ESSAYS ON MACROECONOMIC POLICY AND INFLATION IN LOWER-INCOME COUNTRIES

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Thesis submitted to
The University of Nottingham
for the degree of Doctor of Philosophy

June 2018

Nottingham School of Economics

Abstract

This thesis critically analyses the deficits-inflation nexus and inflation targeting in lower-income countries. Previous research has found a significant relationship between fiscal deficits and inflation in low-income countries, but not in high-income countries. It is shown here that the crucial factor is the quality of institutions. The relationship holds in countries with weak institutions, but not in those with strong institutions, even if their per capita GDP is quite low. The implication is that institutional improvements can enhance macroeconomic outcomes in poor countries. The robustness of the findings is tested using various measures of institutional quality. On the other hand, we provide new insights on inflation targeting (IT) in low-income countries. Previous research on inflation targeting has focused on high-income and emerging market economies since low-income countries (LICs) were slow to adopt the framework. Only recently has enough data accumulated for the performance of IT in LICs to be assessed. We show that unlike in emerging markets, in LICs IT is not been effective in reducing inflation. Weak institutions, a typical feature in LICs, do help explain this especially when we examine their role under floating exchange rate regimes. Finally, we characterise monetary policy in Ghana, one of the earliest low-income countries to adopt an IT framework, but where IT has not been very successful in reducing the levels and volatility of inflation within a modified Taylor rule. We investigate whether poor conduct of monetary policy is responsible for the poor performance of IT and find that is not. Monetary policy reaction functions are similar to those estimated for countries with successful monetary policies, and interest rates respond in the theoretically recommended way to inflation shocks.

Acknowledgements

I would like to thank my supervisors, Professor Michael Bleaney and Dr. Atsuyoshi Morozumi, for their extraordinary patience and invaluable guidance throughout the process of this research. I am grateful to Professor Tim Lloyd, who was part of the team at the early stages for his support. I am grateful to the School of Economics for the opportunity. Indeed, it has been an exciting experience.

I am grateful to the Ghana Education Trust Fund (GETFUND) and the Bank of Ghana, my employers for providing the financial support for this research. I am particularly grateful to the Management of the GETFUND and the Bank's Management for the support.

I would also like to thank the participants of the various Ph.D conferences (at the School of Economics; the Macro Money and Finance Conference at University of Birmingham and the European Public Choice Society Conference at the University of Freiburg, Germany). I would like to thank Professor Oliver Morrissey for his usually detailed additional comments and suggestions after the conference and Dr. Markus Eberhardt for graciously giving me access to his material. Many other professors and Ph.D students at the School of Economics have helped me to improve my research with specific comments, or through discussions over the years of my Ph.D. I would like to thank my office (B49) colleagues in the School of Economics for their support.

I am grateful to my examiners, Professor Kevin Lee, Head of School of Economics and Professor Christopher Bowdler, University of Oxford for the time they devoted to reading this thesis and their thorough and insightful comments during the viva voce examination.

Finally, and probably most importantly, there are many friends and family members whose support made this research possible and I owe them special thanks for all their support.

I am solely responsible for remaining errors.

Table of Contents

List of Tables

List of Figures

Chapter 1
General Introduction

1.1 Background

The main motivation of this thesis is to provide new insights on the conduct of macroeconomic policy in lower-income countries where severe institutional constraints are commonplace. The first part, comprising of chapters 1 – 4, deals with issues of fiscal deficits and inflation. This section follows the strand of the literature espoused in Sargent and Wallace (1981), that under a regime of "fiscal dominance" (that is unconstrained fiscal policy) deficits may be covered in the short run by borrowing, but in the long run they are financed by seigniorage (printing of money). Empirical evidence has established a significant relationship between fiscal deficits and inflation in the long run especially in low-income countries, but not in high-income countries (Catão and Terrones, 2005; Lin and Chu, 2013 and Bleaney and Francisco, 2016). We provide a theoretical and empirical extension of the literature in this section.

Our baseline theoretical model and empirical strategy are based on the work of Catão and Terrones (2005). However, unlike Catão and Terrones (2005), we incorporate the role of institutions in the model. At the outset however, it is useful to clarify the type of institutions examined, because institutions, defined as rules and organisations of a society that affect economic incentives of different agents and shape interactions among them, is a fundamentally broad concept. The focus here is on the type of institutions which prompt a government to be accountable to the public, rather than ones affecting citizen-citizen relations. These include institutions such as competitive elections, transparency of government policies, and freedom of media, which are all expected to constrain governments' behaviour and facilitate the public's political participation.

The model is a simple monetary model of an endowment economy without uncertainty, consisting of a government and infinitely-living

households. Money is incorporated into the model following the money-in-utility (MIU) approach, i.e., by assuming that households' utility is increasing in real money balances due to transaction services money brings (Sidrauski, 1967). Governments finance deficits either by issuing bonds or by creating money. Fundamentally, we assume that under weak institutions, where government officials are unconstrained, there are leakages in tax revenues, and this siphoning of the revenues by corrupt officials creates economic inefficiency and ultimately inflation through its impact on seigniorage.

We test this model on a large sample of countries using a methodology that allows for cross-country heterogeneity and cross-sectional dependence (unobserved common factors) across the countries, that is, correlation of residuals across countries in each year. The choice of this methodology is motivated by the following two observations. First, in general, an increasing number of works illustrate the importance of cross-section dependence in macroeconomic panel analysis (see for instance Chudik *et al.* 2013 and Eberhardt and Presbitero, 2015). Second, in the context of the present chapter, common unobserved international shocks such as the recent financial crisis of 2007-09 may affect the deficits-inflation nexus across countries[1], and also fiscal policies have international spill-over effects on macroeconomic variables (including inflation rates) in other countries, as illustrated in the theoretical literature on new open economy models initiated by Obstfeld and Rogoff (1995).

The second part of the thesis, comprising chapters 5 and 6, deals with inflation targeting (IT). In this section, we extend the empirical literature on inflation targeting to the experience of lower-income countries. Previous research on IT focused on high-income and emerging market economies. Only recently has enough data accumulated for the performance of IT in low-income countries (LICs) to be assessed. We show that unlike in emerging markets, in LICs IT is not effective in reducing inflation. Weak institutions, a typical feature in LICs, help to explain this difference especially when we examine their role under floating exchange rate regimes. Finally, we provide a case study of

[1] The financial crisis affected not only advanced economies, but also a large number of emerging market economies (See, e.g., (Blanchard *et al*. 2013, 2010)), thus covering countries with a wide variety of institutional qualities.

monetary policy in Ghana, the first low-income country in Africa to adopt an IT framework, but where IT has not been very successful in reducing the levels and volatility of inflation. We examine whether the conduct of monetary policy is responsible and find that it is not. Monetary policy reaction functions are similar to those estimated for countries with successful monetary policies, and interest rates respond in the theoretically recommended way to inflation shocks.

We note an important difference between the empirical models applied in chapters 2 and 3 (where we analyse the fiscal deficit – inflation nexus) and those in chapter 5 (analysis of the effect of IT across countries). An important control in both cases is the quality of institutions, and since institutional quality evolves only slowly (i.e. little time variation), we split the data into strong and weak institutions in both chapters in an attempt to analyse the role of institutions.[2] However, in chapters 2 and 3, we applied a heterogeneous panel data methodology that also allowed for cross-country heterogeneity because all countries in the sample have data on fiscal balance and over an extended time span which makes it possible to apply such a methodology. In contrast, the chapter 5 model contains a dummy variable for IT which is zero throughout the sample for countries that have never switched to IT, and that means those countries would have to be excluded from the sample if the methods used in chapters 2 and 3 were used in chapter 5. Then the sample of countries would be too small to split the sample by institutional quality, as in chapter 2. Therefore it seems better to use fixed effects methods in chapter 5. Moreover, since some previous research on IT has applied this methodology on different samples (Mishkin and Schmidt-Hebbel, 2007; Gemayel *et al.* 2011), the approach similarly allows us to be comparable with these studies.

[2] A number of studies have followed this approach in the analysis of institutions (for instance see Acemoglu *et al*. (2008)).

1.2 Thesis Outline

The rest of the thesis is organised as follows. In Chapter 2, the first of our three main chapters, we provide an empirical analysis of the fiscal deficit-inflation nexus based on panel data methodology that allows for cross-sectional heterogeneity and cross-sectional dependence, incorporating differences in institutional quality to explain recent findings on the nexus. In Chapter 3, we examine closely the alternative macroeconometric panel estimators applied in chapter two. The main purpose of this chapter is to compare estimates from the Mean Group (MG) and Pooled Mean Group (PMG) which allow for complete (MG) or considerable degree (PMG) of parameter heterogeneity on the one hand, and on the other, the traditional dynamic fixed effects or two-way fixed effects models that allow for country-specific effects but constrain all slope parameters to be similar across countries. We further show that under the mean group estimator, the mean of the individual country coefficients can easily be distorted by outliers leading to biased estimates and potentially misleading inference. In this case, two alternative estimators, the median and robust regression estimators, present more reliable estimates.

In chapter 4, we develop a simple theoretical model of the inflation-fiscal balance nexus that includes a role for institutions. The model is a simple money-in-utility (MIU) monetary model in which lack of institutional quality (i.e. the quality of institutions and governance) is modelled as net loss of fiscal resources. This may arise from inefficiencies in the tax system (for instance bureaucratic corruption, high collection costs and tax evasion) leading to lower government tax receipts. Thus, the poorer the institutional quality, the greater is this loss.

In Chapters 5 and 6, our remaining two main chapters, we shift to the analysis of inflation targeting with a focus on the experience of low-income countries. Using a broader set of countries than previous research, which allows for the experience of low-income countries to be assessed as a separate group in chapter 5, we show that, unlike in emerging markets, in LICs IT is not effective in reducing inflation. Differences in institutions do help explain this if we examine their role particularly under floating exchange rate regimes. Our interpretation is that even when exchange rate flexibility is met as a prerequisite

for IT, unconstrained governments and poor institutions undermine central bank independence significantly, making it difficult for IT to work successfully.

Finally, using data on Ghana, the first low-income country in Africa to adopt IT and where the framework has been less successful in significantly reducing the level of inflation, we investigate whether poor conduct of monetary policy is responsible for this outcome and find that is not. Monetary policy reaction functions are similar to those estimated for countries with successful monetary policies, and interest rates respond in the theoretically recommended way to inflation shocks.

Chapter 7 summarises the key findings and contributions of the study, and also provides policy implications. The chapter also discusses the limitations of the research and makes appropriate recommendations for future research.

Chapter 2

Fiscal Deficits and Inflation: Institutions Matter

"Government deficits can and sometimes do contribute to inflation. However, the relation between deficits and inflation is far looser than is widely believed. Moreover, the major harm that deficits do is foster irresponsible government spending." (Friedman, 1981, p. 1)

"….. new view of price determination and control suggests that the statutory independence of the central bank is not sufficient to achieve it. The central bank can only achieve price stability if is supported by an appropriate fiscal policy." (Canzoneri *et al.* 2011, p. 937)

2.1 Introduction

In this chapter, we provide an empirical analysis of the fiscal deficit-inflation nexus, incorporating a role for differences in institutional quality to explain recent findings on the relationship. We use a panel data methodology that allows for cross-sectional heterogeneity and cross-sectional dependence.

The interaction between fiscal and monetary policy has long been recognized as important in macroeconomic theory and policy. Large and persistent fiscal deficits in particular, have been shown to influence a country's inflation dynamics (Friedman, 1968; Sargent and Wallace, 1981). In economies with considerable tax-capacity constraints and underdeveloped financial markets, seigniorage revenues provide a 'captive' source of revenue for funding government's intertemporal budget constraints precisely because of their lower relative cost (Dornbusch *et al.* 1990; Catão and Terrones, 2005). In terms of evidence, although the correlation between fiscal deficits and inflation has often proved difficult to establish[3] (e.g. Grossman, 1982; De Haan and Zelhorst, 1990; Hondroyiannis and Papapetrou, 1997), recent studies based on a large country sample and making use of advances in modelling techniques generally support the hypothesis that fiscal deficits are inflationary in the long run, especially in

[3] As shown by Friedman (1981) in the quote above.

developing countries and economies with high inflation (Catão and Terrones, 2005; Lin and Chu, 2013).

This chapter aims to add to the empirical strand of the literature, by examining the possible role of institutions in the nexus. Institutions are "the rules of the games in a society", and may include both "formal" rules such as constitutions and laws enforced by the state and "informal" constraints such as "codes of conduct, norms of behaviour, and conventions" which, generally, are enforced by the members of the relevant group (North, 1991, p.97). Since Hall and Jones (1999) and Acemoglu *et al.* (2001) , various studies have shown that weak institutions have unfavourable long-run macroeconomic effects. Moreover, these studies also show that developed countries have much better institutions than developing countries.

Given the emerging consensus about the primacy of institutions, it is natural to think that differences in institutional quality could possibly explain the recent findings that fiscal deficits are inflationary in developing countries and high inflation economies and not in advanced, low-inflation countries. First, in advanced economies, institutions may prompt a government to rely less on seigniorage as a financing source of deficits. Specifically, when citizen's political participation is guaranteed in those economies, the political leadership may be more sensitive to the public's dislike for inflation, so that fiscal shocks that lead to a build-up of public debt tend to induce fiscal consolidations rather than a resort to seigniorage revenue, as documented for the United States by Bohn (1998). Second, to the extent that governments in low-income countries are susceptible to low credibility amid weak institutions of their countries, they may have a limited access to the international capital market (e.g., Kumar and Baldacci, 2010). This, in turn, may imply that such countries find it less costly to finance deficits with seigniorage than with borrowing, strengthening deficits-inflation nexus as a result.

An illustration of the role of institutions is formally presented in a theoretical model in chapter 4. Using a simple Money in Utility (MIU) model in which weak institutions is modelled as net loss of fiscal resources to government, the chapter shows that weak institutions yield a higher long run inflation for a

given deficit. Two reasons account for this. First, under weak institutions (i.e. inefficient tax collection), a higher deficit resulting from tax revenue leakage raises the amount of seigniorage to finance a given deficit. The higher seigniorage is achieved with higher money supply growth rates that leads to higher inflation rate. On the other hand, for given deficits, lower private consumption, due to a crowding-out under weak institutions, leads to higher inflation. This is because with lower consumption, real money balance is lower, which, in turn, must be compensated by higher money supply growth rates, i.e., higher inflation rate (to keep the same level of seigniorage, equivalently, deficits). Thus, under weak institutional quality, equilibrium inflation is higher (i.e., through higher deficit/seigniorage, and through lower consumption).

Moreover, specifically, acknowledging however, that the quality of institutions, which could be proxied, for instance, by the degree of property rights protection, tends to be positively associated with the income level of a country, we examine whether the difference in institutional quality still matters, *even among* low-income countries. This exercise is motivated by the possibility that poor institutions, even for a given income level, may reduce the relative cost of seigniorage, thus yielding inflation in the long run. This is yet to be systematically investigated across a large panel of countries in studying the fiscal balance – inflation nexus.

Using an extended dataset over the period 1970 – 2013 for 67 countries, we find that institutions matter for the relationship between fiscal deficits and inflation. While confirming in the context of our dataset that the relationship is stronger for lower-income countries as in previous studies, we show that *even* among these countries, the quality of institutions still does matter, making the relationship significantly stronger for countries with weak institutions.[4] Importantly, while we obtain these results by applying the Mean Group and Pooled Mean Group estimators (proposed by Pesaran and Smith, 1995; Pesaran *et al.* 1999, respectively) as in Catao and Terrones (2005) we *further* address the possible presence of cross-section dependence (CSD) in our panel dataset, which

[4] For this study, lower income countries are countries classified by the World Bank as either low- or lower middle-income countries.

would yield endogeneity problems when ignored (Pesaran 2006; Binder and Offermanns, 2007; De Hoyos and Sarafidis, 2006; Chudik *et al.* 2011; Chudik and Pesaran, 2013; Eberhardt and Presbitero, 2015). In fact, this chapter shows that without taking account of this dependence, the fiscal deficits-inflation nexus often becomes less distinct especially in examining the role of institutions, suggesting the importance of addressing this source of endogeneity in the nexus. We show that these results still stand to various robustness checks, including: 1) the use of different proxies of institutional quality; 2) the way countries are classified into higher- and lower-quality institutions (with different thresholds); and 3) controlling for central bank independence (CBI) as well as other variables such as oil prices and exchange rate schemes – well-known drivers of inflation across countries.

The rest of the chapter is organized as follows. In section 2.2, we present a brief review of the relevant theoretical and empirical literature. Section 2.3 sets out the theory and empirical methodology while section 2.4 presents the empirical results. Section 2.5 concludes.

2.2 Review of Relevant Literature

2.2.1 Theoretical Literature

Much of the theoretical literature revolves around two main views about inflation, namely the monetarist view based on the quantity theory of money which emphasizes *"inflation is always and everywhere a monetarist phenomenon"* and the fiscal theory of price level (FTPL) in which inflation is essentially driven by fiscal policy. Two versions of the FTPL have been discussed in the literature – the weak and strong versions (Ekanayake, 2012).

The first relates to the strand espoused by Sargent and Wallace (1981) in the unpleasant monetarist arithmetic. According to this view, under certain conditions, depending on the nature of the relationship between the fiscal and monetary authorities, higher budget deficits may, rather than lead to increased taxes, result in monetary accommodation that fuels inflation, especially where the link between inflation and high powered money is strong. Canzoneri *et al.* (2011) show that the interaction between monetary and fiscal authorities is one

of a "game of leadership" and depends on whether the monetary authority or fiscal authority makes the first move in the process of satisfying government's consolidated budget constraint. Two strategies are therefore identified, namely *monetary dominance* or *fiscal dominance*. The former relates to a situation where the central bank makes the first move, fixing a path of seigniorage consistent with the inflation target, which then constrains the fiscal authorities to set a path of primary surpluses consistent with these targets. Conversely, under *fiscal dominance* the fiscal authorities make the first move in setting the path of current and future debt and deficits, thus requiring the central bank to sooner or later, deliver segniorage revenues to satisfy the constraints imposed by the fiscal authorities. This leaves monetary policy with limited role over the control of money supply and ultimately inflation. Put differently, as the fiscal authority independently sets its budgets, the monetary authority faces constraints imposed by the demand for government bonds and must cover any shortfalls to the budget, ultimately through seigniorage. The creation of money to accommodate the large deficits in this case will imply the monetary authority must tolerate additional inflation.

The strong version of FTPL is based on a non-Ricardian equivalence hypothesis under which inflation is driven by fiscal forces (debt, current and future budgetary arrangements) with no role for monetary policy (Leeper, 1991; Woodford, 1994; Sims, 1994). Economic agents view a shift from tax to debt finance, for a given level of current government spending, as creating wealth which spurs aggregate demand and ultimately inflation, with no role for monetary variables. The price dynamics ensure government's inter-temporal budget constraints (Ekanayake, 2012). In contrast, with the Ricardian equivalence hypothesis, an increase in fiscal deficits does not affect real interest rates and thus aggregate demand and inflation (Barro, 1978; 1989). In this setting, future taxes implicit in the deficit of public debt are fully capitalized and therefore the shift from tax to debt finance does not have any initial expansionary impact on aggregate demand and prices (Barro, 1978).

2.2.2 Empirical Literature

Conflicts between the standard predictions above and empirical studies have spurred considerable interest in examination of the link between fiscal deficits and inflation. These studies, using a broad array of methodologies (time series analysis of individual countries, cross-section or even panel data methodologies), have yielded varied and generally inconclusive results.

A number of early studies, examining the relationship based on data from advanced countries, generally point to a statistically insignificant relationship (Grossman, 1982; Hondroyiannis and Papapetrou, 1997). Grossman (1982) for instance, investigates the experience of the United States of America over the period 1953 to 1981, concluding that monetary policy, inflation, and aggregate economic activity are all largely independent of the fiscal deficit. Similarly, Hondroyiannis and Papapetrou (1997) in their study of the case of Greece provide evidence that shows no direct impact of fiscal deficits on inflation. Further, De Haan and Zelhorst (1990), studying 17 developing countries for the period 1961 to 1985 could not provide general support for the hypothesis, except that there is high correlation in periods of high inflation.

On the other hand, a number of studies, building on Sargent and Wallace (1981), find support for the hypothesis of a strong link between fiscal deficits and inflation during episodes of hyperinflations (Edwards and Tabellini, 1991; Darrat, 2000; Fischer *et al.* 2002). Fischer *et al.* (2002) in their study of the experience of 94 countries using a fixed effects model with both country and time dummies, conclude that the fiscal balance drives inflation especially in high inflation periods. More recently, Catão and Terrones, 2005; Lin and Chu, 2013; and Ishaq and Mohsin, 2015, using either broad-based datasets or advanced panel data techniques, provide evidence in support of the hypothesis that fiscal deficits are inflationary. Similarly, Ekanayake (2012) used time series to analyse the case of Sri Lanka for the period 1959 to 2008, and provides evidence that fiscal deficits are inflationary and the link is particularly strong when the deficit includes wage expenditures.

