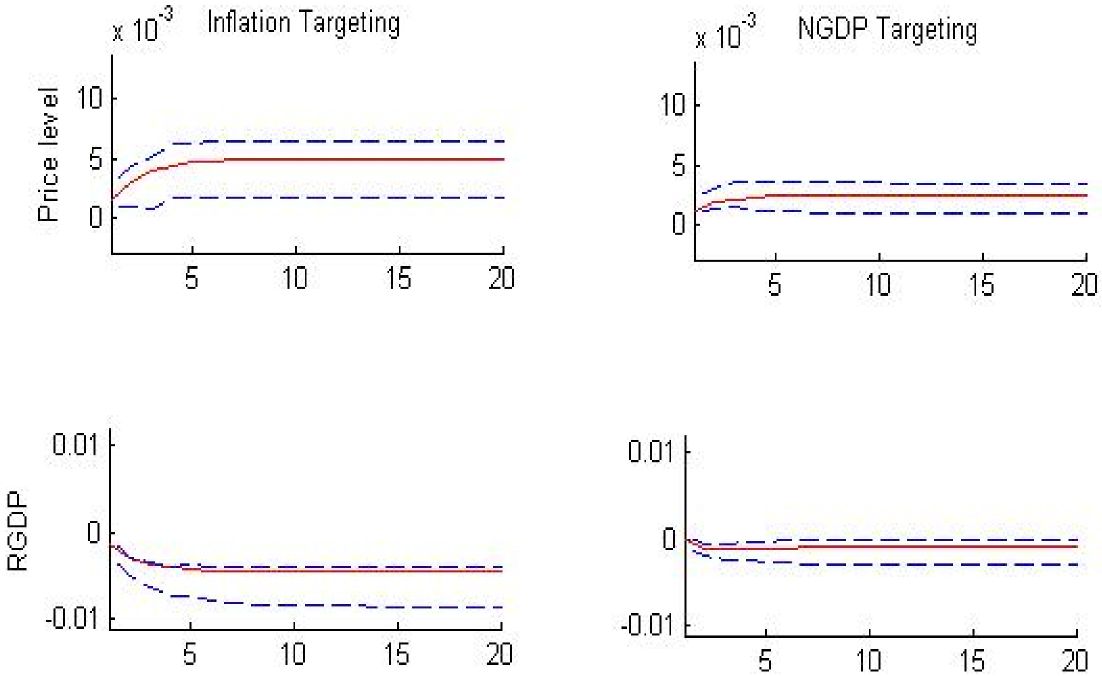

Figure 3. Impulse response for a 10% shock increase to oil prices, comparing Inflation Targeting against NGDP Targeting.

Following Figure 3, we see that under inflation targeting, inflation increases by 0.005% after seven quarters as opposed to what we have in figure 2, where the initial oil shock causes inflation to increase by 0.007%. This confirms the economic expectation that contractionary policy does, ipso-facto, cause a decrease in price level. We also observe that output growth falls below -0.002% as is what we had in figure 2. We thereby confirm the theory that contractionary policy does exacerbate declining output levels.

On the other hand, we observe that under our NGDP targeting simulated scenario, inflation increases by 0.0025% after five quarters to an initial oil shock. Output growth falls to about -0.002% after 2-3 quarters.

Considering how we estimate level of stability as the measured deviation of impulse responses from the zero base line, we observe that on both inflation and output, our NGDP targeting scenario appears to be more stabilizing after an initial shock on oil prices on an economy.

4.3.3 Inflation Targeting vs. NGDP Targeting during recessions

Considering the recent clamor for NGDP targeting as an alternative framework commenced in light of the Great Recession, we fill the urge to compare both inflation targeting and NGDP targeting under a recession while still putting in play, an exogenous shock to the system. We estimate this comparison in similar demeanor as in section 4.3.2. We make another assumption with respect to only NGDP targeting as we believe assumption 1 still holds whether or not there is a recession.

Assumption 3: In addition to an ongoing recession characterized by declining income and output, an oil shock will further dilapidate RGDP. Hence, our price level and RGDP proportionality theory would no longer hold. NGDP growth rate would be below target. Therefore, central banks would be obliged to stimulate the economy via an expansionary monetary policy.