Lin and Chu (2013) apply a dynamic panel quantile regression under the ARDL model to account for a possible selection bias in the country groups in

the face of significant heterogeneity and to allow for dynamics in their study of the deficit–inflation relationship across 91 countries from 1960 to 2006. Results from the study show that the impact of deficits on inflation varies across different quantiles of inflation. Fiscal deficits are inflationary in high- and middle inflation episodes, and are weakly or insignificantly related to inflation in low-inflation episodes. The study thus suggests that considering the heterogeneous effects of deficits on inflation is important in resolving the puzzle between theoretical and empirical studies while fiscal consolidation would be more effective in price stabilization the higher the inflation rate.

Most closely related in motivation to this work is Catão and Terrones (2005) who use annual data from 1960 to 2001 on an unbalanced panel of 107 countries to test this relationship using an ARDL specification based on the Mean Group (MG) and Pooled Mean Group (PMG) estimators proposed by Pesaran and Smith (1995) and Pesaran *et al.* (1999) respectively. They find that the hypothesis holds for developing countries, but not for advanced countries. A natural explanation for this is that, at least for many lower income countries, there are tight borrowing constraints on government debt which, alongwith prevailing tax-capacity constraints, imply increased reliance on seigniorage revenues. In contrast, for advanced countries, a negative shock can be met by considerable expansion of government borrowing and dramatic increases in debt levels, such as has occurred in the wake of the global financial crisis. The difference is the degree of investors' confidence that debts will be repaid in full. There is a long history of sovereign debt defaults that result in significant losses to investors (Edwards, 2015). Therefore, it seems plausible that investors' willingness to lend reflects the social and political environment that pertains in a country, or what is sometimes referred to as the "quality of its institutions".

Previous research has shown that weak institutions have unfavourable long-run macroeconomic effects (Hall and Jones, 1999; Acemoglu *et al.* 2001). Acemoglu *et al.* (2001) for instance study the relationship between property rights and economic growth using instrumental variable approach and find large effects of institutions on income per capita. Weak institutions not only fail to reassure economic agents about the smooth functioning of both market and non-

market mechanisms within the economy, but also severely limit the availability of and access to external financing (see Baldacci and Kumar, 2010), thus possibly reducing the relative costs of seigniorage revenues. Figure 2.1 which plots average institutional quality (including corruption, rule of law and bureaucratic quality from the International Country Risk Guide (ICRG) index) and average ratings (based on the Fitch ratings) provides some support for this effect.[5] The figure provides preliminary evidence that bad institutions are significantly positively correlated with poor ratings. This suggests that bad institutions potentially limit access to external finance or induce higher risk premia.

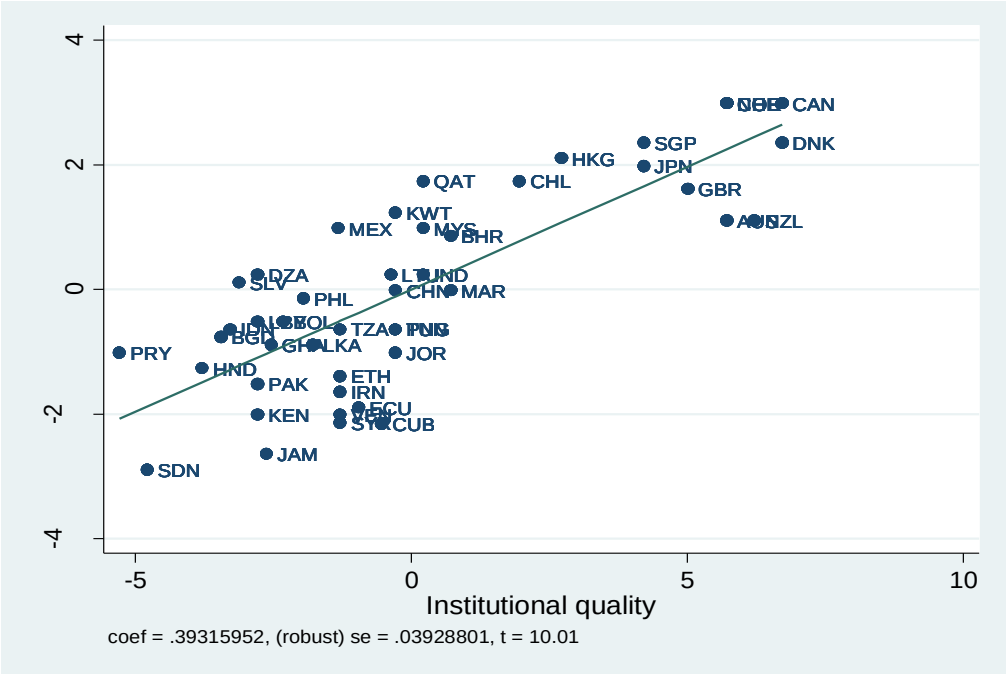


Figure 2.1: Country Risk Rating and Institutional Quality

In this chapter we add to the empirical literature by focusing on the role of institutions in the deficit-inflation nexus. Specifically, using some empirical measures of institutional quality, we test the hypothesis that deficits are inflationary in countries with relatively poor institutions. Furthermore, acknowledging that the quality of institutions, which could be proxied, for instance, by the degree of property rights protection, tends to be positively

[5] See section 2.3.4 ahead for explanation of the index.

associated with the income level of a country, we examine whether the difference in an institutional quality still matters, *even among* low-income countries. This exercise is motivated by the possibility that poor institutions, even for a given income level, may reduce the relative cost of seigniorage, thus yielding inflation in the long run. Empirically, we adopt a dynamic panel data strategy that allows for possible cross-section dependence of the errors which may emanate from common effects and shocks overtime across countries. Therefore, in contrast with the earlier literature on the fiscal balance-inflation nexus, we attempt to systematically examine the role of institutions while accounting for all three dimensions of the panel, namely dynamics, heterogeneity and cross-section dependence in an ARDL framework.

2.3 Theory and Empirical Methodology

Our theoretical model and empirical strategy are based on the work of Catão and Terrones (2005). What we add to their model (apart from an updated data set) is an examination of the role of institutions, and, in the empirics, the use of recent techniques that allow for cross-country dependence in the residuals.

Catão and Terrones (2005) present a simple model of an endowment economy consisting of a government and households who allocate their time between shopping and leisure activities. The motivation for holding money is that it is assumed to economise on shopping time. They derive the following equation in stationary long-run equilibrium:[6] [7]

$$\frac{\pi}{1+\pi} = \frac{p(g - t + rb)}{M} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2.1)$$

where π is the inflation rate, p is the price level, g is primary government expenditure, t is tax revenue, r is the real interest rate, b is government debt and M is base money. Note that the term in parentheses is just the fiscal deficit, so the equation says that in long-run equilibrium inflation (as transformed in equation (2.1)) is proportional to the ratio of the fiscal deficit to base money.

[6] Note that $p(g - t + rb)$ is the nominal equivalent of the real budget deficit concept underlying their theoretical model.

[7] In the empirical estimations, we approximate transformed inflation ($\frac{\pi}{1+\pi}$)as the log difference of the CPI. This is partly to downweight the impact of outliers.

Because, as inflation rises, the ratio of base money to GDP tends to fall, equation (2.1) implies a non-linear relationship between inflation and the ratio of the fiscal deficit to GDP, which makes it preferable to use the ratio of the fiscal deficit to base money in empirical tests.

Catão and Terrones (2005) use annual data from 1960 to 2001 on an unbalanced panel of 107 countries to test this relationship. They find that it holds for developing countries, but not for advanced countries. A natural explanation for this is that, at least for many developing countries, there are tight borrowing constraints on government debt which, when binding, mean that equation (2.1) holds even in the short run, whereas for advanced countries a negative shock can be met by a considerable expansion of government borrowing and dramatic increases in debt levels, such as has occurred in the wake of the global financial crisis. The difference is the degree of investors' confidence that debts will be repaid in full. There is a long history of sovereign debt defaults that result in significant losses to investors (Edwards, 2015). It seems plausible that investors' willingness to lend reflects the social and political environment that pertains in a country, or what is sometimes referred to as the "quality of its institutions".

Like Catão and Terrones (2005), we estimate equation (2.1) using an autoregressive distributed lag (ARDL) model, allowing either all of the parameters, or all except the long-run coefficient, to vary across countries by applying the Mean Group (MG) and Pooled Mean Group (PMG) estimators proposed by (Pesaran and Smith, 1995) and Pesaran *et al.* (1999) respectively. This framework not only allows for a clear distinction between the short-run and long-run effects of the dynamics but has been shown to be capable of accommodating cross-country heterogeneity in the inflation inertia (Catão and Terrones, 2005).[8] Two versions of the ARDL model namely the traditional ARDL under the assumption of cross-section independence and a cross-sectionally augmented version (CS-ARDL) which assumes cross-section dependence are presented.

[8] Moreover, the ARDL estimation approach avoids technical issues bordering on the power of unit root tests since the model generates consistent estimates of the parameters irrespective of whether the variables are I(1) or I(0).

An increasing number of studies have documented the presence of substantial cross-sectional dependence in the error terms in macro panel data models driven by common shocks and unobserved common factors (Pesaran, 2006; De Hoyos and Vasilis, 2006; Eberhardt and Presbitero, 2015; Ruge-Leiva, 2015). As pointed out by De Hoyos and Vasilis (2006) for instance, this has partly arisen from increasing economic and financial integration across countries over the last couple of decades. The recent global financial crisis and attendant synchronized stimulus (expansionary fiscal and monetary) policies across most industrial and emerging market economies has been cited as an example of these common shocks (Eberhardt and Presbitero, 2013).

Figure 2.2 provides some simple descriptive analysis to illustrate the possible presence cross-sectional dependence in inflation and fiscal deficits across a large panel of countries. The figure plots simple histograms for these variables, counting for each year over the sample duration (i.e., 1970-2013), the number of countries which exhibit the peak inflation and deficits in that year. It shows that peaks for most of the countries tend to occur in only a few years: in the case of inflation, more than 43 percent (of countries) show their peak in 1991, 1994, 1995 and 2008, while for fiscal deficits, these peaks occur in only 1992, 1993, 1998 and 2008 for almost one-third of the countries. Thus, the indication appears to be that there may be certain international shocks which drive these variables across countries, which we control for formally in the analysis.

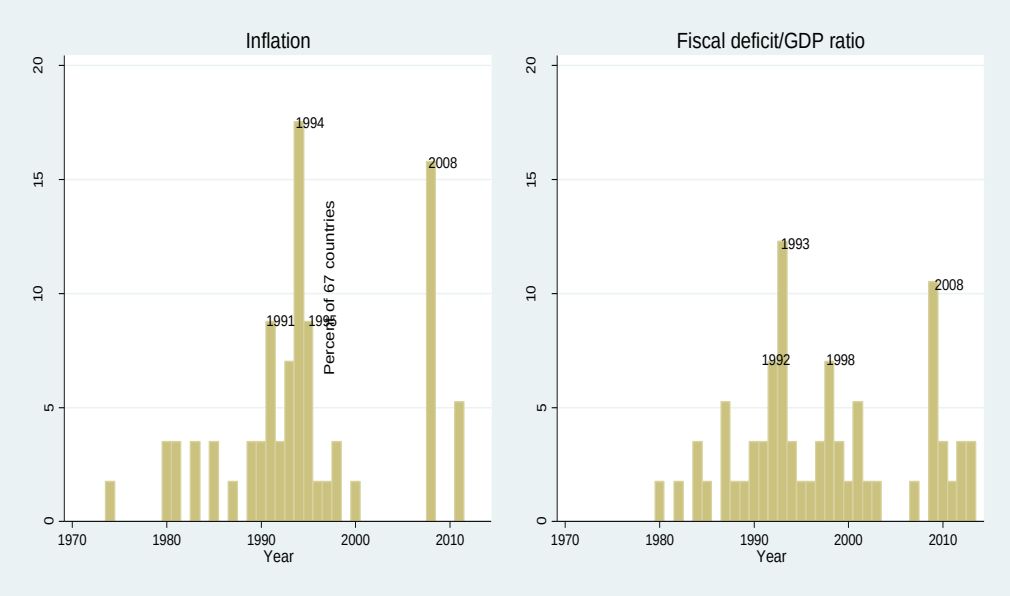


Figure 2.2: Year of Peak Inflation and Fiscal Deficits Distribution

The potential endogeneity problems associated with such correlation are well-documented in the literature, and include inconsistent or even biased estimates and wrong inference (De Hoyos and Sarafidis, 2006; Eberhardt and Presbitero 2015). Therefore, we use a factor model in which the sources of cross sectional dependence are assumed to be represented by a few unobserved common factors that affect all the observations and can be found in the error term (Pesaran, 2006; Chudik *et al.* 2011; Chudik and Pesaran, 2013). We now formally set out the empirical framework accounting for unobserved common shocks in the relationship.

The ARDL model of equation (2.1) relating inflation (π) to a set of explanatory variables *(X)* may be written as:

$$\pi_{i,t} = \sum_{j=1}^{p} \lambda_{ij}\pi_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij}X_{i,t-j} + \eta_i + u_{it} \dots\dots\dots\dots (2.2)$$

where $X_{i,t}$ is a (kx1) vector of explanatory variables and includes $\begin{bmatrix} FB_{it} \\ x^*_{i,t} \end{bmatrix}$. $FB = \frac{p(g-t+rb)}{M}$ is government fiscal balance scaled by base money as in equation (2.1), $x^*_{i,t}$ is a (k-1, 1) vector other covariates including for instance petrol price inflation, exchange rate among others which can also influence the inflation dynamics across countries. η_i represents country fixed effects; λ_{ij}, coefficient of

the lagged dependent variables are scalars and δ'_{ij} are kx1 coefficient vectors; and i=1, 2….., N; t=1, 2….., T. The number of lags (p, q) is determined by the Bayesian Information Criterion (BIC).

To allow for the possibility of unobserved common factors and shocks (f_t) in this framework, we follow Pesaran (2006) and Chudik *et al.* (2011) among others, who propose the use of factor models in which the sources of CSD are assumed to be represented by a few unobserved common factors that affect all the observations and can be found in the error term. Therefore, we specify the following multi-factor error structure:

$$u_{it} = \gamma_{i1} f_{1t} + \cdots \ldots \ldots \ldots + \gamma_{im} f_{mt} + \varepsilon_{it} = \boldsymbol{\Gamma}_i' \boldsymbol{f}_t + \varepsilon_{it} \ldots \ldots \ldots \ldots (2.3)$$

where each f_{jt}, for j=1,……,m represents a single unobserved common factor that affects all cross-section units but in varying degrees depending on its j^{th} heterogeneous factor loading γ_{i1}. $\boldsymbol{\Gamma}_i$ is a mx1 vector of factor loading, $\boldsymbol{f}_t$ a mx1 vector represents the unobserved common factors which can either be strong (possibly correlated with fiscal balance) or weak, semi-weak or semi-strong (and thus assumed to be uncorrelated with the fiscal balance) with heterogeneous factor loading $\boldsymbol{\Gamma}_i$.[9] ε_{it} represents idiosyncratic errors, which are assumed to be distributed independently across *i* and *t*, and not correlated with the regressors.

The unobserved common factors $\boldsymbol{f}_t$, may reflect aggregate financial and or real shocks (for instance the recent global financial crisis and ensuing synchronized stimulus with expansionary fiscal and monetary policies across most industrial and emerging market economies has been cited as an example of these common shocks).[10] Thus, $\boldsymbol{f}_t$ potentially introduces cross-error correlation across countries and possibly inconsistent or even biased estimates and wrong inference (Eberhardt and Presbitero, 2013; 2015).

Pesaran (2006) and Binder and Offermanns (2007) suggest that these common factors could be represented by cross-section averages of the

[9] In the presence of such factors, estimates based on the standard pooled fixed effects, mean group or pooled mean group estimators, will likely yield an inconsistent estimate of the long run relationship between fiscal balance and inflation as it will be subject to omitted variable bias where average parameter values for the factor loading is non-zero (i.e $\overline{\boldsymbol{\Gamma}}_i \neq 0$)

[10] Including Eberhardt and Presbitero, 2015. This has partly arisen from increasing economic and financial integration across countries (De Hoyos and Vasilis 2006).

observables in the regression, an approach that has been applied in the study of a number different issues including growth and debt and growth spillovers (see Chudik and Pesaran, 2013; Eberhardt and Presbitero, 2015; Ruge-Leiva, 2015). Combining equations (2.2) and (2.3), and averaging across *i* yields:

$$\bar{\pi}_t = \sum_{j=1}^{p} \bar{\lambda}_j \bar{\pi}_{t-j} + \sum_{j=0}^{q} \bar{\delta}'_j \bar{X}_{t-j} + \bar{\eta} + \bar{\mathbf{\Gamma}}' \boldsymbol{f}_t + \bar{\varepsilon}_t \dots\dots\dots\dots (2.4)$$

where variables with a bar denote simple cross-sectional averages of the variables in year *t*. Note that since ε_{it} is independently distributed, the $\lim_{n\to\infty} \bar{\varepsilon}_t = 0$ in root mean square error. Therefore, the common factors can be represented by a linear combination of the cross-section averages as:

$$\mathbf{\Gamma}'_i \boldsymbol{f}_t = a_i^* \bar{\pi}_t + b_i^{*'} \bar{X}_t + \sum_{j=0}^{p-1} c_{ij}^* \Delta\bar{\pi}_{t-j} + \sum_{j=0}^{q-1} d_{ij}^{*\prime} \Delta\bar{X}_{t-j} + g_i \bar{\eta} \dots\dots\dots\dots (2.5)$$

where $g_i = \frac{\mathbf{\Gamma}'_i}{\bar{\mathbf{\Gamma}}}$; $a_i^* = g_i(1 - \sum_{j=1}^{p} \bar{\lambda}_j)$; $b_i^* = g_i(\sum_{j=0}^{q} \bar{\delta}_j)$; $c_{ij}^* = g_i(1 - \sum_{m=j+1}^{p} \bar{\lambda}_m)$ and $d_{ij}^* = g_i(1 - \sum_{m=j+1}^{p} \bar{\delta}_m)$.

Substituting equation (2.5) into (2.3) and re-parameterizing yields:

$$\Delta\pi_{i,t} = \phi_i \pi_{i,t-1} + \beta_i' X_{i,t} + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta\pi_{i,t-j} + \sum_{j=0}^{q-1} \delta^{*\prime}{}_{ij} \Delta X_{i,t-j} + a_i^* \bar{\pi}_t + b_i^{*'} \bar{X}_t + \sum_{j=0}^{p-1} c_{ij}^* \Delta\bar{\pi}_{t-j} + \sum_{j=0}^{q-1} d_{ij}^{*\prime} \Delta\bar{X}_{t-j} + \mu_i + \varepsilon_{i,t} \dots\dots\dots (2.6)$$

Or by rearranging slightly as:

$$\Delta\pi_{i,t} = \phi_i \left[\pi_{i,t-1} - \theta_i X_{i,t}\right] + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta\pi_{i,t-j} + \sum_{j=0}^{q-1} \delta^{*'}{}_{ij} \Delta X_{i,t-j} + a_i^* \bar{\pi}_t + b_i^{*'} \bar{X}_t + \sum_{j=0}^{p-1} c_{ij}^* \Delta\bar{\pi}_{t-j} + \sum_{j=0}^{q-1} d_{ij}^{*\prime} \Delta\bar{X}_{t-j} + \mu_i + \varepsilon_{i,t} \dots\dots\dots (2.7)$$

where $\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right)$, $\beta_i = \sum_{j=0}^{q} \delta_{ij}$. $\theta_i = \sum_{j=0}^{q} \delta_{ij} / \left(1 - \sum_{j=1}^{p} \lambda_{ij}\right) = \phi^{-1} \beta_i$ are kx1 vector of long run coefficients that represent the equilibrium relationship between the variables; $\mu_i = \eta_i - g_i \bar{\eta}$. The parameter ϕ_i is the error-

correcting speed of adjustment term. If $\phi_i = 0$, then there is no evidence of a long-run relationship. This parameter is expected to be significantly negative under the prior assumption that the variables show a return to long-run equilibrium (i.e. cointegration). Moreover, *T* must be large enough so that the model can estimated for each cross-section. [11]

Finally, to explicitly examine the role of income (role of institutions), we estimate:[12]

$$\Delta\pi_{i,t} = \phi_i\pi_{i,t-1} + \beta'_{i\,h}H_i^{inc,inst}\mathrm{x}\,FB_{i,t} + \beta'_{i\,l}L_i^{inc,inst}\mathrm{x}\,FB_{i,t} + \beta'_i x^*{}_{i,t} + \sum_{j=1}^{p-1}\lambda^*_{ij}\Delta\pi_{i,t-j} + \sum_{j=0}^{q-1}\delta^{*\prime}{}_{ij}\Delta X_{i,t-j} + a_i^*\bar{\pi}_t + b_i^{*\prime}\overline{\mathrm{X}}_{\mathrm{t}} + \sum_{j=0}^{p-1}c^*_{ij}\Delta\bar{\pi}_{t-j} + \sum_{j=0}^{q-1}d^{*\prime}_{ij}\Delta\bar{X}_{t-j} + \mu_i + \varepsilon_{\mathrm{i,t}} \ldots\ldots\ldots\ldots (2.8)$$

Or

$$\Delta\pi_{i,t} = \phi_i\left[\pi_{i,t-1} - \theta_{i\,h}H_i^{inc,inst\prime}\mathrm{x}\,FB_{i,t} - \theta_{i\,l}L_i^{inc,inst\prime}\mathrm{x}\,FB_{i,t} - \theta_i x^*{}_{i,t}\right] + \sum_{j=1}^{p-1}\lambda^*_{ij}\Delta\pi_{i,t-j} + \sum_{j=0}^{q-1}\delta^{*\prime}{}_{ij}\Delta X_{i,t-j} + +a_i^*\bar{\pi}_t + b_i^{*\prime}\overline{\mathrm{X}}_{\mathrm{t}} + \sum_{j=0}^{p-1}c^*_{ij}\Delta\bar{\pi}_{t-j} + \sum_{j=0}^{q-1}d^{*\prime}_{ij}\Delta\bar{X}_{t-j} + \mu_i + \varepsilon_{\mathrm{i,t}} \ldots\ldots (2.8')$$

where $H_i^{inc,inst}$ $\left(L_i^{inc,inst}\right)$ takes 1 if country *i's* income or institutional quality is high (low) and β_{ih} (β_{il}) are the associated long run semi-elasticities; and $\theta_{ih} = \frac{\beta_{ih}}{\phi_i}$; $\theta_{il} = \frac{\beta_{il}}{\phi_i}$.

Next, we briefly spell out the key assumptions under the two estimators we apply in the estimations.

[11] Ruge-Leiva (2015) has shown that the lagged cross-section averages of the dependent and independent variables are typically chosen on the basis of a rule of thumb $T^{1/3}$). Chudik and Pesaran (2013) and Eberhardt and Presbitero (2013) similarly recommend inclusion of cross-section averages of one or more other covariates which may help in identifying the unobserved common factors (other than say inflation and fiscal balance).

[12] Similar conclusions are arrived at if we allow differences in the dynamics (see Bleaney *et al.* forthcoming).

2.3.1 Pooled Mean Group (PMG) Model

The PMG constrains the long-run elasticities to be homogenous across countries, that is $\theta_i = \theta$ for all i while allowing the short run coefficients, including the intercepts, speed of adjustment to long run equilibrium parameters and error variances to differ freely across countries. Pesaran *et al.* (1999) identify a number of reasons why it might be imperative to impose long run homogeneity including budget or solvency constraints, arbitrage conditions, or common technologies influencing all groups in a similar way. On the other hand, it can be argued that country heterogeneity is particularly important in short-run relationships, given that countries are affected by over lending, borrowing constraints, and financial crises in short-time horizons, albeit to different degrees.

Pesaran *et al.* (1999) follow a maximum likelihood estimation (MLE) approach to estimate the short run and the long run parameters. First of all, they prepare the likelihood of panel data written as the product of the likelihoods for each group. The ML estimation of the long run coefficients and the group-specific error-correction coefficients are then estimated by maximizing the concentrated log likelihood function. Once the long run parameters are estimated by using pooled ML estimation, the short run coefficients can consistently be estimated by running the individual OLS regressions. The PMG estimator thus generates consistent estimates of the mean of short-run coefficients across countries by taking the simple average of individual country coefficients as:

$$\hat{\phi}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\phi}_i}{N};\ \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\beta}_i}{N};\ \hat{\lambda}_{j\,PMG} = \frac{\sum_{i=1}^{N} \tilde{\lambda}_i}{N},\ \text{j=1, ...}, p-1;$$

$$\hat{\delta}_{j\,PMG} = \frac{\sum_{i=1}^{N} \tilde{\delta}_{ij}}{N},\ \text{j=0, ...}, q-1;\ \hat{\theta}_{PMG} = \tilde{\theta}.$$

Pooling across countries yields efficient and consistent estimates when the restrictions are true. In some instances however, the hypothesis of slope homogeneity can be rejected empirically. If the true model is heterogeneous, the PMG estimates are inconsistent; and the MG estimates are consistent in either case (Pesaran and Smith, 1995).

2.3.2 Mean Group (MG) Model

This approach does not impose any restrictions as it allows the coefficients to vary and be heterogeneous across countries both in the short run and long run. Under this approach, separate regressions are estimated for each country, with the coefficients calculated as unweighted means of the estimated individual countries' coefficients as:

$$\hat{\phi}_{MG} = \frac{\sum_{i=1}^{N} \hat{\phi}_i}{N};\ \hat{\beta}_{MG} = \frac{\sum_{i=1}^{N} \hat{\beta}_i}{N};\ \hat{\lambda}_{j\,MG} = \frac{\sum_{i=1}^{N} \hat{\lambda}_i}{N},\ \text{j=1, ……., } p-1;$$

$$\hat{\delta}_{j\,MG} = \frac{\sum_{i=1}^{N} \hat{\delta}_{ij}}{N},\ \text{j=0, ……., q – 1;}\ \hat{\theta}_{MG} = \frac{1}{N}\sum_{i=1}^{N}\left(\hat{\phi}_i^{-1}\hat{\beta}_i\right).$$

where $\hat{\phi}_i$, $\hat{\beta}_i$, $\hat{\lambda}_{ij}$, $\hat{\delta}_{ij}$ are obtained individually from equation (2.6) using OLS estimation.

The MG estimator provides consistent estimates of the mean of the long-run parameters, though these will be inefficient if slope homogeneity holds (Pesaran *et al.* 1999). With long-run slope homogeneity, the pooled estimators are consistent and efficient. In general, for both estimators, it is required that that the relative size of *N* and *T* must be large to allow for sufficient lags of (*p*, *q*) to ensure that the residuals are serially uncorrelated.

2.3.3 Model Selection

The hypothesis of homogeneity of the long-run parameters cannot be assumed a priori and is tested empirically in all specifications. The presence of heterogeneity in the means of the coefficients is examined by a Hausman-type test that is applied to the difference between the MG and the PMG. Specifically, the null of this test is that the difference between PMG and MG estimations is not significant. If the null is not rejected, they are not significantly different; one uses the PMG estimator, since it is efficient. The alternative is that there is a significant difference between PMG and MG. If the null is rejected, they are significantly different, and one uses the MG estimator. The Hausman test statistic is calculated from the formula:

$$H = (\hat{\beta}_{MG} - (\hat{\beta}_{PMG})'[(Var(\hat{\beta}_{MG}) - Var(\hat{\beta}_{PMG})]^{-1}(\hat{\beta}_{MG} - \hat{\beta}_{PMG})$$

where $\hat{\beta}_{MG}$ and $\hat{\beta}_{PMG}$ are the vectors of coefficient estimates for the MG and PMG models respectively. This statistic is $\chi^2(k)$ distributed under the null hypothesis. Under the null hypothesis the difference in the estimated coefficients between the MG and PMG estimators is not significant and PMG is more efficient.[13]

2.3.4 Data and Preliminary Evidence based on Correlations

The dataset consists of a panel of observations for 67 countries covering the period 1970-2013.[14] The sample countries include high, upper and lower middle and low-income countries based on the World Bank classification.[15] The main source of data is the World Bank's database which includes the relevant macroeconomic and institutional variables and probably, the most up-to-date dataset on studies on the link between inflation and fiscal deficits. However, we sourced per-capita income in purchasing power parity terms from the world economic outlook database of the International Monetary Fund (IMF). The main variables are inflation, government overall fiscal balance, money supply - M1 (defined as currency with the non-bank public and demand deposits), current gross domestic product (GDP) and per-capita income. Inflation is measured as the annual percent change in the consumer price index while the fiscal balance is the government overall fiscal balance scaled by M1.

To capture institutions in our empirical analysis, we employ a number of measures. First, we use Polity2 scores from the Polity IV project (Marshall *et al.* 2013), one of the most popular measures of a country's political regime as it provides one of the broadest coverage of democracy indicators including openness of political institutions, electoral rules as well as other information about democracy.[16] This variable which measures how a country's political system is organised, (whether democratic or autocracy - i.e. the presence or

[13] We also compared with the dynamic fixed effects model (DFE) using the LR test and the results show that the PMG should be preferred model (see A2.11 in appendix A)
[14] List of countries in Table A2.13 in appendix A
[15] As of July 1, 2013, the World Bank classification of countries by gross national income was: high $12,616 or more; upper middle income $4,086 - $12,615; lower middle income $1,036 - $4,085 and low income $1,035 or less. For this study, we regrouped the countries into two, merging high and upper middle income and lower middle with low income countries.
[16] We also preferred this measure partly because of data coverage.

otherwise of a system with institutionalized procedures for open and competitive political participation, where chief executives are chosen in competitive elections and where substantial limits are imposed on powers of the chief executive), broadly reflects the extent of application of the rule of law. The basic assumption here is that compliance with the rule of law is generally more likely in democracies than non-democracies. Polity2 is measured on a scale of -10 (completely autocratic) to +10 (completely democratic). Higher scores on the scale represent more participation of the citizens in the governance process and thus the more accountable the government.

In addition, we use data from the International Country Risk Guide (ICRG), a monthly publication of Political Risk Services (PRS). This ICRG index - a measure of the risks of doing business in a country, broadly deals with issues of interest to business corporations and potential investors and assesses the political risks for investors in different countries (for instance contract enforcement, investor protection, rule of law and corruption. Given that different indicators tend to measure different aspects of institutions, a multidimensional index of the PRS indicators is constructed to measure the overall institutional quality in line with the literature (Demetriades and Law, 2006; Keefer and Knack, 2007; Baldacci and Kumar, 2010).[17] These are: (i) Corruption (reflecting the likelihood that officials will demand illegal payment or use their position or power to their own advantage), where widespread corruption may affect the availability of resources to the government (Al-Marhubi, 2000); (ii) Rule of Law (measuring the degree to which citizens are willing to accept established institutions to make and implement laws and to adjudicate dispute); (iii) Bureaucratic Quality (which represents autonomy from political pressure, strength, and expertise to govern without drastic changes in policy or interruptions in government services, as well as the existence of an established mechanism for recruitment and training of bureaucrats).

Overall, these measures reflect the extent of security of property and contractual rights (Knack and Keefer, 1995), and may similarly convey

[17] This is done to partly mitigate issues with measurement errors in individual institutional measures.

information about a country's fiscal capacity, particularly the ability to curb fiscal profligacy or at least assure the markets of mechanisms that ensure fiscal prudence. In line with the literature (e.g Demetriades and Law, 2006), the index of institutional quality is derived by summing these indicators, where higher values imply better institutional quality and vice versa.

Other variables including oil price inflation and exchange rate regime are included to test for their relevance and robustness of the estimates on the inflation-fiscal balance dynamics. Oil price inflation is measured as the log difference of nominal crude oil prices while the exchange rate regime is based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

Similarly, we expand the measure of institutional quality based on the ICRG to include other dimensions (e.g investment profile, which measures risks relating to contract viability/ expropriation, profits repatriation and payment delays) as well as setting different thresholds for institutional quality to establish robustness of our key results.

Finally, we further check robustness of the results on institutions by controlling for central bank independence (CBI), a key driver of inflation across countries (Cukierman *et al.* 1992). To do this, we use average rate of turnover of governors as a proxy for CBI (see Dreher *et al.* 2010; Dreher *et al.* 2008; Sturm and De Haan 2001).[18] As measured here, high average turnover rates indicate less independence (weak central bank) and vice versa.

Figure 2.3 plots a bivariate relationship between inflation and fiscal balance for a sub-sample of 37 lower income countries over the period 1970 – 2013. To capture the long-run relation between the variables, we use the average fiscal balance and median inflation for each country, the latter to avoid the influence of hyper-inflations. Broadly, the figure provides preliminary evidence in support of the hypothesis that fiscal deficits are inflationary in lower income countries based on these simple correlations. The first subfigure covers the

[18] This is a measure of how on average, central bank governors are replaced outside of their legally mandated term.

correlation particularly among lower-income countries, while the second subfigure, albeit still focusing on lower-income countries, differentiates the relation according to the level of institutional quality within this income group.[19] Notice that although the (negative) relation appears to be well established in lower-income countries in general (as shown by the previous literature), this correlation becomes much less distinct in low-income countries with relatively *higher*-quality institutions, being consistent with our conjecture.[20]

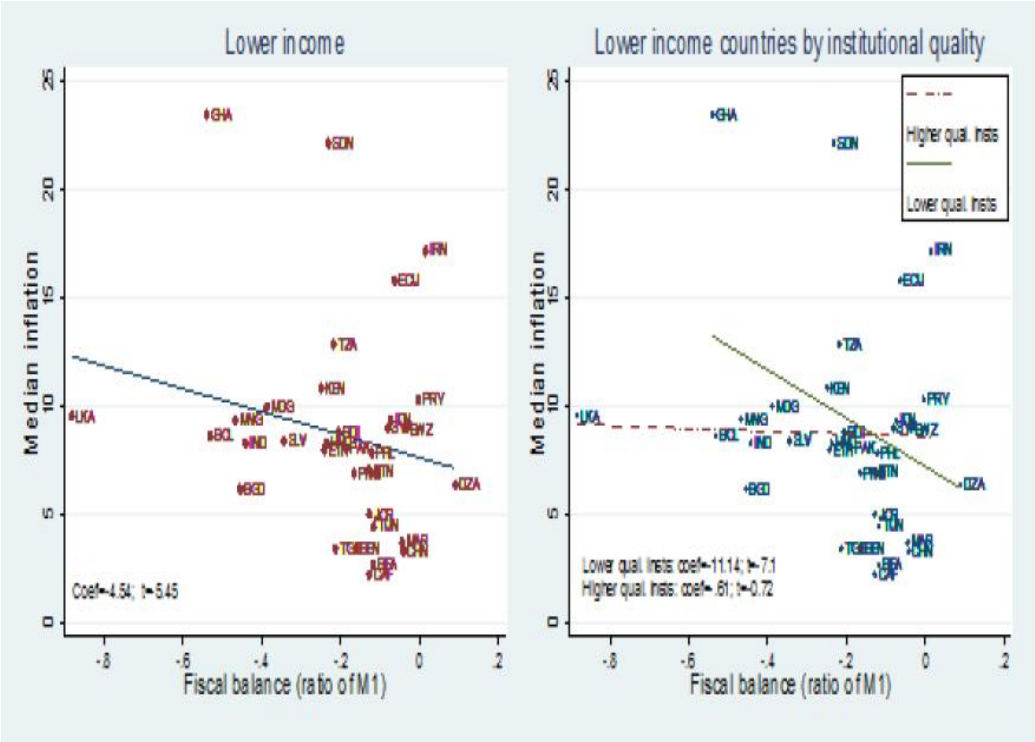


Figure 2.3: Fiscal Balance Inflation Relationship

Table 2.1 provides a summary of basic statistics of the data, showing the averages over the whole sample period, decade long sub-sample averages and developments over more recent period since the last financial crisis.[21] Panel A provides these statistics for all countries and for the various country groups. This is augmented by other features including whether countries are implementing inflation targeting or not, and high or low inflators.[22] Two features of the data

[19] We use a composite of selected variables from the International Country Risk Guide (ICRG) of the Political Risk Service (PRS) as a proxy for the institutional quality. The detailed explanation of this variable is given below.
[20] Fiscal balance takes a positive value when there is a surplus.
[21] In the case of inflation, the medians were used to avoid the influence of hyperinflations. These are computed as the overall median for the group for the specified period. The fiscal balance figures are simple averages for the relevant time periods.
[22] High and low inflators are countries with inflation rates above the 75th percentile (9%).

stand out: both the rate and volatility of inflation have declined substantially over the sample period except for low income countries (LICs) where improvement was more measured; and alongside, the fiscal balance broadly improved. Countries with high inflation and inflation volatility appear to be strongly correlated with high fiscal deficits. In addition, virtually all country-groups have witnessed some deterioration in the fiscal balance (perhaps reflecting fiscal stimulus programs in some instances following the economic and financial crisis) in the 2008 – 2013 period. These patterns broadly suggest a close link between inflation and fiscal balance consistent with the theoretical postulates, although a precise quantification of this relationship empirically has tended to be elusive.

Table A2.1 in appendix A provides further detailed descriptive statistics for the key variables. As the Table shows, of those indicators, the institutional quality proxies for instance show an average of 0.19 in the range -10 and +10 for polity2 and 8.8 in the range 1 – 16 for the ICRG index. In general, higher income countries have better institutions, averaging 2.6 for polity2 and 11.2 for ICRG relative to -1.2 and 7.1 respectively for polity2 and ICRG in the case of lower income countries. Moreover, classifying countries by institutional quality based on the different proxies of institutional quality shows significant differences across countries, reflecting possibly performance of the countries on the different dimensions of institutions. For instance, separating countries by polity2, the difference between the mean ICRG index for strong and weak institutions is 1.3 (i.e. 9.13-7.87) compared to 4.5 (i.e. 10.77-6.28) when separated by ICRG.

These patterns suggest clear shifts in country classification depending on the institutional quality, albeit that a sizeable number of countries also overlap. For instance, 13 countries are classified as strong under both polity2 and ICRG out of the 29 countries while for weak institutions countries, 10 out of 28 countries under polity2 or 23 under ICRG are classified as weak under both. Therefore, using different institutional proxies and in some cases pooling the different dimensions is important for robustness of the results.

Table 2.1: Selected Indicators (averages by groups, unless otherwise stated)

	1970-2013	1970-1979	1980-1989	1990-1999	2000-2009	2008-2013
Panel A						
All Countries						
Inflation[1]	6.2	8.7	8.2	5.8	3.9	4.6
Fiscal Balance[2]	-2.1	-2.3	-4.3	-3.0	-0.5	-1.7
Narrow money[2]	20.3	17.9	18.5	18.4	22.9	27.1
Oil price Inflation[3]	10.4	36.0	-5.5	0.1	12.3	6.3
Polity2	0.2	-2.6	-2.0	1.4	2.4	2.9
High Income Countries						
Inflation	3.1	8.4	5.6	2.1	2.1	2.4
Fiscal Balance	0.5	-1.6	-1.0	-2.4	4.0	1.6
Narrow money	23.4	18.3	17.6	20.4	30.6	39.6
Polity2	3.8	3.9	3.5	3.8	4.0	3.9
Upper Middle Income Countries						
Inflation	4.4	9.8	5.8	3.6	3.2	3.6
Fiscal Balance	-2.0	-5.8	-5.6	-2.2	-0.4	-1.6
Narrow money	19.5	15.3	17.4	18.5	21.6	26.3
Polity2	1.2	-1.1	-1.6	2.7	3.1	3.6
Lower Middle Income Countries						
Inflation	8.2	8.5	11.8	9.4	4.8	5.3
Fiscal Balance	-2.8	0.9	-5.1	-2.9	-1.9	-2.6
Narrow money	21.4	20.5	22.3	18.6	22.6	25.1
Polity2	-1.5	-5.5	-3.1	-0.1	1.3	1.9
Low Income Countries						
Inflation	8.3	8.2	9.9	9.7	7.6	8.1
Fiscal Balance	-3.9	-7.8	-5.8	-3.9	-2.6	-3.5
Narrow money	16.8	15.6	14.8	14.3	18.1	21.4
Polity2	-0.8	-4.3	-4.8	0.5	2.3	3.1
Panel B						
Inflation targeting Countries						
Inflation	2.9	n.a	5.7	1.7	3.2	3.8
Fiscal Balance	-0.5	n.a	-1.8	-2.1	0.8	-2.1
Narrow money	21.5	n.a	11.4	15.4	23.5	23.0
Polity2	9.3	n.a	10.0	10.0	9.2	9.1
Top 25% Inflators[4]						
Inflation	11.9	10.7	20.2	20.1	9.6	9.2
Fiscal Balance	-4.0	0.9	-6.5	-4.8	-2.4	-3.7
Narrow money	17.3	16.2	20.1	16.6	16.6	16.8
Polity2	-0.1	-3.9	-3.2	0.9	3.8	3.8
Bottom 25% Inflators[4]						
Inflation	4.5	8.3	6.4	3.6	2.9	3.6
Fiscal Balance	-1.6	-2.4	-3.7	-2.4	0.2	-1.1
Narrow money	21.4	18.5	18.0	19.0	25.1	30.7
Polity2	0.3	-2.0	-1.5	1.7	1.9	2.6

1/ Median of annual percent change in the consumer price index

2/ Percent of GDP

3/ Oil price inflation is average log difference of nominal crude oil pricesis the log difference of nominal crude oil prices

4/ High (low) inflators are countries with sample median inflation rates above (below) the 75th percentile (9%)

2.4 Empirical Results

This section presents results of the dynamic panel estimates of inflation (defined as the log difference of the consumer price index) and fiscal balance (represented by the ratio of government overall fiscal balance to narrow money, M1). First, we estimate equation (2.7) with and without the cross-section terms for the whole sample of countries based on the PMG and MG and then use the Hausman *h-test* to test the validity of the restrictions implied by the PMG (i.e homogeneity of the long-run coefficients). We then estimate equation (2.8') in a bid to examine the role of income and institutional quality in the fiscal balance-inflation nexus. In the tables, we report results of the long-run and error correction coefficients and the *h-test* statistic. The optimal lag length is selected based on the Bayesian information criterion (BIC).[23] We highlight the preferred results in bold for the most part.