Following assumptions 1 and 3, the only change in our inflation targeting scenario is that $Crisis_{it} = 1$ signifying crisis period, while our NGDP targeting scenario is identified by $Infl_{it} = 0$, $Crisis_{it} = 1$ and monetary policy rate falls by 100bps.

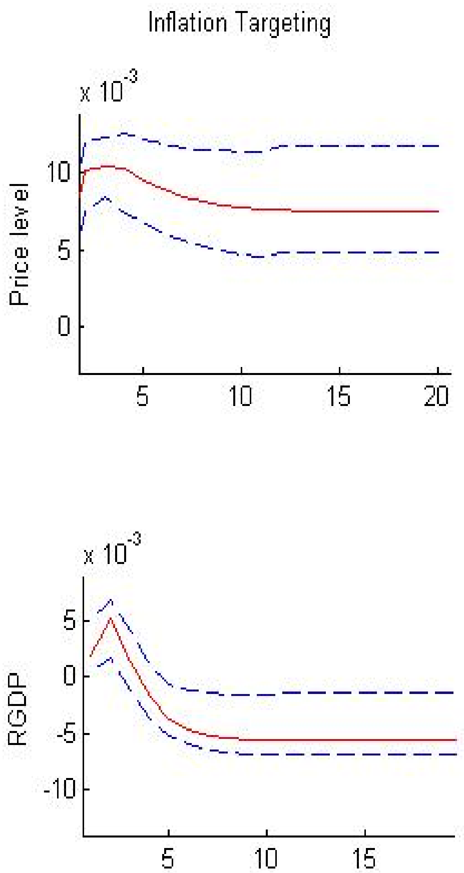

Figure 4. Impulse response for a 10% shock increase to oil prices, comparing Inflation Targeting against NGDP Targeting. (Crisis scenario)

The results obtained are outlined by Figure 4. We observe that under a crisis scenario, inflation increases sharply within the first two quarters by 0.01%, before gradually falling to 0.0085% by the 10th quarter after an initial shock. Output growth falls to -0.005% at the 10th quarter after an initial rise to 0.005% within the first two quarters when monetary policy operates under an inflation targeting framework. When monetary policy operates under NGDP targeting, we also see a sharp but lower increase in inflation by 0.008% in the first two quarters, as compared to the inflation targeting scenario, after which price level immediately begins to fall. At the 10th quarter, price level falls to 0.002%. Interestingly, we observe a similar rise in output growth to 0.008% within the first three quarters, after which this rise in output growth reduces to 0.003% at around the 3rd onwards quarter. We believe this positive response of output growth is as a result of an expansionary policy that counters the initial shock in oil prices.

In comparing both inflation and NGDP targeting within a crisis scenario, we see that our simulated NGDP targeting scenario appears to be more stabilizing than when monetary policy operates under inflation targeting.

Also, given the disparities in both figure 2 and 3 with respect to inflation and output growth under both regimes, we infer a reasonable argument that during recession, monetary policy has less stabilizing effect on macroeconomic factors as opposed to when not in recessions.

4.3.4 Flexible Inflation Targeting vs. NGDP Targeting

In the ongoing debate over whether there is a need for NGDP targeting as an alternative monetary framework, one begs to ask if there is a need for a debate. This is simply due to the fact that inflation targeting can become flexible and act in similar fashion as monetary policy under NGDP targeting. In our study we investigate this notion.

To estimate this comparison, we simulate a scenario where monetary policy operates under a flexible inflationary regime. We then investigate the performance of macroeconomic conditions after an initial oil shock when the monetary policy is guided by flexible inflation targeting against when it is guided by NGDP targeting.

In order to simulate our flexible inflation targeting scenario, we make an additional assumption:

Assumption 4: In the light of an oil shock, monetary policy under flexible inflation targeting will allow for more discretionary polices. Policy makers would boycott the demands of a strict inflation targeting regimes and allow the effect of oil shock die out. Therefore, would choose not to respond largely due to concerns of attenuating output any further.

Therefore, our flexible inflation targeting scenario is characterized by $Infl_{it} = 1$ showing that monetary policy is operating under an inflation targeting framework. Also, there is no change in benchmark policy rates while also keeping $Crisis_{it} = 0$ for no crisis period.