Table 2.2 presents the unconditional estimates of the bivariate relation between inflation and the fiscal balance for the sample of 67 countries. In general, the results point to the existence a cointegrating relationship between inflation and the fiscal balance, as the null of no cointegration is rejected in all cases. The CS-ARDL model which controls for cross-section dependence generally yields more statistically significant coefficients and provides a better fit for the data which indicates that the CS-ARDL results should be preferred. The Hausman (*h*) test statistic is a test of the null hypothesis that the equality of long-run coefficients assumed in PMG estimation is not rejected; if it is not significant (as in Table 2.2) the PMG results are to be preferred – the column in bold.

In Table 2.2, the CS-ARDL coefficient of the fiscal balance [(T – G)/M1] for PMG estimation is -0.00786, with a *t*-statistic of -3.16, indicating a significant negative correlation with inflation. The sample standard deviation of (T – G)/M1 is 0.48, so a one-SD improvement in the fiscal balance reduces inflation by 0.48 x 0.00786 = 0.0038.[24] Since the dependent variable is the log

[23] The lag length selection was based on a user written code by Sebastian Kripfganz (see http://www.statalist.org/forums/forum/general-stata-discussion/general/95329-ardl-in-stata

[24] See Table A2.1 in appendix A for details on the summary statistics

change in prices, this is only about 0.4 percentage points, which is quite a small effect.

Table 2.2: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance (1970 - 2013)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
(T-G)/M1	0.00458	-0.0533	**-0.00786*** **	-0.108*
	(1.26)	(-1.22)	**(-3.16)**	(-1.74)
EC coefficient (ϕ)	-0.508***	-0.550***	**-0.803*** **	-0.813***
	(-16.57)	(-16.47)	**(-19.01)**	(-18.53)
h-statistic	0.91 [0.339]		**0.92 [0.339]**	
N x T	2573	2573	**2477**	2477

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equation 2.7 without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

2.4.1 Role of Income in the Fiscal Balance - Inflation Nexus

Previous research has suggested that the coefficient is smaller and not statistically significant in higher-income countries. Table 2.3 shows that this is true in our sample as well. Since the *h*-statistic is not significant, the PMG results should be preferred. The Wald test statistic (which is a test of the null of equality of the effects in lower and higher-income countries) is significant at 1 per cent, indicating a statistically significant difference between the fiscal balance coefficients in high-income and low-income countries. Under the CS-ARDL for instance, the coefficient in high-income countries is an insignificant -0.00294 with *t*-statistic of -0.89, whereas in low-income countries it is -0.0192, with a *t*-statistic of -3.97. This implies that in low-income countries a one-SD

improvement in the fiscal balance reduces inflation by about 1.1 percentage points.[25]

Table 2.3: Role of Income Levels in the Fiscal Balance - Inflation Nexus

Dependent variable Δlogcpi				
	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Low income dum*(T-G)/M1	-0.0191***	-0.1000***	**-0.0192*** **	-0.104*
	(-3.00)	(-2.97)	**(-3.97)**	(-1.72)
High income dum*(T-G)/M1	0.0140***	0.0467*	**-0.00264**	-0.00536
	(2.71)	(1.85)	**(-0.89)**	(-0.56)
EC coefficient (ϕ)	-0.510***	-0.550***	**-0.811*** **	-0.827***
	(-16.25)	(-16.47)	**(-20.32)**	(-19.41)
h-statistic	4.32		**0.72**	
	[0.116]		**[0.698]**	
Wald test-statistic	16.29	13.22	**8.49**	2.58
	[0.000]	[0.000]	**[0.004]**	[0.108]
N x T	2573	2573	**2477**	2477

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equation 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Lower (higher) income countries include countries classified by the World Bank as low and lower middle (high, high OECD and upper middle) income countries. The Wald test-statistic refers to the test of parameter equality between low income dum*(T-G)/M1 and high income dum*(T-G)/M1 Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

In line with Catão and Terrones (2005) who show that oil price inflation and exchange rate regimes are important determinants of inflation across countries, we test robustness of the results provided in Table 2.3 to the inclusion of these variables.[26] The results, provided in Table A2.2 in appendix A, corroborate the earlier finding that fiscal deficits are inflationary in low income countries. Moreover, as shown by Catão and Terrones (2005), both oil prices and exchange rate regime are significant drivers of inflation across countries.

[25] To test the robustness of the results, we repeated the empirical estimations by scaling fiscal balance by GDP and splitting the data into separate subsamples (higher and lower income) and similar results have been obtained.

[26] See for instance Catão and Terrones (2005) for a justification for the inclusion of these variables.

To summarize, our results confirm the previous finding (see Fischer *et al.* 2002; Catão and Terrones, 2005; Lin and Chu, 2013) that fiscal deficits are a significant driver of long run inflationary dynamics in lower income countries. Similarly, there is no evidence of statistically significant impact of the fiscal deficits on inflation in higher income countries. Put differently, these results suggest that higher income countries are less susceptible to fiscal dominance than poorer ones. A plausible hypothesis about the apparent relevance of the income levels is that certain institutional characteristics associated with income levels may shape the relation between deficits and inflation. For instance, in advanced economies, institutions may prompt a government to rely less on seigniorage as a financing source of deficits. Specifically, when citizen's political participation is guaranteed in those economies, the political leadership may be more sensitive to the public's dislike of inflation, so that fiscal shocks that lead to a build-up of public debt tend to induce fiscal consolidations rather than a resort to seigniorage revenue, as documented for the United States by Bohn (1998). Moreover, to the extent that governments in low-income countries are susceptible to low credibility amid weak institutions of their countries, they may have a limited access to the international capital market (Kumar and Baldacci, 2010). This, in turn, may imply that such countries find it less costly to finance deficits with seigniorage than with borrowing, strengthening deficits-inflation nexus as a result. We test this formally in the next sections.

2.4.2 Role of Institutions in the Fiscal Balance - Inflation Nexus

We present results of the role of institutions in the nexus across countries. As stated earlier, the institutional proxies we use include polity2 – a measure of how a country's political system is organised (i.e. whether democratic or autocratic) broadly reflects the extent of application of the rule of law; and the ICRG index which measures the risks that business corporations and potential investors face in doing business in a country (for instance corruption, rule of law. bureaucratic quality, contract enforcement, and investor protection).

Table 2.4 presents results considering differences in institutional quality across countries.[27] The *h-test* statistic again implies that the PMG estimates

[27] Results are based on Polity2 scores.

should be preferred. However, under the ARDL, the PMG coefficient of 0.0017 for countries with weak institutions is not statistically significant while the PMG estimate of 0.0161 with a t-statistic of 2.44 for countries with strong institutions is actually 'wrongly' signed. Moreover, under the CS-ARDL, the *h*-statistic is not significant, which means the PMG results should again be preferred – the column in bold. For this, the PMG yields a statistically significant coefficient of -0.010 and a *t*-statistic of -3.42 for countries with weak institutions while the coefficient of 0.0011 for countries with strong institutions is statistically insignificant. The Wald-test statistic rejects the null, implying statistically significant difference between the coefficients for countries with weak institutions and those with strong institutions. Specifically, a one-SD improvement in the fiscal balance in countries with weak institutions reduces inflation by some 0.6 percentage points. This probably reflects a greater tendency for recourse to seigniorage in countries where institutions are weak with little or no constraints aligning public borrowing closely with tax and spending smoothing, or more broadly, unavailability of other viable financing options.

Table 2.4: Role of Institutions in the Fiscal Balance Inflation Nexus (Polity2)

Dependent variable Δlogcpi				
	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Weak insts*(T-G)/M1	0.00168	-0.0544***	**-0.0101*** **	-0.0106
	(0.40)	(-2.86)	**(-3.42)**	(-0.36)
Strong insts*(T-G)/M1	0.0161**	0.00113	**0.00109**	-0.0585
	(2.44)	(0.03)	**(0.31)**	(-1.10)
EC coefficient (ϕ)	-0.506***	-0.550***	**-0.741*** **	-0.764***
	(-16.41)	(-16.47)	**(-17.96)**	(-17.76)
h-statistic	4.71		**0.46**	
	[0.095]		**[0.794]**	
Wald test-statistic	3.37	1.62	**6.03**	0.62
	[0.066]	[0.203]	**[0.014]**	[0.431]
N x T	2573	2573	**2477**	2477

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average polity2 score below (above) the median value for the sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

To test the robustness of the above results which use polity2 as our empirical measure of institutional quality, we use an alternative measure of institutional quality based on the ICRG index. Table 2.5 shows that using this measure yields qualitatively similar results.[28] Further, expanding the ICRG index to include investment profile yields qualitatively similar results (Table A2.3 in appendix A). These findings are probably consistent with the views that weak institutions severely limit the availability of and access to external financing (e.g Kumar and Baldacci, 2010) and the ability to charge and collect taxes (e.g Cukierman *et al.* 1992; Aisen and Veiga, 2006) either or both of which reduce the relative cost of seigniorage revenues.

[28]Including oil price inflation and exchange rate regimes in the analysis does not similarly alter the role of institutions.

Table 2.5: Role of Institutions in the Fiscal Balance Inflation Nexus (ICRG Index)

Dependent variable Δlogcpi				
	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Weak insts*(T-G)/M1	0.00357*	-0.0659**	**-0.0453*** **	-0.0700
	(1.88)	(-1.97)	**(-4.69)**	(-1.29)
Strong insts*(T-G)/M1	0.00493	-0.0247*	**-0.00632*** **	-0.00555
	(1.32)	(-1.85)	**(-2.77)**	(-0.18)
EC coefficient (ϕ)	-0.539***	-0.587***	**-0.765*** **	-0.814***
	(-18.15)	(-18.86)	**(-18.48)**	(-20.89)
h-statistic	5.28		**0.07**	
	[0.071]		**[0.965]**	
Wald test-statistic	0.1	1.26	**15.43**	1.06
	[0.746]	[0.262]	**[0.000]**	[0.303]
N x T	1949	1949	**1949**	1949

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average ICRG index equal to or below (above) the median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

2.4.3 Role of Institutions in the Fiscal Balance - Inflation Nexus in Lower Income Countries

The preceding discussion, however, raises the question as to whether institutions still play a key role in the budget deficits-inflation nexus even when income level is controlled for. To shed light on this question, we estimate the role of institutions in the nexus, only using the subsample of lower-income countries. To ensure robustness, we again use the two different institutional proxies, namely Polity2 and ICRG index.[29] Further, following Catão and Terrones (2005), Columns 3 and 4 additionally control for oil price inflation and exchange rate regimes.

For brevity, Table 2.6 only reports the PMG results based on CS-ARDL, because the long-run slope homogeneity of coefficients is not rejected by the *h*-

[29] See section on data for more details on the components and construction of this index.

statistic for both proxies. Based on Polity2 for instance, we obtain a sizable and statistically significant long-run coefficient of -0.0312 for lower-income countries with weak institutions, which is about twice the effect in lower-income countries with strong institutions. In fact, the Wald test statistic strongly rejects the null of equality between the effects across different institutional qualities. Economically, the results imply that a one-SD improvement in the fiscal balance reduces inflation by a sizable 1.84 percentage points in countries with weak institutions, compared with 0.58 percentage points in lower income countries with strong institutions. The key results are robust to the use of ICRG index as an alternative institutional proxy as well as expanding this index to include other dimensions (e.g investment profile) and setting different thresholds.[30] Further, the results still stand even when we control for oil price inflation and exchange rate regimes, both of which are significantly associated with inflation, with the higher oil price inflation and more floating regimes corresponding to higher inflation thresholds (Tables A2.4 and A2.5 in appendix A). Therefore, the overall indication is that the quality of institutions still plays a significant role in the fiscal deficits-inflation nexus, even when we only consider lower-income countries.

[30] We repeated the same exercise for both proxies by classifying strong- and weak-institutions with different threshold values (corresponding to upper third- and also upper quartile-values, instead of median values). We find that the qualitative results remain the same.

Table 2.6: Role of Institutions in the Fiscal Deficit - Inflation Nexus in Lower Income Countries

Dependent variable Δlogcpi				
Based on the Cross-Sectionally Augmented ARDL Approach (CS-ARDL [1, 0], ECM)				
	PMG			
	Polity2	ICRG Index	Polity2	ICRG Index
LR elasticities				
Weak insts*(T-G)/M1	-0.0312**	-0.0431***	-0.0356***	-0.0492***
	(-2.42)	(-3.44)	(-2.71)	(-4.39)
Strong insts*(T-G)/M1	0.0162	-0.00610	-0.0000453	-0.0100
	(1.09)	(-0.62)	(-0.00)	(-1.10)
Oil_price inflation			0.0414***	0.0241**
			(3.18)	(2.33)
ExR regime			0.0292***	0.0324***
			(8.97)	(11.55)
EC coefficient (ϕ)	-0.767***	-0.802***	-0.702***	-0.748***
	(-17.42)	(-18.47)	(-11.76)	(-12.00)
h-statistic	0.54 [0.763]	0.40 [0.820]	0.29 [0.991]	0.82 [0.935]
Wald test-statistic	5.79 [0.016]	5.38 [0.020]	3.25 [0.071]	7.35 [0.007]
N x T	1167	899	1167	899

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average polity2 score or ICRG index below (above) the global median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

2.4.4 Further Robustness Checks

Additional robustness checks were conducted on the results reported above and these generally show that the results remain robust. Specifically, we re-estimated separate regressions for the different income level subsamples as in Catão and Terrones (2005); use of different institutional proxies and thresholds as well as continuous interactions in analysing the role of institutions. Finally, since income is highly correlated with central bank independence, we also control for the latter to further test robustness of our results.

Separate regressions by income level and alternative institutional quality measures and thresholds

We split the sample by income level and rerun separate regressions including other controls (for instance oil price inflation) as in Catão and Terrones (2005). Furthermore, we use continuous interactions for income and institutions as well as squared fiscal balance terms to examine possible non-linearity in the relationship. The results provided in Tables A2.6 - A2.10 in appendix A broadly remain qualitatively similar to those shown earlier. In addition, expanding the measure of institutional quality from the ICRG index to include investment profile as well as altering the thresholds (for instance to the upper third) yields broadly similar results. However, using data from the Worldwide Governance indicators from the World Bank and economic freedom data from the Heritage Foundation which are only available for relatively short periods did not yield strongly robust results. Finally, we compared results of the PMG estimator to those of the dynamic fixed effects model (DFE) in which all coefficients except the country-specific effects are simply pooled and treated as homogeneous. The results, provided in Table A2.11 in appendix A, further support the PMG estimator, implying that accounting for heterogeneity is important.

Inflation, Fiscal Balance and Central Bank Independence

Finally, we control for the central bank independence (CBI) since this is highly correlated with income to test robustness of our conclusion that institutions matter. Previous research has shown that CBI, a measure of the extent to which central banks are free to follow their goals and objectives or more broadly, the absence of illegitimate pressure on the central bank to monetize deficits, is an important determinant of inflation across countries (Cukierman, 1992). Neyapti (2003) and Parkin (2012) for instance find a negative correlation between CBI and fiscal deficits especially where borrowing capacity is limited since an independent central bank constrains government's ability to finance deficits from seigniorage. The rationale for CBI partly reflects Rogoff's (1995) findings that delegating the work of a central bank to an

independent agent engenders more credibility and therefore lower inflation bias.[31] An independent central bank thus, more effectively restrains inflation (Brumm, 2002; Alex Cukierman, 1994). These findings therefore suggest that controlling for CBI is important in analyzing the potential role of institutions in the nexus.

Measuring CBI (especially across a broad range countries) has however been a matter of considerable debate and research. A measure that has become popular in the case of developing countries is the turnover rate of central bank governors (ToRG) – a behaviour-oriented measure of CBI (Cukierman *et al.* 1992; Neyapti, 2003). Cukierman *et al.* (1992) argue that in less developed countries where the rule of law is often less strictly applied, behaviour-oriented measures of CBI such as ToRG provide a better proxy while de jure measures such as legal independence is a good proxy for measuring CBI in developed countries.

In line with these concerns, we measure CBI in two ways, namely 1) proxy CBI by ToRG, defined as the average irregular changes of central bank governors (where higher rates of turnover represent less independence and vice versa); 2) Dividing ToRG by the rule of law measure from ICRG as a way of also capturing features of high income countries in our sample and to mitigate potential measurement errors.[32] Using these measures, we control for CBI by focusing only on the subsample of dependent central banks (i.e. with high average ToRG) in order to examine the role of institutions. In the case of ToRG, 38 countries are classified as weak central bank countries including a number of high income countries namely Bahrain, Norway, Qatar and Switzerland. On the other hand, dividing ToRG by rule of law shifts these countries to the high independence countries while Bhutan, Burundi, Central African Republic, Kenya, Libya, Solomon Islands, Swaziland and Seychelles are now classified as countries with dependent central banks.

[31] See Rogoff (1985).
[32] This measure should provide a better proxy for a broad range of countries as it combines features of both lower and higher income countries.

Tables 2.7 and 2.8 provide results based on the two definitions of ToRG respectively across different institutional proxies.[33] Broadly, the results show that deficits remain more inflationary in countries with poor institutions (whether proixied by polity2 or ICRG) albeit with much smaller coefficients. However, perhaps reflecting the difficulty in using ToRG as a measure of CBI across a broad-range of countries, including rule of law in our measure of institutions under ICRG yields insignificant results (see appendix Table A2.12 for details).[34] Furthermore, the results remain robust to the inclusion of oil price inflation and exchange rate regime. Thus, providing support for our key conclusion that institutions matter in the fiscal balance-inflation nexus.

[33] Further details on individual institutional proxies from the ICRG index can be found in Table A2.13 in appendix A. Analysis using democratic accountability which is a measure the political system of a country like the polity2 scores, shows broadly agreement with the conclusion that institutions matter a great deal in the fiscal-balance inflation nexus (results are not included, but are available with authors).

[34] Indeed, defined only based on ToRG, a few higher income countries are classified as countries with weak central banks – notably, Norway and Switzerland.

Table 2.7: Role of Institutions in the Fiscal Deficit - Inflation Nexus in Countries with relatively Weak Central Banks

ICRG index: corruption and bureaucratic quality; Turnover)

Dependent variable Δlogcpi

Based on the Cross-Sectionally Augmented ARDL Approach (CS-ARDL, ECM)

	PMG			
	Polity2	ICRG index (corruption and bureaucratic quality)	Polity2	ICRG index (corruption and bureaucratic quality)
LR elasticities				
Weak insts*(T-G)/M1	-0.0181**	-0.0277**	-0.038***	-0.0299**
	(-2.56)	(-2.08)	(-3.76)	(-2.07)
Strong insts*(T-G)/M1	0.00573	-0.00257	0.0128*	-0.00192
	(0.79)	(-0.54)	(1.75)	(-0.36)
Oil_price inflation			0.0415***	0.0328***
			(4.62)	(4.06)
ExR regime			0.0106**	0.0400***
			(2.02)	(9.66)
EC coefficient (ϕ)	-0.735***	-0.786***	-0.682***	-0.638***
	(-13.96)	(-14.62)	(-12.81)	(-9.82)
h-statistic	0.41	0.76	1.06	0.54
	[0.815]	[0.685]	[0.900]	[0.969]
Wald test-statistic[1]	5.50	3.15	16.30	3.27
	[0.019]	[0.076]	[0.000]	[0.071]
N x T	1267	986	1267	986

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions / central bank independence (ToRG) are those with average polity2 scores or icrg below (above) their respective global median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

Table 2.8: Role of Institutions in the in the Fiscal Deficit - Inflation Nexus in Countries with relatively Weak Central Banks

(ICRG index: corruption, law and order and bureaucratic quality; Turnover divided by law and order)

Dependent variable Δlogcpi

Based on the Cross-Sectionally Augmented ARDL Approach (CS-ARDL, ECM)

	PMG			
	Polity2	ICRG Index (corruption, law and order and bureaucratic quality)	Polity2	ICRG Index (corruption, law and order and bureaucratic quality)
LR elasticities				
Weak insts*(T-G)/M1	-0.0184*	-0.0339***	-0.0291**	-0.0474***
	(-1.88)	(-2.69)	(-2.54)	(-3.91)
Strong insts*(T-G)/M1	0.00466	-0.000345	0.0137*	0.00517
	(0.64)	(-0.07)	(1.84)	(0.99)
Oil_price inflation			0.0458***	0.0372***
			(4.79)	(4.80)
ExR regime			0.0281***	0.0353***
			(5.37)	(10.18)
EC coefficient (ϕ)	-0.765***	-0.821***	-0.687***	-0.720***
	(-15.64)	(-16.92)	(-12.38)	(-12.15)
h-statistic	0.39	0.32	0.61	0.20
	[0.824]	[0.850]	[0.962]	[0.995]
Wald test-statistic[1]	3.57	6.05	9.78	15.93
	[0.059]	[0.014]	[0.002]	[0.000]
N x T	1338	1045	1338	1045

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions / central bank independence (ToRG/ law and order) are those with average polity2 scores or icrg below (above) their respective global median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

2.5 Summary and Conclusions

Macroeconomic theory postulates a negative relationship between the fiscal balance and inflation, particularly when countries are constrained in their ability to borrow. Previous research has shown that the negative relationship holds in lower-income countries. In this chapter, we highlight the role of

institutions in the fiscal balance - inflation nexus using recent econometric techniques that account for all three dimensions of the panel (namely dynamics, heterogeneity and cross-section dependence). Our results confirm the previous finding that deficits are inflationary in lower income countries, but they also show that institutions play a crucial role in mitigating the inflationary impact of deficits. Importantly, we show that *even* among low-income countries, institutional quality still matters, thus making lower-income countries with weak institutions significantly more susceptible to the adverse effect of fiscal deficits on inflation. This is consistent with the view that governments that cannot be trusted to pay their debts have a larger difficulty in financing deficits by borrowing, and thus need to resort to seigniorage revenues.