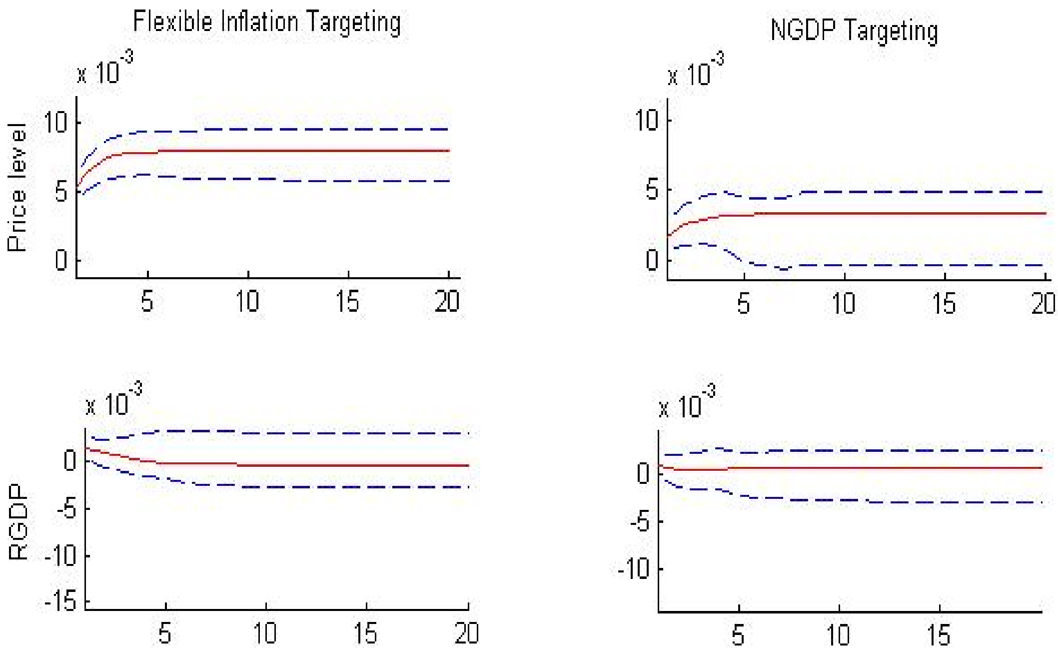

Figure 5. Impulse response for a 10% shock increase to oil prices, comparing Flexible Inflation Targeting against NGDP Targeting.

Using figure 5, we observe that under flexible inflation targeting, inflation increases by 0.008% after five quarters. Under NGDP targeting, we observe that prices rises but at a lower rate as compared to flexible inflation targeting. Inflation increases by 0.003% at the 5th quarter after an initial shock to oil prices. Under both regimes, we see that monetary policy responses are statistically insignificant in affecting output level after an initial oil shock.

With regards to stability, figure 4 shows that monetary policy under NGDP targeting outperforms flexible inflation targeting.

4.3.4 Flexible Inflation Targeting vs. NGDP Targeting during recessions

In estimating this comparison, we acknowledge the uncertainty around the possible monetary policy response under flexible inflation targeting. This is due to the discretionary policies that a flexible inflation targeting regime allows. We are not able to categorically predict the behavior of policy makers with regards to what they feel would be the best policy response while still keeping inflation rate as the key concern for this scenario. Therefore, we postulate two possible theories:

Theory 1: We believe that regardless of recessionary period, assumption 4 will still hold. Thereby, for this particular scenario, monetary policy will still not immediately respond but will allow the economy play out the oil shock before reacting to recession.

Theory 2: In the presence of a recession, we believe policy makers would immediately choose to respond. Therefore, assumption 4 does not hold.

When we investigate the scenario where theory 1 is assumed to be true, and assumption 4 does hold, we observe that the result of the comparison between flexible inflation targeting and NGDP targeting is robust for crisis and no crisis period. Monetary policy appears to have more stability over macroeconomic conditions when operating under NGDP targeting, crisis or no crisis.

Considering the scenario where theory 2 is assumed to be true, and assumption 4 does not hold, we put forward one more assumption:

Assumption 5: Given the presence of a recession characterized by declining income and output, an oil shock will result in further decline RGDP. Also, there is a chance price level falls below desired level. Either for the latter reason or for the sake of buffering output levels against the shocks, monetary policy will respond with an expansionary policy under flexible inflation targeting[35].

Following assumption 3 and 5, we then estimate for the comparison of both regimes during crisis. We identify our simulated flexible inflation targeting as $Infl_{it} = 1$, $Crisis_{it} = 1$ and there is a decrease in benchmark policy rate by 100 bps. We identify our simulated NGDP targeting the same way with the only difference being that $Infl_{it} = 0$. We estimate this comparison, and obtain the results shown in figure 5 below.

[35] Within our assumption 5, we point out the fact that strict inflation targeting will respond the same way in the event the reason for the expansionary response is due to price levels falling below target. Thus, figure 5 may apply also for comparing inflation targeting with NGDP targeting during a recession

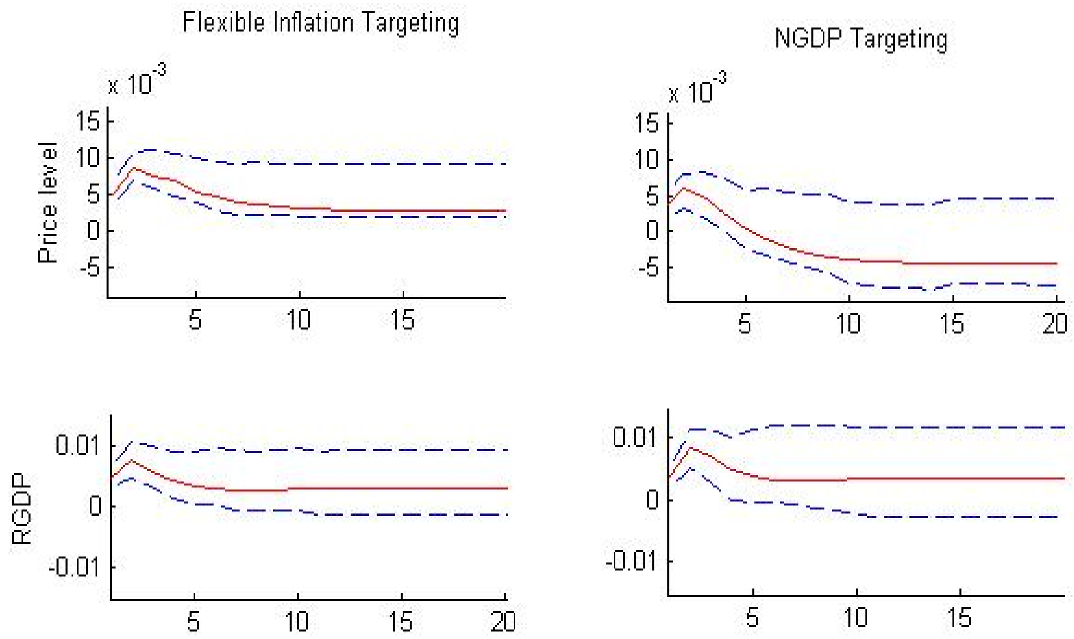

Figure 6. Impulse response for a 10% shock increase to oil prices, comparing Flexible Inflation Targeting against NGDP Targeting. (Crisis scenario)

Under flexible inflation targeting, price level rises sharply within the first two quarters to 0.009% before gradually falling to 0.005% at the 7th quarter. Under NGDP targeting, similar to flexible inflation targeting, price level rises to 0.007% within the first 2-3 quarters after which it begins to fall to -0.005 after the 7th quarter. Output growth on both occasions, rises sharply to 0.009% after two quarters, before steadying at about 0.005% from the 5th quarter after which the effect of monetary policy becomes statistically insignificant. We believe the positive response of output is as a result of an expansionary policy.

With regards to stability, both regimes perform equally concerning output levels. Figure 6 highlights the uncertainty over the stability power of monetary policy on price levels under both regimes during a crisis period.