Appendix A

Table A2. 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
		All countries (67)			
Δlogcpi[1]	2,641	0.09	0.16	-0.20	4.77
Fiscal balance					
ratio of M1[2]	1,794	-0.14	0.48	-3.94	4.51
ratio of GDP	1,860	-0.02	0.07	-1.51	0.43
Polity2	2,438	0.19	7.30	-10.00	10.00
ICRG index[3]	1,477	8.78	3.53	1.00	16.00
Oil price inflation	2,881	0.10	0.32	-0.64	1.36
		By income level [4]			
Higher income (30 countries)					
Δlogcpi	1,208	0.07	0.11	-0.19	1.63
Fiscal balance					
ratio of M1	812	-0.04	0.59	-3.94	4.51
ratio of GDP	854	-0.01	0.09	-1.51	0.43
Polity2	896	2.60	7.85	-10.00	10.00
ICRG index	619	11.16	3.70	4.00	16.00
Lower income (37 countries)					
Δlogcpi	1,433	0.11	0.18	-0.20	4.77
Fiscal balance					
ratio of M1	982	-0.22	0.33	-2.77	1.40
ratio of GDP	1,006	-0.03	0.04	-0.25	0.16
Polity2	1,542	-1.21	6.57	-10.00	10.00
ICRG index	858	7.06	2.12	1.00	12.00
		By institutional quality: polity2 scores [5]			
Strong institutions (29 countries)					
Δlogcpi	1,145	0.10	0.21	-0.08	4.77
Fiscal balance					
ratio of M1	787	-0.24	0.39	-2.77	1.33
ratio of GDP	837	-0.03	0.05	-0.25	0.19
Polity2	1,230	5.20	5.83	-9.00	10.00
ICRG index	734	9.13	4.10	1.00	16.00

Table A2.1 continued next page

Table A2.1 continued

Variable	Obs	Mean	Std. Dev.	Min	Max
Weak institutions (28 countries)					
Δlogcpi	1,104	0.09	0.11	-0.20	0.85
Fiscal balance					
ratio of M1	724	-0.03	0.60	-3.94	4.51
ratio of GDP	734	-0.01	0.10	-1.51	0.43
Polity2	1,208	-4.91	4.62	-10.00	9.00
ICRG index	657	7.87	2.32	1.75	14.50
	By institutional quality: ICRG index [5]				
Strong institutions (29 countries)					
Δlogcpi	1,149	0.08	0.10	-0.10	1.63
Fiscal balance					
ratio of M1	780	-0.09	0.45	-3.94	2.87
ratio of GDP	817	-0.02	0.09	-1.51	0.43
Polity2	1,116	0.95	7.91	-10.00	10.00
ICRG index	820	10.77	3.27	1.75	16.00
Weak institutions (23 countries)					
Δlogcpi	933	0.13	0.23	-0.12	4.77
Fiscal balance					
ratio of M1	592	-0.23	0.41	-2.07	1.49
ratio of GDP	614	-0.03	0.06	-0.25	0.33
Polity2	978	0.18	6.53	-9.00	10.00
ICRG index	657	6.28	1.86	1.00	11.00

Notes:

1. Δlogcpi is the change in the log of consumer price index

2. M1 is base money

3. ICRG is computed as the composite of three components, namely: corruption, law and order and bureaucratic quality

4. Higher income countries are countries classified by the World Bank as high and upper middle income and lower otherwise

5. Strong (weak) institutions are those with median scores or index values above (below) the median values

Table A2.2: Role of Income Levels and Other Controls in the Fiscal Balance - Inflation Nexus

Dependent variable Δlogcpi				
	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Low income dum*(T-G)/M1	-0.0232***	-0.0588	**-0.0172*** **	2.468
	(-3.21)	(-1.24)	**(-2.92)**	(0.97)
High income dum*(T-G)/M1	0.00690	0.00928	**0.00273**	-0.0481
	(1.46)	(0.63)	**(0.98)**	(-0.97)
Oil_price inflation	0.0508***	0.124***	**0.0175*** **	0.271
	(6.05)	(2.65)	**(3.15)**	(1.35)
ExR regime	0.0125***	0.0249	**0.0137*** **	0.561
	(3.87)	(1.09)	**(7.45)**	(0.96)
EC coefficient (ϕ)	-0.470***	-0.567***	**-0.726*** **	-0.802***
	(-15.57)	(-15.27)	**(-16.73)**	(-16.63)
h-statistic	1.12		**0.4**	
	[0.891]		**[0.983]**	
Wald test-statistic	12.18	1.9	**9.3**	0.98
	[0.001]	[0.168]	**[0.002]**	[0.322]
N x T	2469	2469	**2377**	2377

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Lower (higher) income countries include countries classified by the World Bank as low and lower middle (high, high OECD and upper middle) income countries. The Wald test-statistic refers to the test of parameter equality between low income dum*(T-G)/M1 and high income dum*(T-G)/M1 Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

Table A2.3: Role of Institutions in the Fiscal Balance Inflation Nexus (ICRG Index including Investment Profile)

Dependent variable Δlogcpi[b]

	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Weak insts*(T-G)/M1	-0.0171	-0.0792**	**-0.0366*** **	-0.0847
	(-1.27)	(-2.33)	**(-3.86)**	(-1.52)
Strong insts*(T-G)/M1	0.00417**	-0.0114	**0.00155**	0.00912
	(2.30)	(-1.06)	**(0.76)**	(0.33)
EC coefficient (ϕ)	-0.540***	-0.587***	**-0.772*** **	-0.814***
	(-18.29)	(-18.86)	**(-19.92)**	(-20.89)
h-statistic	3.18		**0.28**	
	[0.204]		**[0.866]**	
Wald test-statistic	2.43	3.53	**15.49**	2.29
	[0.119]	[0.060]	**[0.000]**	[0.130]
N x T	1949	1949	**1949**	1949

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average ICRG index including investment profile below (above) the global median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

Table A2.4: Role of Institutions in the Fiscal Balance Inflation Nexus (ICRG Index including Investment Profile; Upper Third Threshold)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG	MG	**PMG**	MG
LR elasticities				
Weak insts*(T-G)/M1	-0.0224	-0.146**	**-0.0426*** **	-0.157
	(-1.48)	(-2.46)	**(-4.24)**	(-1.58)
Strong insts*(T-G)/M1	-0.0186***	-0.0366**	**-0.00991** **	0.0211
	(-2.88)	(-2.48)	**(-2.50)**	(0.42)
EC coefficient (ϕ)	-0.538***	-0.593***	**-0.861*** **	-0.900***
	(-13.73)	(-13.93)	**(-18.22)**	(-18.62)
h-statistic	3.47		**0.54**	
	[0.176]		**[0.762]**	
Wald test-statistic	0.05	2.96	**9.17**	2.62
	[0.817]	[0.085]	**[0.003]**	[0.106]
N x T	1064	1064	**1064**	1064

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average ICRG index including investment profile below (above) the upper third value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

Table A2.5: Role of Institutions in the Fiscal Balance Inflation Nexus (Executive Constraints)

Dependent variable Δlogcpi	All countries		Lower income	
	CS-ARDL (1, 0), ECM		**CS-ARDL (1, 0), ECM**	
	PMG		PMG	
LR elasticities				
Weak insts*(T-G)/M1	-0.00938***	-0.00923***	-0.0692***	-0.0379***
	(-3.13)	(-2.75)	(-4.51)	(-3.06)
Strong insts*(T-G)/M1	-0.000390	0.00246	-0.0124**	-0.0207*
	(-0.11)	(0.91)	(-2.27)	(-1.68)
Oil_price inflation		0.0202***		0.0321***
		(3.66)		(2.90)
ExR regime		0.0148***		0.0314***
		(7.93)		(10.46)
EC coefficient (ϕ)	-0.740***	-0.732***	-0.838***	-0.745***
	(-17.90)	(-16.62)	(-18.28)	(-12.23)
h-statistic	0.58	0.9	1.02	0.69
	[0.747]	[0.925]	[0.601]	[0.953]
Wald test-statistic	3.86	7.41	12.13	0.94
	[0.050]	[0.007]	[0.001]	[0.331]
N x T	2477	2377	1344	1167

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.8' without (with) cross-section terms. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions are those with average executive constraints below (above) the global median value for the sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 2 for no legal tender 3 for peg and 5 for float.

Table A2.6: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance (1970 - 2013)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM						**CS-ARDL (1, 0), ECM**					
	All countries		Higher income		Lower income		All countries		Higher income		Lower income	
	PMG	MG	**PMG**	MG	PMG	**MG**	PMG	MG	**PMG**	MG	**PMG**	MG
LR elasticities												
(T-G)/M1	**0.00458**	-0.0533	**0.0140*** **	0.104*	-0.0191***	**-0.181*** **	-0.00786***	-0.108*	**-0.00162**	-0.00451	**-0.0175*** **	-0.192*
	(1.26)	(-1.22)	**(2.71)**	(1.89)	(-3.00)	**(-3.13)**	(-3.16)	(-1.74)	**(-0.50)**	(-0.20)	**(-3.89)**	(-1.75)
EC coefficient (ϕ)	**-0.508*** **	-0.550***	**-0.477*** **	-0.496***	-0.537***	**-0.593*** **	-0.803***	-0.813***	**-0.629*** **	-0.621***	**-0.945*** **	-0.969***
	(-16.57)	(-16.47)	**(-9.20)**	(-9.37)	(-14.00)	**(-14.18)**	(-19.01)	(-18.53)	**(-10.70)**	(-10.12)	**(-20.90)**	(-19.69)
h-statistic	**0.91**		**2.59**		**3.69**		0.92		**0.02**		**0.81**	
	[0.339]		**[0.107]**		**[0.055]**		[0.339]		**[0.902]**		**[0.369]**	
N x T	**2573**	2573	**1177**	1177	1396	**1396**	2477	2477	**1133**	1133	**1344**	1344

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.6' (2.7), estimating for the full sample as well as splitting into lower (higher) income. Lower (higher) income countries include countries classified by the World Bank as low and lower middle (high, high OECD and upper middle) income countries. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

Table A2.7: Appendix Table 4: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance and Oil Price Inflation (1970 - 2013)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM						CS-ARDL (1, 0), ECM					
	All countries		Higher income		Lower income		All countries		Higher income		Lower income	
	PMG	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG
LR elasticities (T-G)/M1	**0.000912**	-0.128**	**0.00547**	0.0322	**-0.0222*** **	-0.258***	**-0.00719*** **	-0.117	**0.00378**	-0.00567	**-0.0225*** **	-0.208
	(0.25)	(-2.30)	**(1.18)**	(0.95)	**(-3.45)**	(-2.81)	**(-2.89)**	(-1.31)	**(1.38)**	(-0.06)	**(-3.95)**	(-1.46)
Oil_price inflation	**0.0527*** **	0.161**	**0.0799*** **	0.117	**0.0108**	0.196*	**0.00730**	0.182	**0.0232*** **	0.161	**-0.00240**	0.199
	(6.05)	(2.25)	**(6.73)**	(1.35)	**(0.80)**	(1.79)	**(1.30)**	(1.32)	**(3.38)**	(0.69)	**(-0.27)**	(1.21)
EC coefficient (ϕ)	**-0.464*** **	-0.523***	**-0.408*** **	-0.460***	**-0.519*** **	-0.574***	**-0.728*** **	-0.772***	**-0.600*** **	-0.642***	**-0.844*** **	-0.877***
	(-16.89)	(-15.42)	**(-11.32)**	(-8.88)	**(-13.37)**	(-13.16)	**(-16.72)**	(-17.75)	**(-9.66)**	(-9.01)	**(-17.12)**	(-18.41)
h-statistic	**2.28**		**1.32**		**2.51**		**0.46**		**0.26**		**0.43**	
	[0.321]		**[0.518]**		**[0.284]**		**[0.796]**		**[0.879]**		**[0.806]**	
N x T	**2573**	2573	**1177**	1177	**1396**	1396	**2477**	2477	**1133**	1133	**1344**	1344

See notes under Table A2.2. Oil price inflation is the log difference of nominal crude oil price.

Table A2.8: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance, Oil Price Inflation and Per Capita Income (1970 - 2013)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM				CS-ARDL (1, 0), ECM			
	PMG	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG
LR elasticities								
(T-G)/M1	**0.00391**	-0.111*	**-0.143*** **	-3.293***	**0.00585*** **	-0.104	**-0.0878*** **	-0.489
	(1.04)	(-1.71)	**(-3.57)**	(-3.30)	**(4.03)**	(-1.09)	**(-4.17)**	(-0.27)
Oil_price inflation	**0.0823*** **	0.170**	**0.0806*** **	0.117**	**0.0372*** **	0.0327	**0.0269*** **	0.0507
	(9.79)	(2.16)	**(9.50)**	(2.45)	**(8.73)**	(0.37)	**(5.29)**	(0.77)
Per-capita inc.	**-0.0303*** **	-0.0126	**-0.0285*** **	0.0470	**-0.0493*** **	0.0824	**-0.0516*** **	0.0416
	(-9.02)	(-0.23)	**(-8.27)**	(0.98)	**(-14.62)**	(0.87)	**(-14.52)**	(0.32)
Per-capita inc* (T-G)/M1			**0.0171*** **	0.420***			**0.00831*** **	0.0570
			(3.59)	(3.48)			**(3.87)**	(0.26)
EC coefficient (ϕ)	**-0.457*** **	-0.617***	**-0.454*** **	-0.656***	**-0.752*** **	-0.932***	**-0.755*** **	-0.977***
	(-17.75)	(-18.05)	**(-16.79)**	(-17.13)	**(-18.91)**	(-15.98)	**(-18.22)**	(-15.90)
h-statistic	**1.33**		**2.81**		**0.24**		**0.08**	
	[0.723]		**[0.590]**		**[0.970]**		**[0.999]**	
N x T	**2573**	2573	**2573**	2573	**2477**	2477	**2477**	2477

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.6' (2.7), interacting per capita income with fiscal balance for the full sample. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1.

Table A2.9: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance, Oil Price Inflation and Polity2 (1970 - 2013)

Dependent variable Δlogcpi

	ARDL (1, 0), ECM				**CS-ARDL (1, 0), ECM**			
	PMG	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG
LR elasticities								
(T-G)/M1	**0.00608***	-0.0799	**0.00503****	-1.147	**0.00253****	-0.0602	**0.00146**	-2.057
	(1.71)	(-1.60)	**(2.12)**	(-1.00)	**(2.01)**	(-0.64)	**(0.50)**	(-1.63)
Oil_price inflation	**0.0485*****	0.137*	**0.0307*****	0.106	**0.0365*****	0.104	**-0.000585**	0.0416
	(4.58)	(1.72)	**(4.13)**	(1.29)	**(8.74)**	(1.18)	**(-0.09)**	(0.37)
Polity2	**-0.00204*****	0.122	**-0.000282**	0.133	**-0.00129*****	0.0322**	**0.00147*****	0.0760
	(-3.99)	(1.13)	**(-1.01)**	(1.18)	**(-7.85)**	(2.16)	**(2.74)**	(1.21)
Polity2* (T-G)/M1			**-0.0000560**	0.263*			**-0.000300**	0.265*
			(-0.16)	(1.82)			**(-0.70)**	(1.75)
EC coefficient (ϕ)	**-0.478*****	-0.610***	**-0.474*****	-0.636***	**-0.742*****	-0.854***	**-0.741*****	-0.965***
	(-12.53)	(-13.78)	**(-13.03)**	(-14.29)	**(-15.19)**	(-17.33)	**(-17.01)**	(-12.42)
h-statistic	**2.12**		**2.52**		**1.05**		**1.3**	
	[0.547]		**[0.642]**		**[0.790]**		**[0.861]**	
N x T	**2178**	2178	**1426**	1426	**2096**	2096	**1424**	1424

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.6' (2.7), interacting institutional quality (polity2) with fiscal balance for the full sample. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil price.

Table A2.10: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance and Oil Price Inflation including Squared Overall Government Fiscal Balance Term (1970 - 2013)

	ARDL (1, 0), ECM						CS-ARDL (1, 0), ECM					
	All countries		Higher income		Lower income		All countries		Higher income		Lower income	
	PMG	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG	**PMG**	MG
LR elasticities (T-G)/M1	**0.00103**	-0.0532	**0.00541**	-0.0674	**-0.0279*** **	-0.0416	**0.00105**	0.134	**-0.00306**	0.0139	**-0.0261*** **	0.231
	(0.30)	(-0.58)	**(1.17)**	(-0.62)	**(-2.77)**	(-0.30)	**(0.62)**	(0.72)	**(-1.51)**	(0.18)	**(-4.02)**	(0.70)
[(T-G)/M1]^2	**0.00191**	0.837	**0.000175**	-0.254	**-0.00388**	1.721	**0.00327*** **	1.224	**-0.00360*** **	-0.0153	**-0.00798** **	2.229
	(1.15)	(0.98)	**(0.08)**	(-1.18)	**(-0.69)**	(1.12)	**(4.71)**	(0.96)	**(-4.81)**	(-0.12)	**(-2.12)**	(0.97)
Oil_price inflation	**0.0512*** **	0.167**	**0.0798*** **	0.188	**0.0111**	0.150	**-0.0230*** **	0.0245	**0.00988** **	0.0193	**-0.00116**	0.0287
	(5.92)	(2.29)	**(6.70)**	(1.59)	**(0.82)**	(1.63)	**(-6.08)**	(0.40)	**(2.54)**	(0.21)	**(-0.25)**	(0.35)
EC coefficient (ϕ)	**-0.466*** **	-0.544***	**-0.409*** **	-0.455***	**-0.519*** **	-0.616***	**-0.821*** **	-0.902***	**-0.643*** **	-0.711***	**-0.853*** **	-1.056***
	(-16.87)	(-13.31)	**(-11.32)**	(-8.69)	**(-13.35)**	(-10.52)	**(-14.82)**	(-9.47)	**(-8.60)**	(-5.63)	**(-7.43)**	(-7.83)
h-statistic	**1.57**		**1.85**		**1.09**		**1.25**		**2.97**		**2.51**	
	[0.667]		**[0.603]**		**[0.780]**		**[0.742]**		**[0.396]**		**[0.474]**	
N x T	**2573**	2573	**1177**	1177	**1396**	1396	**2477**	2477	**1133**	1133	**1344**	1344

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.6' (2.7), including squared fiscal balance term. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil price.

Table A2.11: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance (1970 - 2013)

Dependent variable Δlogcpi[a]

	ARDL [1, 0], ECM	
	PMG	DFE
LR elasticities		
(T-G)/M1	0.00458	-0.0724
	(1.26)	(-1.06)
EC coefficient (ϕ)	-0.508***	-0.397***
	(-16.57)	(-13.34)
Maximized log likelihood	3224	1243
N x T	2573	1758
N x T	2573	1758

Notes: t statistics in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01

The *h*-statistic refers to the Hausman test on long-run homogeneity restriction

a. Δlogcpi is log difference of CPI

b. fiscal balance is government revenue less government expenditure, expressed as ratio of M1

LR test	3963.42
	[0.000]

Table A2.12: Role of Institutions in the in the Fiscal Deficit - Inflation Nexus in Countries with relatively Weak Central Banks

Dependent variable Δlogcpi

Based on the Cross-Sectionally Augmented ARDL Approach (CS-ARDL, ECM)

	PMG									
	Polity2	ICRG Index				Polity2	ICRG Index			
		Corruption	Bureaucratic quality	Rule of law	Invest. Profile		Corruption	Bureaucratic quality	Rule of law	Invest. Profile
LR elasticities										
Weak insts*(T-G)/M1	-0.0181**	-0.0249*	-0.0170**	0.000374	-0.0216	-0.0379***	-0.0311**	-0.0358***	0.00175	-0.0333
	(-2.56)	(-1.86)	(-2.52)	(0.03)	(-1.26)	(-3.76)	(-2.16)	(-4.08)	(0.10)	(-1.37)
Strong insts*(T-G)/M1	0.00573	-0.00303	0.00500	-0.00595	-0.00420	0.0128*	-0.00177	0.00645	-0.00615	-0.00406
	(0.79)	(-0.64)	(0.78)	(-1.28)	(-0.91)	(1.75)	(-0.33)	(1.04)	(-1.17)	(-0.79)
Oil_price inflation						0.0415***	0.0329***	0.0367***	0.0308***	0.0311***
						(4.62)	(4.07)	(4.57)	(3.80)	(3.87)
ExR regime						0.0106**	0.0400***	0.0387***	0.0390***	0.0392***
						(2.02)	(9.65)	(9.43)	(9.33)	(9.46)

Table continued next page

Continued from previous page

EC coefficient (ϕ)	-0.735***	-0.785***	-0.786***	-0.787***	-0.786***	-0.682***	-0.637***	-0.641***	-0.640***	-0.641***
	(-13.96)	(-14.51)	(-15.00)	(-14.33)	(-14.38)	(-12.81)	(-9.73)	(-10.26)	(-9.71)	(-9.88)
h-statistic	0.41	0.57	0.22	0.66	0.85	1.06	0.42	0.88	0.58	0.88
	[0.815]	[0.751]	[0.895]	[0.717]	[0.653]	[0.900]	[0.981]	[0.927]	[0.966]	[0.928]
Wald test-statistic[1]	5.50	2.38	5.63	0.18	0.97	16.30	3.62	15.06	0.20	1.38
	[0.019]	[0.123]	[0.018]	[0.672]	[0.326]	[0.000]	[0.057]	[0.000]	[0.656]	[0.240]
N x T	1267	986	986	986	986	1267	986	986	986	986

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. The h-statistic refers to the Hausman test of long-run homogeneity restriction. Countries classified as having weak (strong) institutions / central bank independence (CBI) are those with average polity2 scores or icrg below (above) their respective global median value for our sample. The Wald test-statistic refers to the test of parameter equality between weak insts*(T-G)/M1 and strong insts*(T-G)/M1. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float.