4.3.5 Inflation Targeting vs. Flexible Inflation Targeting (Decision rule or framework)

We go further to investigate how inflation targeting is best applied. Should it be conceived as a decision rule or as a discretionary framework? To investigate this issue, we simply compare the performance of monetary policy under a strict inflation targeting regime with monetary policy performance under a flexible inflation targeting regime. This comparison makes sense considering our evaluation of a strict inflation targeting is based on it being a strict decision rule. While our evaluation of flexible inflation targeting is based on a discretionary framework which permits policy makers to sometimes forgo inflation concerns and do what is best for economic stability in a given circumstance. Therefore, we estimate this comparison following assumption 1 and 4. We identify strict inflation targeting as $Infl_{it} = 1$ and an increase in benchmark policy rates by 100 bps. Our simulated flexible inflation targeting is identified the same way with exception to changes in benchmark policy rates. In the case of flexible inflation targeting, there is no change in benchmark policy rates. Since we use the comparison between strict inflation targeting and flexible inflation targeting as a proxy for comparison between inflation targeting as a strict decision rule and as a discretionary framework, we are not particularly concerned with the crisis dummy. Therefore we set $\beta_{l,4}^{ab} = 0$ from Eq. (7).

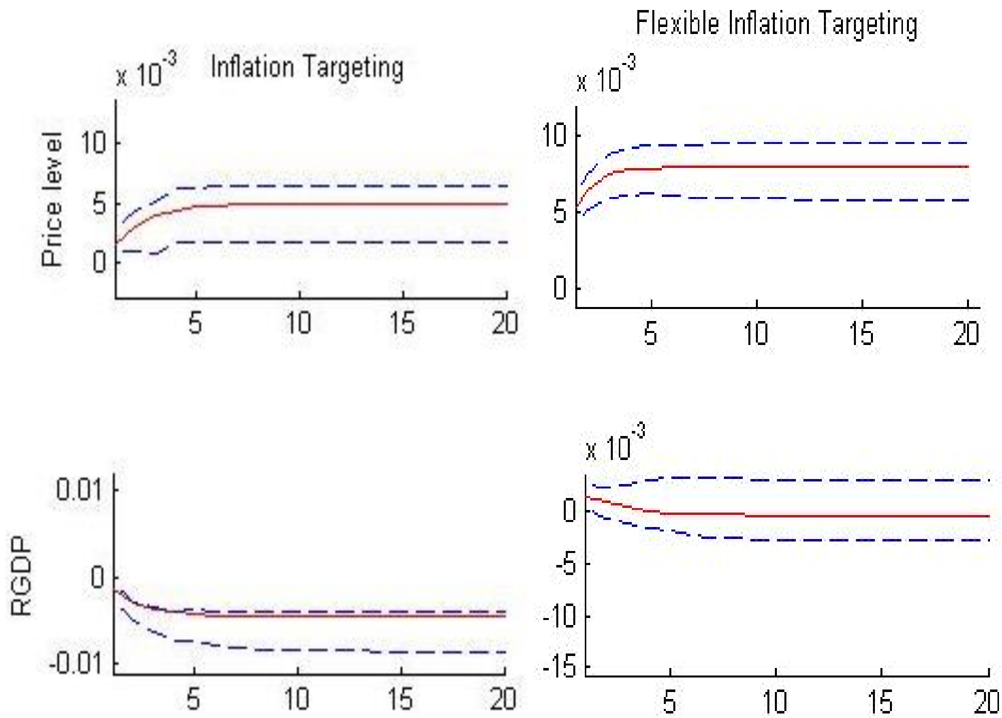

Figure 7. Impulse response for a 10% shock increase to oil prices, comparing Inflation Targeting against Flexible Inflation Targeting.

Following figure 7, we observe that when inflation targeting operates as a decision rule, monetary policy has more stability power over inflation than when inflation targeting operates as a discretionary framework. With respect to output, when inflation targeting operates as a strict decision rule, its mandated contractionary policies tend to cause further decline in output after an initial oil shock. As for inflation targeting operating as a discretionary, figure 7 shows that the effect of monetary policy is statistically insignificant in affecting output. Thus, we may be led to infer that inflation targeting as a decision rule provides more stability after an initial oil shock.

Chapter 5

CONCLUSION

In conclusion, our study attempts to empirically compare between inflation targeting framework and NGDP targeting framework. We do so using an IPVAR, which allows us to identify variances in macroeconomic conditions as a result of simulating different monetary policy responses under different targeting regimes in accordance to expected theories. Various authors and monetarists provide theoretical and few empirical studies in support of NGDP targeting. In the same spirit, our findings show that monetary policy under NGDP targeting performs better at stabilizing macroeconomic conditions as opposed to when guided by inflation targeting. We show that this finding is robust for whether the economy is in a recession or not. We also find that comparison between flexible inflation targeting and NGDP targeting is uncertain especially during a recession. This is due to the difficulty in predicting what policy makers may feel is the appropriate response in a given circumstance. Although, our findings show that NGDP targeting performs better than flexible inflation targeting when not in a recession. We go further to show that monetary policy has more stabilizing power when guided by inflation targeting as strict decision rule, as opposed to a discretionary framework. We believe this is due to the inconsistency in policy decisions that may possibly arise when policy makers are allowed discretionary freedom. In the process of our study we confirm the findings of various authors on the effectiveness of monetary policy and oil shocks. We find that contractionary policy in response to an oil shock further exacerbates the decline in output levels.

While our findings show support for a NGDP targeting regime, we clearly outline the operational difficulties in the implementation of such a regime while also pointing out key benefits of continued operation of monetary policy under an inflation targeting framework. Whether or not central banks adopt NGDP targeting largely depends on a clear a feasible medium as to how it will operate given the fact that there are no cases of such at the moment, and the literature remains nebulous. However, given our empirical findings, we may infer that a successful implementation of NGDP targeting may in fact give monetary policy better combating power against recessions. Although, given the genesis of the Great Recession postulated to be asset price bubbles, we clearly outline the coyness of the literature on how NGDP targeting would have prevented the Great Recession. Also, it is worth noting that it may be easier to continue with an efficiently modified and implemented version of what we already know works giving international evidences from inflation targeting countries.

Within our methodological framework, we acknowledge that our findings are, to a large scale, based on subjective economic theories and assumptions. Although, we believe the theories and assumptions to be consistent, realistic and in line with the literature, we do recognize their possible fallibility. Also, our findings do not control for reactions of macroeconomic factors based on expectation theories, or forward guiding behaviors, which are part of how monetary frameworks operate. Additionally, it advisable for future research to build upon our methodology for a panel of developing countries and compare the findings with our study. Judging from international evidences, we believe that it is possible that countries with double-digit or relatively high inflation- largely developing economies- would tend to do better with inflation targeting. Therefore, NGDP targeting may be a feasible and prosperous framework for only economies that already know how to “tame the beast” inflation i.e. advanced economies.

APPENDICES

Appendix A

Inflation Targeters

Table A 1. Inflation targeters and their year of adoption.

Year	Country
1990	New Zealand
1991	Canada
1992	United Kingdom
1993	Sweden
	Australia
1997	Israel
1998	Czech Republic
	South Korea
1999	Poland
	Columbia
	Chile
	Brazil
2000	Switzerland
	Thailand
	South Africa
2001	Norway
	Iceland
	Mexico
	Hungary
2002	The Philippines
	Peru
2006	Turkey
2012	United States

Source: Official web pages of central banks

Note: There is not yet an official declaration of the adoption of inflation targeting from the official web page of the Fed. Nonetheless we do include the U.S as inflation targeters given the public declaration of a point target of 2% made by the Fed as at January 2012.

Table A 2. Inflation targeters and their inflation targets as of 2015

Countries	Inflation targets
Australia	2-3%
Brazil	4.5% (+/- 2%)
Canada	2%
Chile	3% (+/- 1%)
Columbia	3%
Czech Republic	1-3%
Hungary	3%
Iceland	2.5%
Israel	1-3%
Mexico	3%
New Zealand	1-3%
Norway	2.5%
Peru	2%
Poland	2.5% (+/- 1%)
South Africa	3-6%
South Korea	3% (+/- 0.5%)
Sweden	2%
Switzerland	Less than 2%
Thailand	2.5% (+/- 1.5%)
The Philippines	3% (+/- 1%)
Turkey	5% (+/- 2%)
United Kingdom	2%
United States	2%

Source: Official web pages of central banks

Note: the values within the bracket denote the corridor target range

Appendix B

Data

Table B 1. Data source and description

Variable	Source	Description
Economic growth (Output) - Real gross domestic product (RGDP)	OECD statistics	Quarterly seasonally adjusted RGDP in billions of chained 2009 prices
Inflation - Consumer price index (CPI)	OECD statistics	CPI including all prices Seasonally adjusted. Quarterly data aggregated using average. Index 1982-1984 = 100.
Crude oil - Nominal oil price	U.S Energy Information Administration	Crude oil prices – Brent spot Cushing price, dollars per barrel. Quarterly data aggregated using average
Inflation targeting periods	Official web pages of central banks	Periods under inflation targeting framework spanning 1986-2015 across countries
Monetary policy - Benchmark policy rates	DataStream	Benchmark policy rates, not seasonally adjusted. Quarterly data aggregated using average.