Table A2.13: List of Countries

Country	*Classification by:*			Country	*Classification by:*		
	Income	Institutions (polity2)	Institutions (icrg index)		Income	Institutions (polity2)	Institutions (icrg index)
Bahamas	HIC	-	Strong	Algeria	LMC	Weak	Weak
Bahrain	HIC	Weak	Strong	Bhutan	LMC	Weak	-
Hong Kong	HIC	-	Strong	Bolivia	LMC	Strong	Weak
Kuwait	HIC	Weak	Strong	China	LMC	Weak	Strong
Qatar	HIC	Weak	Strong	Ecuador	LMC	Strong	Strong
Singapore	HIC	Weak	Strong	El Salvador	LMC	Strong	Weak
Australia	HIC_OECD	Strong	Strong	Honduras	LMC	Strong	Weak
Canada	HIC_OECD	Strong	Strong	India	LMC	Strong	Strong
Denmark	HIC_OECD	Strong	Strong	Indonesia	LMC	Weak	Weak
Iceland	HIC_OECD	-	Strong	Iran	LMC	Weak	Strong
Japan	HIC_OECD	Strong	Strong	Jordan	LMC	Weak	Strong
New Zealand	HIC_OECD	Strong	Strong	Mongolia	LMC	Strong	Strong
Norway	HIC_OECD	Strong	Strong	Morocco	LMC	Weak	Strong
Switzerland	HIC_OECD	Strong	Strong	Paraguay	LMC	Strong	Weak
Dominica	UMC	-	-	Philippines	LMC	Strong	Weak
Equatorial Guinea	UMC	Weak	-	Sri Lanka	LMC	Strong	Weak
Fiji	UMC	Strong	-	Sudan	LMC	Weak	Weak
Gabon	UMC	Weak	Weak	Swaziland	LMC	Weak	-
Grenada	UMC	-	-	Syria	LMC	Weak	Strong
Jamaica	UMC	Strong	Weak	Tunisia	LMC	Weak	Strong
Libya	UMC	Weak	Weak	Vanuatu	LMC	-	-
Lithuania	UMC	Strong	Strong	Bangladesh	LIC	Strong	Weak
Malaysia	UMC	Strong	Strong	Benin	LIC	Strong	-
Mexico	UMC	Weak	Weak	Burkina Faso	LIC	Weak	Weak
Panama	UMC	Strong	Weak	Burundi	LIC	Weak	-
Saint Kitts and Nevis	UMC	-	-	Central African Republic	LIC	Weak	-
Saint Lucia	UMC	-	-	Ethiopia	LIC	Weak	Strong
Saint Vincent and the Grenadines	UMC	-	-	Ghana	LIC	Strong	Weak
Seychelles	UMC	-	-	Kenya	LIC	Weak	Weak
Suriname	UMC	Strong	Weak	Madagascar	LIC	Weak	Strong
				Mozambique	LIC	Strong	Weak
				Pakistan	LIC	Strong	Weak
				Papua New Guinea	LIC	Strong	Strong
				Solomon Islands	LIC	Strong	-
				Tanzania	LIC	Weak	Strong
				Togo	LIC	Weak	Weak
				Yemen	LIC	Weak	Weak

Chapter 3

The Mean Group and Pooled Mean Group Estimators and Outliers

3.1 Introduction

As seen in the previous chapter, the pooled mean group (PMG) and mean group (MG) estimators can produce significantly different results, reflecting among others, the underlying assumptions and data characteristics. In the case of the MG for instance, the averaging of individual country parameters is easily distorted by outliers, which can lead to potentially misleading inference. The main purpose of this chapter is therefore to carefully examine these differences with the view to assessing whether the use of two alternative robust estimators, the median and robust regression estimators based on the MG can potentially yield more agreement between the PMG and MG estimates. Furthermore, we compare these results to those of the two way fixed effects estimator which allows for heterogeneity in only country fixed effects while constraining all slope parameters to be the same across countries. The analysis shows that using such robust estimators can potentially yield substantially smaller disagreement between the PMG and MG estimators, narowing on average by at least 80 percent in our sample. We begin by providing a brief description of the alternative estimation techniques and demonstrating these differences in the context of the fiscal balance-inflation nexus for example.

3.2 Pooled Mean Group, Mean Group and the Dynamic Fixed Effects Models

The Pooled Mean Group (PMG) estimator (Pesaran *et al.* 1999), a maximum likelihood-based approach, constrains the long-run elasticities to be

equal across all countries, while allowing the short run coefficients, including the intercepts, speed of adjustment to long run equilibrium parameters and error variances to differ freely across countries. The common long-run coefficient and country specific short-run coefficients are computed by maximum likelihood estimation. This estimator however yields inconsistent estimates if the true model is heterogeneous, and the MG estimates are consistent in either case.

The mean group (MG) estimator (Pesaran and Smith, 1995) on the other hand, estimates separate regressions for each country and computes the coefficients as a simple arithmetic mean of the individual country coefficients. Unlike the PMG and the Dynamic Fixed Effects (DFE) models, this approach does not impose any parameter restrictions, and thus allows both the long-run and the short-run coefficients including the adjustment to long-run equilibrium parameters and country specific intercepts as well as the error variances to vary across countries.[35] The MG estimator provides consistent estimates of the mean of the long-run parameters, though these will be inefficient if slope homogeneity holds. With long-run slope homogeneity, the pooled estimators are consistent and efficient. In general, for both estimators, it is required that that the relative size of *N* and *T* must be large to allow for sufficient lags of (p, q) to ensure that the residuals are serially uncorrelated.

An important condition for consistency and validity of the approach entails having a sufficiently large time series dimension of the data. Further, as Lee *et al.* (1997) and Demetriades and Law (2004) for instance point out that the MG estimator is likely to be inefficient in small country samples, where any country outlier could severely influence the MG coefficients. Based on our data used in the preceding chapter, we demonstrate this for instance in the case of fiscal balance-inflation nexus using data on a large panel of countries with wide differences across them.

[35] The dynamic fixed effects estimator (DFE) is very similar to the PMG estimator. This estimator constrains all the slope coefficients and error variances to be equal across countries in the long run. The DFE model further constrains the speed of adjustment coefficient and the short-run coefficient to be equal across countries. However, the model features country-specific intercepts.

Applying the PMG, MG and two-way fixed effects estimators to the sample of 37 lower income countries for this dataset for instance shows clearly that the magnitude and significance of the long-run coefficients can vary widely depending on whether all the parameters, or all except the long-run, or only the country specific effects are allowed to vary across countries. In particular, adjusting the MG coefficients for outliers yields considerably close estimates to the PMG, reflecting the importance of outliers in the case of the MG estimator. Moreover, the two way fixed effects estimator which constrains all slope parameters to be the same across countries, with heterogeneity in only country specific factors produces broadly larger coefficients, though statistically insignificant.

3.3 Model Estimation and Empirical Results

As outlined above, we apply the PMG, MG and the two-way fixed effects estimators to estimate equations $(2.6')$ and (2.7) shown in the previous chapter. Table 3.1 reports results of the ARDL and its cross-sectionally augmented (CS-ARDL) version for the sample of 37 lower income countries. The table shows significant differences between the estimates of the PMG and MG estimators. In all the estimations, the absolute value of the MG coefficient remains significantly larger than that for the PMG. Under panel (a) of the Table for instance, the MG coefficient of -0.176 with a *t*-statistic of -2.98 is more than ten times bigger than the PMG coefficient of -0.0167 with a t-statistic of -2.67. Including other variables in the estimations as in models 2 and 3 of the table, shows similar patterns with a difference that ranges between almost four times for model 3. Panel (b) of the Table shows broadly similar results, with the absolute values of the MG coefficients remaining significantly larger.

Two alternative outlier-robust estimates are provided by the median and robust regression estimators which downweights the effect of the outliers. These robust estimators provide an alternative summary of the coefficients from the regressions underlying the MG estimator. Specifically, the median regression estimator is based on the median of the estimated MG coefficients and therefore downweights the influence of outliers among these coefficients. In STATA, this

is implemented by the qreg command. The robust regression estimator on the other hand is a weighted OLS estimator based on the absolute residuals. The weights are based on Huber and Tukey biweights, implemented in STATA by the rreg command.

The robust estimators are provided in Table 3.1. The table shows that adjusting the MG coefficients under the median and robust regression techniques, yields coefficients that remain much similar in magnitude to those of the PMG, thus pointing to the influence of outliers on the MG estimator. The median regression under model 1 of the table for instance produces -0.052, almost as low as one-third of the corresponding MG coeffecient, remaining generally similar or even lower in some instances for the other models. The estimates under the robust regressions similarly downweights all the MG coefficients by an almost similar mangnitude. For this sample, on average, the robust estimators yield coefficients of almost as low as one-third of the MG coefficients, remaining significantly closer to the PMG estimates and therefore potentially more reliable than the MG estimates which are susceptible to influence of outliers. Economically, based on the MG estimate of -0.18 in panel (a) (Table 3.1), a one-SD improvement in the fiscal balance reduces inflation by 10 percent compared with measured improvements of 3 percent and 5 percent for the median regression and robust regression respectively. The corresponding improvement implied by the PMG is 1 percent.[36]

The above trends are summarized in the ratio of MG difference from PMG statistic. This statistic is a measure of the spread of the MG robust estimators from the PMG (i.e. ratio of the difference between the outlier robust MG and PMG coefficients divided by the difference between the MG and PMG cofficients. Clearly, the analysis shows that the using such robust estimators can potentially yield substantially smaller disagreement between the PMG and MG estimators, narowing on average by at least 80 percent in our sample.

[36] Table A2.1 in Appendix A shows the simple descriptive statistics.

Table 3.1: Dynamic Panel Estimates of Inflation on Overall Government Fiscal Balance (1970 - 2013)

(a) Based on the ARDL Approach (ARDL)

	Model 1				Model 2				Model 3			
	PMG	**MG**	**MG_{median}**	**MG_{rreg}**	**PMG**	**MG**	**MG_{median}**	**MG_{rreg}**	**PMG**	**MG**	**MG_{median}**	**MG_{rreg}**
LR elasticities												
(T-G)/M1	-0.0167***	-0.176***	-0.052	-0.0769*	-0.0161**	-0.112	-0.0304	-0.0284	-0.0139*	-0.0492	-0.0195	-0.0137
	(-2.67)	(-2.98)	(-1.25)	(-2.68)	(-2.41)	(-1.16)	(-0.70)	(-1.14)	(-1.81)	(-0.57)	(-0.58)	(-0.57)
Oil_price inflation					0.0112	0.0506	0.0147	0.00732	0.0171	0.138*	0.0143	0.0210
					(0.88)	(0.83)	(0.36)	(0.25)	(1.26)	(1.79)	(0.42)	(0.95)
ExR regime					0.00942**	0.0422	0.00637	0.0147	0.0221***	0.0340	0.0258*	0.0243*
					(2.43)	(1.16)	(0.33)	(1.51)	(5.82)	(1.05)	(2.06)	(2.60)
Polity2									-0.00330***	0.0942	-0.00649	-0.00691*
									(-4.56)	(0.87)	(-1.20)	(-2.10)
EC coefficient (ϕ)	-0.554***	-0.610***	-0.641***	-0.608***	-0.545***	-0.659***	-0.715***	-0.674***	-0.593***	-0.753***	-0.760***	-0.732***
	(-14.37)	(-14.79)	(-9.52)	(-14.02)	(-13.00)	(-13.96)	(-10.17)	(-12.82)	(-9.73)	(-12.30)	(-10.05)	(-12.50)
Ratio of MG difference from PMG			**0.22**	**0.38**			**0.15**	**0.13**			**0.16**	**-0.01**
N x T	923	923			862	862			839	839		

(b) Based on the Cross-Sectionally Augmented ARDL Approach (CS-ARDL)

	Model 1				Model 2				Model 3			
	PMG	**MG**	**MG_{median}**	**MG_{rreg}**	**PMG**	**MG**	**MG_{median}**	**MG_{rreg}**	**PMG**	**MG**	**MG_{median}**	**MG_{rreg}**
LR elasticities												
(T-G)/M1	-0.0235***	-0.185*	-0.0300	-0.0343	-0.0219***	-0.0901	-0.0449	-0.0335	-0.0249***	-0.409	-0.0225	-0.0137
	(-5.43)	(-1.73)	(-1.11)	(-1.78)	(-5.33)	(-0.83)	(-0.76)	(-1.40)	(-4.44)	(-1.47)	(-0.64)	(-0.57)
Oil_price inflation					-0.0289***	0.0638	-0.00659	-0.00965	-0.0162**	0.189	0.00606	-0.00788
					(-6.97)	(0.62)	(-0.11)	(-0.24)	(-2.12)	(1.33)	(0.16)	(-0.31)
ExR regime					0.00149	-0.0360	0.00679	0.00101	0.0184***	-0.0249	0.00475	-0.000823
					(1.12)	(-0.37)	(0.69)	(0.13)	(10.09)	(-0.48)	(0.37)	(-0.07)
Polity2									0.00107	0.00853	0.00702	0.00671*
									(1.50)	(0.27)	(1.32)	(2.05)
EC coefficient (ϕ)	-0.966***	-0.966***	-1.035***	-1.017***	-1.017***	-1.147***	-1.141***	-1.099***	-0.997***	-0.913***	-1.129***	-1.119***
	(-24.00)	(-24.00)	(-15.87)	(-23.02)	(-17.56)	(-13.28)	(-13.45)	(-13.79)	(-12.40)	(-3.52)	(-9.40)	(-12.52)
Ratio of MG difference from PMG			**0.04**	**0.07**			**0.34**	**0.17**			**-0.01**	**-0.03**
N x T	923	923			862	862			839	839		

Notes: t statistics in parentheses; *, **, *** indicate significance at 10%, 5% and 1% respectively. The ARDL (CS-ARDL) specifications are given by equations 2.6' (2.7). Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil prices. ExR regime is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float. Polity2 is the proxy for institutional quality and is interacted with fiscal balance. The Ratio of MG difference from PMG is a ratio of the spread of the MG robust estimators from the PMG (i.e. ratio of the difference between the outlier robust MG and PMG coefficients divided by the difference between the MG and PMG cofficients.

These large differences similarly pertain in the coefficients of the other variables and may generally reflect the influence of outliers on the MG coefficients. We show this in Figure 3.1 and Figure 3.2 and in Table 3.2. Figure 3.1 and Figure 3.2 which plot the distribution of the individual country coefficients corresponding to the regressions in Table 3.1 with and without other controls as well as without cross section and with cross section terms. Table 3.2 provides information on the skewness of the MG coefficients. Under model 1 of the ARDL estimation for instance, some 65 percent of the countries have absolute MG coefficients below the average MG estimates. This trend which remains broadly similar for the CS-ARDL suggests presence of substantial outliers as shown in figure 1 and formally tested in Table 3.2. Since under the MG, separate equations are estimated for each of the N and simple arithmetic averaging of parameters is susceptible to influence by these outliers and therefore potentially be misleading.

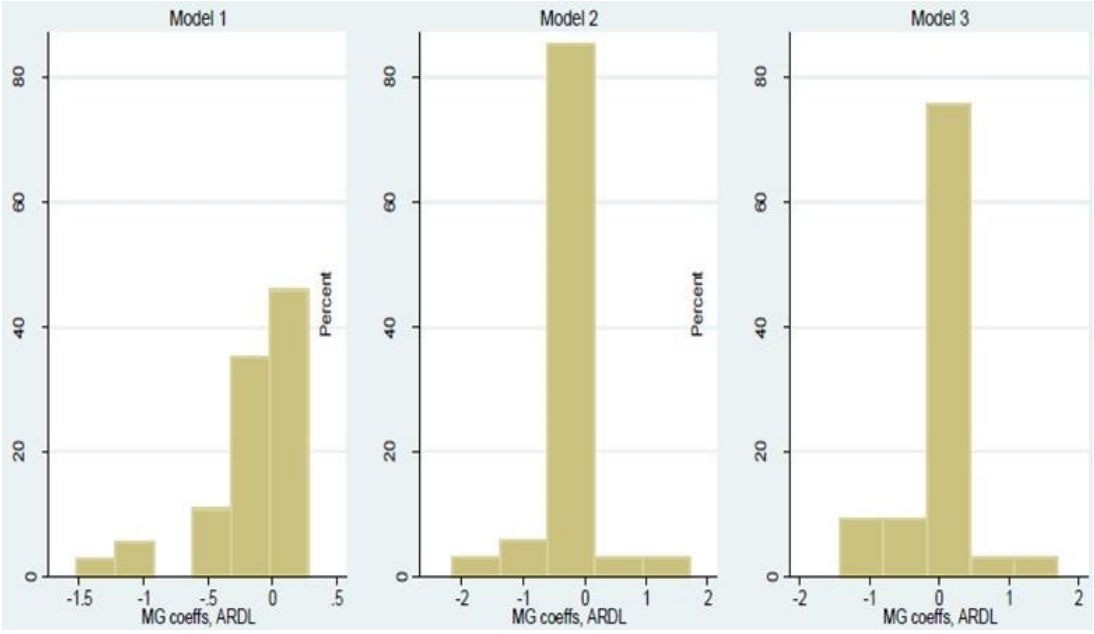


Figure 3.1: Distribution of the MG Coefficients of Fiscal Balance for Lower Income Countries (ARDL)

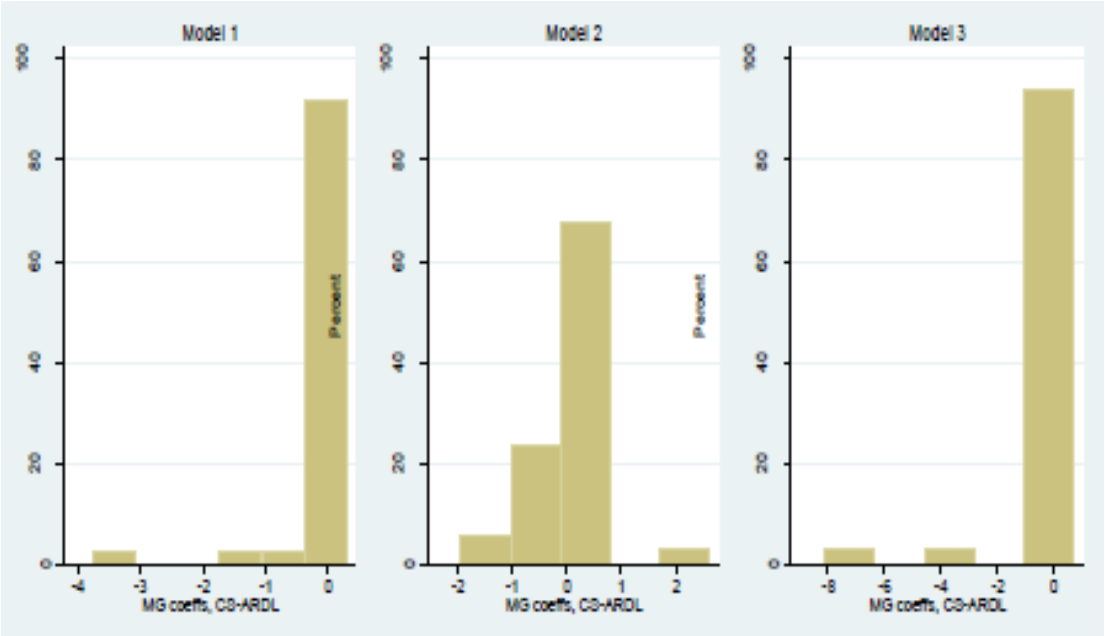


Figure 3.2 Distribution of the MG coefficients of Fiscal Balance for Lower Income Countries (CS-ARDL)

Table 3.2: Skewness/Kurtosis Tests for Normality for the MG Coefficients of the Fiscal Balance

	Sample	Obs	skewness	Pr(Skewness)	Pr(Kurtosis)	chi2(2)	Prob>chi2	Min	Max
ARDL	Model 1	37	-2.40	0.000	0.0004	23.84	0.000	-1.52	0.28
	Model 2	34	-0.83	0.0442	0.0002	14.09	0.0009	-2.15	1.71
	Model 3	33	0.31	0.4273	0.0006	10.15	0.0063	-1.42	1.71
CS-ARDL	Model 1	37	-4.88	0.000	0.000	48.45	0.000	-3.75	0.29
	Model 2	34	1.58	0.0007	0.000	22.0	0.000	-1.93	2.63
	Model 3	33	-4.25	0.000	0.000	40.23	0.000	-8.11	0.71

The two-way fixed effects estimator which involves a substantial degree of pooling, allowing only country fixed effects to differ across countries under the assumption of homogeneous slopes and adjustment to long run equilibrium,

yields even larger estimates than the MG and PMG, albeit statistically insignificant (Table 3.3).

Table 3.3: Dynamic Fixed Effects Panel Estimates of Inflation on Overall Government Fiscal Balance including Controls (Lower Income Subsample, 1970 - 2013)

Dependent variable Δlogcpi	ARDL			
	Model 1	Model 2	Model 3	Model 4
LR elasticities				
(T-G)/M1	-0.282	-0.260	-0.262	-0.245
	(-1.40)	(-1.33)	(-1.35)	(-1.48)
Oil_price inflation		0.815	0.788	0.590
		(1.21)	(0.98)	(0.98)
ExR regime		0.0679**	0.0711**	0.0613**
		(2.09)	(2.11)	(2.54)
Polity2			-0.00108	-0.00555
			(-0.30)	(-1.07)
Polity2* (T-G)/M1				-0.0166
				(-0.84)
EC coefficient (ϕ)	-0.425***	-0.438***	-0.439***	-0.436***
	(-16.67)	(-17.16)	(-16.83)	(-13.30)
N x T	923	862	839	839

Notes: t statistics in parentheses; *, ** , *** indicate significance at 10%, 5% and 1% respectively. Estimations are based on the two way fiexed effects model. Δlogcpi is log difference of CPI and fiscal balance is government revenue less government expenditure, expressed as ratio of M1. Oil price inflation is the log difference of nominal crude oil price. Polity2 is the proxy for institutional quality and is interacted with fiscal balance.

3.4 Conclusion

The analysis above shows that estimating panel data models allowing for either all of the parameters, or all except the long-run fiscal balance coefficient, to vary across countries can produce significantly different results. We showed that in the case of MG estimation, the mean of the individual country coefficients can easily be distorted by outliers, so we also consider alternatives to the arithmetic mean MG coefficients. The next chapter develops a formal theoretical model of the link between fiscal deficits and inflation that includes the role of institutions.

Chapter 4

Fiscal Policy, Institutional quality and Inflation: A Theoretical Model

4.1 Introduction

In this chapter, we develop a simple theoretical model of the inflation-fiscal balance nexus that includes a role for institutions. Sargent and Wallace (1981) show that, under a regime of "fiscal dominance" (unconstrained fiscal policy), deficits may be covered in the short run by borrowing, but in the long run they are financed by seigniorage. Catão and Terrones (2005) derive a long-run theoretical relationship between consumer price inflation and the ratio of fiscal deficits to the narrow money stock, and test it on data for 107 countries using annual data from 1960 to 2001. They find that the relationship holds in developing countries and emerging markets, but not in the advanced countries. Lin and Chu (2013) repeat the exercise using data for the ratio of fiscal deficits to GDP up to 2006, and with different estimation methods. They also find a significantly weaker relationship for OECD than for non-OECD countries, although unlike Catão and Terrones they find that the relationship is statistically significant for OECD countries. Bleaney and Francisco (2016) report a robust correlation between inflation and cumulated fiscal deficits in sub-Saharan Africa.

These empirical results suggest that the strength of the connection between deficits and inflation may be conditional on countries' income levels. A plausible hypothesis about the apparent relevance of the income levels is that certain institutional characteristics associated with income levels may shape the relation between deficits and inflation. This was the subject of chapters 2 and 3. The hypothesis was formulated in different ways. First, in advanced economies, institutions may prompt a government to rely less on seigniorage as a financing source of deficits. Specifically, when citizen's political participation is

guaranteed in those economies, the political leadership may be more sensitive to the public's dislike for inflation, so that fiscal shocks that lead to a build-up of public debt tend to induce fiscal consolidations rather than a resort to seigniorage revenue, as documented for the United States by Bohn (1998). Second, to the extent that governments in low-income countries are susceptible to low credibility amid weak institutions of their countries, they may have a limited access to the international capital market (e.g., Kumar and Baldacci, 2010). This, in turn, may imply that such countries find it less costly to finance deficits with seigniorage than with borrowing, strengthening deficits-inflation nexus as a result.

The focus of the present chapter is thus to present a simple theoretical model of the deficit-inflation nexus that includes a role for institutions. At the outset however, it is useful to clarify the type of institutions examined, because institutions, defined as rules and organisations of a society that affect economic incentive of different agents and shape interactions among them, is a fundamentally broad concept. Given this, our focus is on the type of institutions which prompt a government to be accountable to the public, rather than ones affecting citizen-citizen relations.[37] These include institutions such as competitive elections, transparency of government policies, and freedom of media, which are all expected to constrain governments' behaviour and facilitate the public's political participation. This choice of an institutional type is in line with the above mention of the relevance of citizen's political participation alongside their dislike for inflation.

The model is a simple money-in-utility (MIU) monetary model in which institutional quality is modelled as net loss of fiscal resources. This may arise from inefficiencies in the tax system (for instance bureaucratic corruption, high collection costs and tax evasion) leading to lower government tax receipts. Thus, the poorer the institutional quality, the greater is this loss.

[37] This way of categorising types of institutions follows Acemoglu and Johnson (2005), who differentiate institutions affecting government-citizen (i.e., vertical) relations and citizen-citizen (i.e., horizontal) relations.

Catão and Terrones (2005) use a similar specification to that of Ljungqvist, Lars and Sargent (2004) in analyzing the relationship between fiscal balance and inflation in the context of small open economy. While maintaining the general structure, the current model is different in a number of ways, namely: 1) extending the model to incorporate institutional quality; 2) using a slightly different but equivalent specification in which we assume that money provides direct utility services (that is a money-in-utility function) instead of a shopping time model as in Catão and Terrones (2005). Moreover, we solve the model by assuming explicit functional form.

The macroeconomic consequences of institutions have attracted a great deal of interest over the last couple of decades, with emerging consensus that weak institutions are associated with unfavourable macroeconomic outcomes – notably poor investment and low growth as well as high inflation (Hall and Jones, 1999; Acemoglu *et al.* 2001; Al-Marhubi, 2000; Keefer and Knack, 2007; Blackburn and Powell, 2011; Blackburn *et al.* 2008)**.** In terms of the impact on inflation, Al-Marhubi (2000) for instance, using cross-sectional data of 41 countries, shows that corruption is positively associated with inflation, while Blackburn and Powell (2011) show in their theoretical model that bureaucratic corruption impedes investment and growth.

This chapter therefore adds to the literature by blending the two strands of the literature that is: those on the deficit and inflation nexus on the one hand, and that on the effects of institutional quality on the other hand to analyse the role of institutions in the relationship.

4.2 Model

The model is a simple monetary model of an endowment economy without uncertainty, consisting of a government and households, where money provides direct utility. The motivation for holding money is facilitation of transactions and it also serves as a store of value. The choice of this model is motivated by its relative simplicity.[38]

[38] See Croushore (1993) for a demonstration of the equivalence between the money in utility function and the shopping time model which Catão and Terrones (2005) used.

4.2.1 Households

Preferences of the household are ordered as:

$$U = \sum_{t=0}^{\infty} \beta^t (logc_t + \delta logm_t) \dots\dots\dots\dots\dots\dots\dots \quad (4.1)$$

where: c_t is consumption in period t, $m_t = (\frac{M_t}{p_t})$ is household real money holding in period t, M_t is nominal money balances and p_t is the period-t price level, δ is a parameter measuring the weight of money in the utility function, and $\beta \in (0,1)$ is the subjective discount factor. U is assumed to be increasing and strictly concave in consumption and money.

Households face the following budget constraint:

$$c_t + \frac{b_t}{r_t} + m_t = y - \tau_t + b_{t-1} + p_{t-1}\frac{m_{t-1}}{p_t} \dots\dots\dots\dots\dots\dots\dots \quad (4.2)$$

where y is the constant real income which the household is assumed to be endowed with in each period ($y > 0$ in each period), b_t is the real value of one period government bond, r_t is the real gross rate of return on bonds and τ_t is lump sum tax. The left-hand side of equation (4.2) shows the allocation of household incomes to consumption, purchase of government bonds and real money holdings. This is matched by the right-hand side, which consists of endowment net of taxes, repayment of bonds from period *t-1* from government and the real value of money held over from period *t-1*.

Households maximize *U* subject to the budget constraint as in the following lagrangian:

$$\underset{c_t, b_t, m_t}{\mathcal{L}} = \sum_{t=0}^{\infty} \beta^t \Big\{ logc_t + \delta logm_t + \lambda_t \Big(y - \tau_t + b_{t-1} + \frac{p_{t-1}}{p_t} m_{t-1} - c_t - \frac{b_t}{r_t} - m_t \Big) \Big\}$$

The first order conditions (FOCs) are:

$$\frac{\partial \mathcal{L}}{\partial c_t} = 0 \rightarrow \frac{1}{c_t} - \lambda_t = 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (4.3)$$

$$\rightarrow \frac{1}{c_t} = \lambda_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.3')$$

$$\frac{\partial \mathcal{L}}{\partial b_t} = 0 \rightarrow -\lambda_t \frac{1}{r_t} + \beta\lambda_{t+1} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.4)$$

$$\rightarrow \beta\lambda_{t+1} = \lambda_t \frac{1}{r_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.4')$$

$$\frac{\partial \mathcal{L}}{\partial m_t} = 0 \rightarrow \frac{\delta}{m_t} - \lambda_t + \beta\lambda_{t+1}\frac{p_{t-1}}{p_t} = 0 \ldots\ldots\ldots\ldots (4.5)$$

$$\rightarrow m_t = \frac{\delta}{\lambda_t - \beta\lambda_{t+1}\frac{p_{t-1}}{p_t}} \ldots\ldots\ldots\ldots\ldots\ldots (4.5')$$

Equations $(4.3')$ and $(4.4')$ define the real gross rate of return on bonds (r_t) as:

$$r_t = \frac{1}{\beta}\frac{c_{t+1}}{c_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.6)$$

Combining equations$(4.3')$, $(4.4')$ and $(4.5')$ of the household maximization define money demand function as:

$$m_t = \delta c_t \left(\frac{r_t}{r_t - r_{mt}}\right) = \delta c_t \left(\frac{1+i_t}{i_t}\right) \ldots\ldots\ldots\ldots\ldots\ldots (4.7)$$

where $1 + i_t = \frac{r_t}{r_{mt}}$ is gross the nominal interest rate and $r_{mt} = \frac{p_{t-1}}{p_t}$ is the real gross return on money since there is no interest on money. Equation (4.7) is a typical money demand function, with demand for money increasing in consumption and decreasing in interest rates.

4.2.2 Government

Government finances its expenditure (g_t) in any period using tax revenues (τ_t), borrowing (b_t) or seigniorage (printing of money). The innovation in our model is to assume that tax revenues are reduced by institutional inefficiency factor θ, where $\theta \geq 0$. If $\theta = 0$, tax collection is fully efficient.

$$g_t = \tau_t - \theta_t + \frac{b_t}{r_t} - b_{t-1} + \frac{M_t - M_{t-1}}{p_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.8)$$

where M_t is currency issued by government. $\theta \geq 0$ is institutional inefficiency reflecting the degree of tax collection inefficiency and evasion or more broadly, a measure of or bureaucratic corruption.[39] g_t, τ_t, θ_t and M_t are assumed to be exogenously determined.

4.2.3 Steady-state Equilibrium

With our interest in the long-run relation between deficits and inflation, we focus on the steady-state equilibrium of the model, where all the real variables and inflation rates (correspondingly, money supply growth rate) are constant over time. We assume the following:

$g_t = g, \theta_t = \theta,\ \forall t \geq 0;\ \tau_t = \tau$ and $b_t = b\ \ \forall t > 0; \tau_0 \neq \tau; b_0 \neq b$ …. (4.9)

Moreover, in stationary equilibrium,

$$p_{t-1}/p_t = r_m, \quad r_t = r, \quad c_t = c, \quad \forall t \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots (4.10)$$

Substituting equations (9) and (10) into (6), (7) and (8) yield:

$$r = \frac{1}{\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.11)$$

$$m = \delta c\left(\frac{r}{r - r_m}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.12)$$

$$g - \tau + \theta - \frac{b}{r} + b = m(1 - r_m) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.13)$$

where $m(1 - r_m) = \frac{M_t}{p_t} - \frac{M_{t-1}}{p_{t-1}}\frac{p_{t-1}}{p_t}$ since $\frac{M_{t-1}}{p_{t-1}} = \frac{M_t}{p_t} = \frac{M}{p} = m$ in the steady state.

Combining equations (4.11), (4.12) and (4.13), we derive an expression for the long-run micro-founded institutional-augmented budget constraint for government as:

$$g + (1 - \beta)b - (\tau - \theta) = \pi\frac{\delta c}{1 - \beta + \pi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.14)$$

[39] Similar assumption has been made by Huang and Wei (2006), Dimakou (2006) and Dai and Spyromitros (2015).

where $(1 - r_m) = (p_t - p_{t-1})/p_t = \frac{\pi}{1+\pi}$ is transformed inflation; $1 - \beta r_m = \frac{1-\beta+\pi}{1+\pi}$; and the economy-wide resource constraint implies that $c = y - g - \theta$.

Equation (4.14) defines the long-run relationship between deficits on inflation, conditional on the institutional quality. The LHS of equation represents the institutions-augmented gross of interest deficit while the RHS defines seigniorage as a function of consumption, nominal interest rates $(1 - \beta + \pi)$ and inflation (π).

4.2.4 Comparative Statics

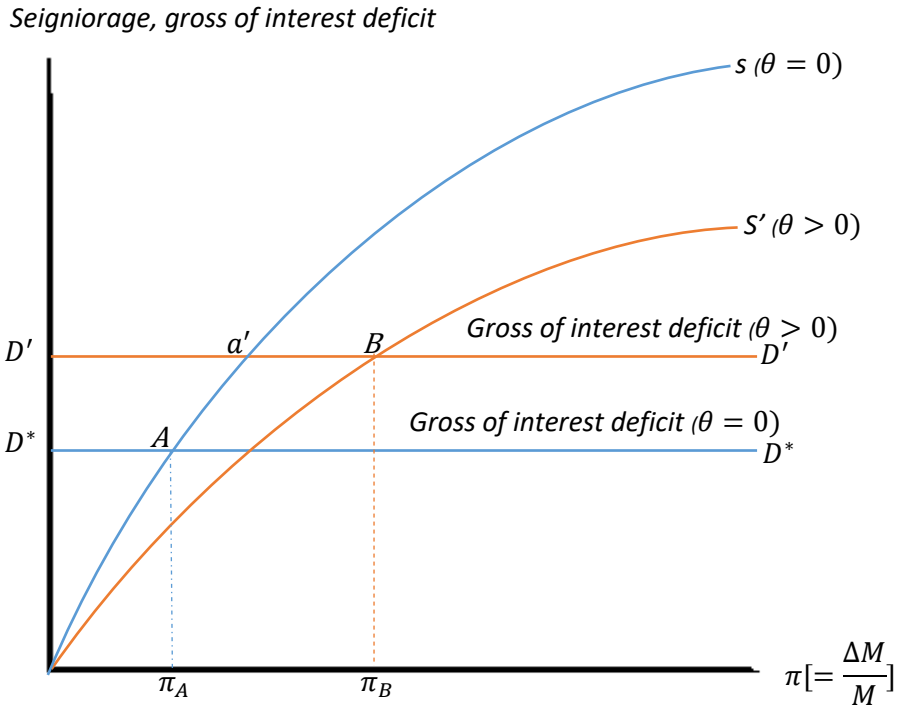
On the assumption that fiscal variables are exogenous, the only endogenous variable in Equation (4.14) is inflation rates. To see how equilibrium inflation (π) responds to changes in the fiscal balance for different levels of institutional quality, we use figure 1 which represents equation (4.14) diagrammatically. To do this, let $D^* = g + (1 - \beta)b - (\tau - \theta)$ represent the fiscal balance when institutional quality is good (i.e $\theta = 0$) and $D^* < D'$ is the fiscal balance when institutional quality is weak (i.e $\theta > 0$). These are represented in figure 1 below as two horizontal lines where the vertical axis measures gross of interest deficit or seigniorage and the horizontal axis measures equilibrium inflation.

Similarly, we show the seigniorage (Laffer curve) schedule which is concave in inflation (given that inflation affects seigniorage through two opposing channels - i.e through its impact on consumption and interest rates). More formally, the concavity of this schedule is demonstrated as follows. Let $s = \pi \frac{\delta c}{1-\beta+\pi}$ = seigniorage. The first and second order conditions of *s* with respect to π are respectively:

$$\frac{\partial s}{\partial \pi} = \frac{\delta(y - g - \theta)(1 - \beta)}{(1 - \beta + \pi)^2} > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.15)$$

$$\frac{\partial^2 s}{\partial \pi \partial \pi} = -\frac{2\delta(y - g - \theta)(1 - \beta)}{(1 - \beta + \pi)^3} < 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.15')$$

which imply a concave relationship between seigniorage and inflation.



Equilibrium A: Steady state equilibrium under good institutions

Equilibrium B: Steady state equilibrium under bad institutions

Figure 4.1: Institutions and Fiscal Balance-Inflation Nexus

Figure 4.1 plots the relationship between fiscal balance, inflation and institutional quality. The equilibrium when institutional quality is strong (i.e. tax collection is fully efficient) is at point *A* corresponding to fiscal balance D^* and seigniorage $s(\theta = 0)$ with equilibrium inflation at π_A. When institutional quality is weak (i.e. tax collection is not efficient), equilibrium is at point *B* with deficit D' and seigniorage $s'(\theta > 0)$ corresponding equilibrium inflation $\pi_B > \pi_A$. There are two main reasons accounting for the higher inflation at point *B*, namely 1) the effect of higher deficits and 2) lower private consumption under bad institutions. In the first case, under weak institutions, the higher deficit resulting from tax revenue leakage raises the deficit from D^* to D'. This corresponds to higher seigniorage (point a′in this long-run equilibrium since long-run public debt is constant "by assumption"). The higher seigniorage is achieved with higher money supply growth rates, corresponding to higher inflation rate. An important assumption here is that seigniorage is always increasing in money supply growth rates, consistent with our simple utility

function which rules out the "right, decreasing part" of the Laffer curve.[40] On the other hand, for given deficits, lower private consumption, due to the crowding out under weak institutions, leads to higher inflation. This is because with lower consumption, real money balance is lower, which, in turn, must be compensated by higher money supply growth rates, i.e., higher inflation rate (to keep the same level of seigniorage, equivalently, deficits). Thus, under weak institutional quality, equilibrium inflation is higher (i.e., through higher deficit/seigniorage, and through lower consumption). This is clearly shown in figure 1 above at equilibrium points *A* and *B* corresponding to inflation π_A and π_B, where $\pi_B > \pi_A$.

The key question is how much inflation responds to changes in deficits at points *A* and *B*? On this, we show formally that *any given increase in the fiscal deficit, results in a higher level of equilibrium inflation when institutional quality is bad* ($\theta > 0$).

First, this result follows directly from equations (4.15) and (4.15′) which imply concavity of the Laffer curve. Moreover, differentiating equation (4.14) with respect to g, b and τ shows that for any given increase in the fiscal deficit, inflation is higher when institutional quality is bad (i.e. when $\theta > 0$). These are:

$$\frac{\partial \pi}{\partial g} = \frac{(1-\beta+\pi(1+\delta))(1-\beta+\pi)}{(1-\beta)\delta(y-g-\theta)} > 0 \dots\dots\dots\dots\dots (4.16)$$

$$\frac{\partial \pi}{\partial b} = \frac{(1-\beta+\pi)^2}{\delta(y-g-\theta)} > 0 \dots\dots\dots\dots\dots (4.17)$$

$$\frac{\partial \pi}{\partial \tau} = -\frac{(1-\beta+\pi)^2}{(1-\beta)\delta(y-g-\theta)} < 0 \dots\dots\dots\dots\dots (4.18)$$

Or more generally, that

$$\left.\frac{\partial \pi}{\partial D}\right|_{D=D^*} < \left.\frac{\partial \pi}{\partial D}\right|_{D<D'} \dots\dots\dots\dots\dots (4.19)$$

[40] In general, a rise in money supply growth can lead to *lower* seigniorage, to the extent that real money balances decrease significantly.