Table B 2. Crisis periods

	Peak (beginning of crisis)	Trough (end of crisis)
The mild recession of the early 90s	Q3 1990 July	Q1 1991 March
The Dot-Com bubble	Q1 2001 March	Q4 2001 November
The Great Recession	Q4 2007 December	Q2 2009 June

Source: NBER

Appendix C

Pre-estimation tests: Augmented Dickey-Fuller (ADF) test

The ADF test is estimated in the following form:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta \; Y_{t-1} + \sum_{i=1}^{m-1} \alpha_i \Delta Y_{t-i} + \varepsilon_t \tag{16}$$

With,

$$\alpha_i = -\sum_{k=i+1}^{m} \delta k \qquad \text{and} \qquad \delta = \left(\sum_{i=1}^{m} \delta_i \right) - 1$$

Under the hypothesis that H_0 = Unit-root, H_1 = No unit-root

Or the hypothesis that $H_0 : \delta = 0$, $H_1 : \delta = 1$

Where *Y* represents the series for the independent variable; *t* = time; β = intercept; ε_t delineates the Gaussian white noise, and *m* = the length of lags. In this study we deploy the ADF test with *m* = 0. It is worth mentioning that the formulation above is a depiction of the most general and unrestricted form of the ADF test. The ADF test can be further estimated in more restricted models by the preclusion of the trend and drift terms. In our study we estimate our test including the trend and drift terms, after which we preclude the trend term.

Pre-estimation tests: Phillips-Perron (PP) test

The Phillips-Perron unit root coefficient as estimated by Newey-West (Bartlett-Kernnel) is expressed as follows:

$$\omega_k = \frac{1}{T}\sum_{s=k+1}^{T} \ell_t \ell_{t-s} \qquad k = 0,\ p = k^{\text{th}} \text{ auto-covariance of residuals}$$

$$\omega_0 = \left[(T-K)/T\right]s^2 \qquad \textit{where} \qquad s^2 = \frac{\sum_{t=1}^{T} \ell_t^2}{T-K}$$

$$\gamma = \omega_0 + 2\sum_{k=i+1}^{n}\left(1-\frac{k}{n+1}\right)\omega_k \tag{17}$$

Under the hypothesis that H_0 = Unit-root, H_1 = No unit-root.

n as appear in the equation above indicates the restricted lag form for estimating the PP test statistic. ω_k is the correlation coefficient of changes in residuals. Similar to our estimation technique in ADF, we test using both unrestricted and restricted model (including only drift term).

Table C 1. Unit root test using Im, Peseran and Shin test

Statistics (Level)	Central bank rates	lag	LRGDP	lag	LCPI	lag	LCrude oil	lag
τ_T (IPS)	-2.8699*	(2)	-0.04970	(2)	-2.12377**	(2)	-0.11098	(2)
τ_μ (IPS)	-0.81091	(2)	-0.86724	(2)	-5.81960*	(2)	-1.96489	(2)
Statistics (First Difference)	Central bank rates	lag	LRGDP	lag	LCPI	lag	LCrude oil	lag
τ_T (IPS)	-10.5768*	(2)	-9.12493*	(2)	-11.7275*	(2)	-12.4406*	(2)
τ_μ (1PS)	-11.4409*	(2)	-9.68431*	(2)	-9.40172*	(2)	-13.3085*	(2)

Source: Author's estimation via Eviews.

Note: This table shows the estimation results of a stationarity test using IPS technique. (τ_T) signifies the the inclusion of a trend and drift term in our test. (τ_μ) indicate the inlusion of just a drift term in our estimations. *, ** and *** indicates the rejection of the null hypothesis (H_o), that is- the hypothesis that series are non-stationary- at 1%, 5% and 10% significance level respectively. Lag lengths, values in brackets, are computed according to Newey-West bandwidth deploying the estimation technique of Bartlett-Kennel. It is also worth noting that given the imperativeness of attaining, of uthmost certitude, stationary series- we pay attention to only results that highlight a rejection at 1% denoted by *.

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