Bad institutions in this case result in more reliance on seigniorage revenues, generating inflation ultimately.

Thus, given the difference in the slope of the Laffer curve at points *A* and *B* in figure 4.1, a given increase in the deficit results in a higher increase in inflation at point *B* (bad institutions) than at point *A* (good institutions). This is clear from the figure for instance when we consider an increase in the deficit increase due to tax cuts, which do not shift the Laffer curve. Now, suppose that there is an infinitesimal increase in deficits. First, at point *B* (as shown above), inflation is higher, meaning nominal interest rate is higher, corresponding to lower real money balances. Intuitively, this implies that to achieve a given increase in deficits (equivalently seigniorage), a larger increase in money supply growth is required, thus a larger increase in inflation rates. Second, at point *B*, private consumption is lower, which further lowers real money balances. Following the same line of logic, this implies that at point *B*, a given rise in deficits corresponds to a larger increase in inflation rates.

Conversely, at point *A*, inflation (and thus nominal interest rate) is low, and corresponds to higher real money balances. Consequently, a given increase in deficits (equivalently seigniorage), generates a smaller increase in money supply growth, and thus a smaller increase in inflation rate. Moreover, at point *A*, private consumption and real money balances are higher, requiring a smaller increase in money supply growth rate (lower increase in inflation rates) for a given increase in the deficit. The intuition is relatively straightforward and particularly reflects the larger distortionary effects from an even larger money supply increase required to ensure equilibrium under weak institutions (at point *B*) whereas in the case of point *A*, the lower distortions are generated both from efficient institutions (point *A*) and lower money supply increase (corresponding to lower inflation and lower nominal interest rates). Among others, bad institutions (for instance widespread corruption) potentially generate distortions such as reducing taxable assets base and incomes (e.g. through capital flight or more businesses going underground) leading to increased reliance on seigniorage revenues. This is consistent with Al-Marhubi (2000) finding that corruption and inflation are positively correlated.

4.2.5 Conclusion

Thus, when weak institutions allow corrupt officials to steal tax revenues and generate economic inefficiency in general, a given rise in deficits leads to a larger increase in inflation. This is how we formally motivate the hypothesis tested empirically above. An alternative analytical prove is provided in appendix B below.

Appendix B: Analytic presentation of model comparative statics

In this section, we demonstrate analytically that under weak institutions, the inflationary impact of deficits is larger.

From the long-run micro-founded institutional-augmented budget constraint for government (see equation (4.14)):

$$g + (1-\beta)b - (\tau - \theta) = \pi \frac{\delta c}{1 - \beta + \pi} \qquad (B1)$$

Rewriting equation (*B1*) explicitly in π gives:

$$\pi = \frac{(g + z + \theta)(1-\beta)}{\delta(y - g - \theta) - (g + z + \theta)} \qquad (B2)$$

where equilibrium inflation $(\pi) = (p_t - p_{t-1})/p_{t-1}$ and $z = (1-\beta)b - \tau$.

To see how equilibrium inflation (π), responds to changes in the fiscal balance for different levels of institutional quality, we differentiate equation (*B*2) with respect to g and z (and since $z = (1-\beta)b - \tau$, i.e. with respect to b and τ). These are:

$$\frac{\partial \pi}{\partial g} = \frac{(1-\beta)\delta(y + z)}{[\delta(y - g - \theta) - (g + z + \theta)]^2} > 0 \qquad (B3)$$

$$\frac{\partial \pi}{\partial b} = \frac{(1-\beta)^2\delta(y - g - \theta)}{[\delta(y - g - \theta) - (g + z + \theta)]^2} > 0 \qquad (B4)$$

and

$$\frac{\partial \pi}{\partial \tau} = -\frac{(1-\beta)\delta(y-g-\theta)}{[\delta(y-g-\theta)-(g+z+\theta)]^2} < 0 \qquad (B5)$$

Equations (*B*3) - (*B*5) respectively imply that overall, higher levels of deficits are associated with higher levels of equilibrium inflation. To examine the role of institutions in the nexus, we differentiate equations (*B*3) - (*B*5) with respect to θ which yield:

$$\frac{\partial^2 \pi}{\partial g \partial \theta} = \frac{2(1-\beta)(1+\delta)\delta(y+z)}{[\delta(y-g-\theta)-(g+z+\theta)]^3} > 0 \qquad (B6)$$

$$\frac{\partial^2 \pi}{\partial b \partial \theta} = \frac{(1-\beta)^2\delta[2(1+\delta)(y-g-\theta)-(\delta(y-g-\theta)-g-z-\theta)]}{[\delta(y-g-\theta)-(g+z+\theta)]^3}$$
$$> 0 \qquad (B7)$$

$$\frac{\partial^2 \pi}{\partial \tau \partial \theta} = -\frac{(1-\beta)[(y-g-\theta)(\delta+2)+g+z+\theta]}{[\delta(y-g-\theta)-(g+z+\theta)]^3} < 0 \ldots\ldots\ldots\ldots\ldots\ldots (B8)$$

Note that $|(B5)| > |(B8)|$ since $(g+z+\theta) > 0$, implying weak institutions moderate the inflation dampening effect of an increase in tax revenues.

Therefore, any given increase in the fiscal deficit, irrespective of the source of change, results in a bigger increase in the level of equilibrium inflation when institutional quality is bad ($\theta > 0$).

Chapter 5

Inflation Targeting in Lower-Income Countries

5.1 Introduction

The switch to explicit inflation targeting (IT) is arguably the single most important change in the conduct of monetary policy since the collapse of the Bretton Woods system in the early 1970s. IT is a monetary policy framework, characterized by public announcement of medium-term explicit inflation targets and increased central bank commitment to achieving the targets through various institutional and technical arrangements including transparency and accountability mechanisms (Mishkin, 2004). A key feature of an inflation (forecast) targeting regime is that it encompasses a forward-looking decision-making process by which the central bank uses its policy instruments to bring forecast inflation in line with announced targets (Svensson, 1997b).

IT was first adopted in 1990 by New Zealand, followed by a number of other advanced countries and emerging markets. Existing empirical studies suggest that IT has significantly reduced inflation in emerging markets, but has made little difference in advanced countries, where inflation was already low. Only in the twenty-first century have lower-income countries (LICs) begun to adopt IT, and to the best of our knowledge this is the first study to analyse the performance of IT in lower-income countries as a separate group, although a few previous studies included one or two lower income countries in their sample.[41] Using a panel data methodology that allows for the control of unobservable country specific characteristics and time trends as well as other important variables, we find that: 1) the effect of IT is non-monotonic across the country-groups with different income levels: IT has not been successful in reducing inflation in LICs and high income countries (HICs) in the way that it

[41] See empirical literature review and Table 5.2 for more details

has in emerging markets; 2) IT is significantly more effective in floating exchange rate schemes; and 3) IT is more effective under floating in countries with good institutions, although good institutions alone do not significantly affect IT performance.

The theoretical foundation of IT derives from the literature on discretionary policies and commitment developed by Kydland and Prescott (1977) and Barro and Gordon (1983). Proponents argue that IT reduces the dynamic inconsistency problem in monetary policy which helps to lower average inflation while improving resilience to shocks. IT similarly improves central bank credibility through its increased transparency and accountability mechanisms. Moreover, by setting inflation targets for the medium term, IT provides scope for flexibility in stabilizing both deviations in inflation and output. Similarly, the cost of monetary policy failures relative to other regimes is said to be lower under IT (Samarina *et al.* 2013). On the other hand, others argue that by offering little room for discretion, IT may unnecessarily constrain growth and generate significant exchange rate volatility, since price stability is elevated as the primary goal to which all other goals are subordinated. Similarly, IT may not work well in countries that do not meet stringent preconditions – including technical capacity of the central bank, absence of fiscal dominance and well-functioning financial markets, issues that may play a crucial role in LICs.

There has been extensive empirical research on IT performance across advanced and EMEs. However, LICs have been slower to adopt IT, and until now there have been too few LICs adopting the framework for its impact to be separately assessed in these countries. This is the main contribution of this chapter.

The general conclusion from studies on IT performance in the advanced and EMEs is that distinguishing countries by economic development is crucial in assessing the impact of IT across countries. Specifically, the evidence shows small or no effects from IT implementation in advanced economies, while a large and significant effect is found for EMEs (Lin and Ye, 2007, 2009; Samarina *et al.* 2013; Mishkin and Schmidt-Hebbel, 2007). The difference, among others, reflects the relatively strong initial macroeconomic performance of most

advanced economies (low inflation for instance) and sufficiently high degree of credibility. In contrast, EMEs began to implement IT with relatively high levels of inflation and weak credibility (Gonçalves and Salles, 2008) as well as performance heterogeneity (Batini and Laxton, 2006). Although LICs similarly face high inflation, and perhaps even worse credibility challenges, there is a paucity of evidence on the experience of these countries, mainly because few LICs adopted the framework until recently.

The main objective of this paper is to provide further empirical evidence on the effect of IT on macroeconomic performance across a broader number of countries. We provide an assessment of IT performance in LICs as a distinct group, given its increasing popularity among these countries in their quest to improve monetary policy credibility to anchor inflation expectations. Indeed, out of 35 countries formally implementing this new monetary policy framework by the end of 2015, more than one-third (12) were LICs (see Figure 5.1 and Table 5.1 which provides details on LICs adoption dates, inflation performance and exchange rate regimes). The first LIC to adopt IT in our sample is Thailand in 2000, followed by Ghana and the Philippines in 2002. India is the latest to have adopted the framework.

As shown in Table 5.1, average inflation rates broadly declined after IT adoption in these countries but there is significant heterogeneity in performance both before and after IT adoption with respect to the levels and volatility of inflation. Inflation at the time of IT adoption ranged between -0.1 (Moldova in 2009) and 18.8 percent (Uganda in 2011). Average inflation performance in the five-year period before IT adoption ranged between 2.7 and 22.6 percent in Albania and Ghana respectively. This range declined to between 1.7 and 15.2 percent in Thailand and Ghana respectively in the five-year period following IT adoption. Nonetheless, there is significant heterogeneity in performance as inflation increased in some countries – Armenia, Guatemala and Indonesia. Volatility similarly declined but remained significantly heterogeneous across countries.

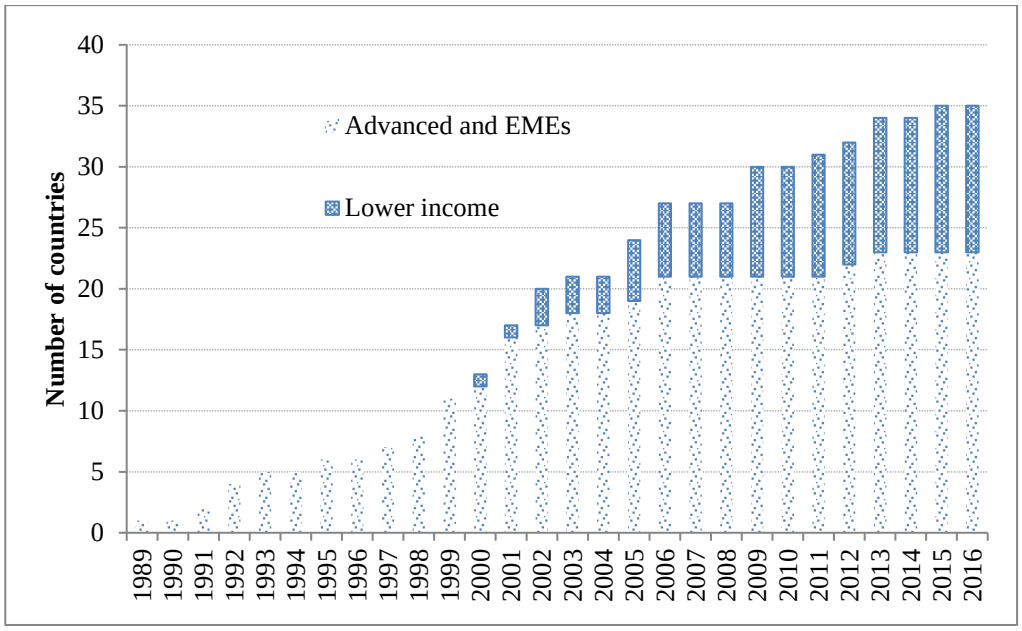


Figure 5.1: Inflation Targeting across Higher and Lower Income Countries

Table 5.1: List of Inflation Targeting Lower Income Countries with their Initial Inflation, Inflation Performance and Exchange Rate Schemes

	Year of adoption (t)	Inflation					Exchange rate Policy
		At year of adoption	*Average*†		*Volatility*†		
			before	after	before	after	
Albania	2009	2.3	2.7	2.7	0.5	0.8	Floating
Armenia	2006	2.9	3.3	5.6	2.6	2.8	Crawl-like peg
Georgia	2009	1.7	8.5	3.2	1.7	4.4	Floating
Ghana††	2002	14.8	22.6	15.2	8.8	6.6	Floating
Ghana††	2007	10.7	16.0	12.9	6.2	4.7	Floating
Guatemala	2005	9.1	6.9	7.1	1.1	3.5	Crawl-like peg
India	2015	5.3	8.0	n.a	2.0	n.a	Floating
Indonesia	2005	10.5	8.0	8.9	3.6	3.3	Floating
Moldova	2009	-0.1	12.4	4.8	0.5	3.1	Floating
Paraguay	2013	2.7	5.9	n.a	3.2	n.a	Floating
Philippines	2002	2.7	6.0	4.4	2.0	1.8	Floating
Thailand	2000	1.6	5.1	1.7	2.9	0.7	Floating
Uganda	2011	18.7	8.5	6.9	3.9	4.0	Floating

Source: International Monetary Fund (2014); WDI database; Central Bank Websites. † Authors' computations, volatility is the standard deviation of inflation for the period. Before is t-5 to t-1 and after is t+1 to t+5. †† Ghana adopted IT in 2002 but the necessary institutional arrangements and technical capacity were still being developed to pave way for full-fledged implementation of the framework, which was subsequently announced in 2007.

There are many features (structural and institutional) specific to LICs that serve as additional constraints on the effective control of inflation in these countries. Food prices for instance, constitute a sizable proportion of the consumer price basket, while public sector prices (utilities, fuel, and public-sector wages) with large discrete administrative adjustments are commonplace. Supply shocks are similarly dominant in these countries (Bleaney and Francisco, 2016). These factors significantly affect the determination of price dynamics in these countries with far-reaching implications for their ability to anchor inflation expectations and therefore successfully implement IT. Moreover, poor fiscal policy alongside weak institutions makes these countries vulnerable to inflation (Bleaney *et al.* forthcoming).[42] Therefore, the experience of LICs is likely to differ markedly from those of the advanced countries and EMEs. We therefore extend the empirical strand of the literature in this chapter to include the possible effects of IT on macroeconomic performance of LICs. Specifically, we examine the impact on inflation, growth and fiscal discipline.

The rest of the chapter is organized as follows. In section 5.2, we present theoretical and empirical review of the relevant literature. Section 5.3 presents the theory of IT while section 5.4 sets out the empirical methodology and describes the data. The empirical results are presented in section 5.5 with interpretation of the results given in section 5.6. Section 5.7 considers the impact of IT on other macroeconomic variables and section 5.8 concludes.

5.2 Literature Review

Inflation targeting has attracted considerable degree of interest among researchers and policymakers in their quest to explain and evaluate the new regime's performance.

[42] Institutional quality is relevant for IT performance because the presence of an unconstrained government is likely to be associated with the issue of fiscal dominance (the subordination of monetary policy to fiscal requirements), which, in turn, impairs central bank's ability to conduct monetary policy in a way consistent with IT

5.2.1 Theoretical Literature

The theoretical foundation of IT is rooted in the literature on commitment and discretion in monetary policy propounded by Kydland and Prescott (1977) and Barro and Gordon (1983). The literature begins with the crucial assumption that there are distortions that generate inefficiently high level of unemployment and create incentives for policymakers to attempt to exploit the short run benefits arising from surprise inflation defined by the Phillips curve.[43] Rational economic agents however fully understand the incentives facing the policymaker and therefore adjust their inflation expectations appropriately. The resulting equilibrium is higher average inflation without any impact on output. This higher inflation arising out of policy inconsistency has been referred to as *inflation bias* (Barro and Gordon, 1983).[44]

The literature shows that the equilibrium under discretion can be improved if policymakers can credibly commit to preannounced policies, although the resulting equilibrium is a second-best equilibrium – since the distortions leading to the initial inflation bias remain. The first best equilibrium can be attained if the distortions are removed.

While commitment (or rule-based approach) has been shown to be preferable to discretion in the sense that that it yields lower or no inflation bias, it comes at the expense of flexibility of monetary policy since it offers no scope for optimally responding to shocks. This can lead to excessively high output variability. Moreover, private agents understand the existence of ex-post incentives for the monetary authority to renege on the initially announced policies once expectations are set. Therefore, the equilibrium under commitment is not time consistent. Other strategies have thus been proposed to improve the

[43] The distortions can include taxes, which reduce households' reward from additional work or imperfect competition that results in firms not receiving all the advantages from additional output or unemployment benefits.

[44] Policy inconsistency also confuses economic agents in the sense that they not only need to consider the policy target, but the probability that the target will be sacrificed which raises their inflation expectations and therefore average inflation. The inflation bias may also result from the lack of adequate knowledge about the working of the economy or uncertainty about the structure of the economy and shocks that imply higher average inflation.

equilibrium under discretion – that is, to reduce or even eliminate the inflation bias.

The theoretical literature has proposed a number of ways to deal with the inflation bias, classified broadly into reputational approaches (Barro and Gordon, 1983); delegation solutions (Rogoff, 1985) and optimal contracts approach (Walsh (1995). For instance, the delegation strategy works through government (the principal) and central bank (the agent) relationship under which the conduct of monetary policy is assigned to a *conservative* central banker – one with preferences for output stabilization lower than society's. Under the optimal contracts approach which is also based on government-central bank relationship, the central banker incurs additional punishment if inflation exceeds the socially optimal level.

Inflation targeting emerged more recently as a way of "flexibly" dealing with the inflation bias problem associated with discretionary policies. The framework combines features of both rules and discretion. Under an inflation targeting regime, the central bank is assigned an explicit inflation target - the ultimate objective of monetary policy – and, by showing commitment to this target through various institutional arrangements, inflation targeting serves as a rule-based policy framework. Moreover, since, the targets are typically specified over a medium term and in some cases in ranges, the strategy offers scope for stabilizing other economic variables to the extent that the primary target is not compromised, thus similarly offering some discretion.

Svensson (1997b) shows theoretically that assigning the central bank an inflation target (π^T) that is lower than the socially optimal rate, ultimately allows the central bank to deliver the on the social preference rate of inflation (π^*) even with discretionary policies. The reasoning here is that by appropriately specifying a low inflation target and with commitment to achieve this target, this will have an impact on private agents' expectations formation and thus average inflation (and ultimately, inflation at the socially optimal rate) – the *second-best* outcome even under discretion with no impact on output. The next section provides a review of the empirical studies on IT.

5.2.2 Empirical Literature

There is extensive empirical work on the effectiveness of IT for the advanced and EMEs. These studies generally conclude that IT has no or small and insignificant effects in advanced economies but large and significant effects in EMEs. Early studies using data on advanced countries include (Neumann and von Hagen (2002), Ball and Sheridan (2004), Hyvonen (2004) and Wu (2004). Using the difference in differences (DiD) methodology, these studies generally focus on estimating the effects of IT on the level and variability of inflation and output, effects on the persistence of shocks to inflation and the effects on interest rates and expectations. Neumann and von Hagen (2002) for instance use data spanning 1978-2001 for six industrial countries that adopted IT in the early 1990's in comparison with Germany, Switzerland and the US. They conclude from the study that IT helps in reducing the level and volatility of inflation alongside significantly larger gains in credibility than non-IT central banks.

Ball and Sheridan (2004) examine two-time periods and two policy regimes (IT and a traditional policy) using DiD methodology based on data from twenty Organization of Economic Cooperation and Development (OECD) countries over the period 1985 to 2001. The study analyses the behaviour of inflation and inflation variability, output growth and volatility and behaviour of interest rates. They consider two specifications:

$$X^j_{post} - X^j_{pre} = \alpha + \beta.I + u \qquad (5.1)$$

$$X^j_{post} - X^j_{pre} = \alpha + \beta.I + c.X^j_{pre} + v \qquad (5.1')$$

where X^j_{post}, X^j_{pre}, are the values of the performance measure j in the period after and before the policy change respectively. I is the IT policy dummy that takes the value 1 if a country targets inflation and 0 otherwise. In this case, for non-targeting countries, the average of targeting countries is chosen as the cut-off to determine their pre and post periods. α is a constant; u and v are error terms. The main idea is to test for the sign and significance of β which measures the impact of inflation targeting. Ball and Sheridan(2004) show that specification (5.1) which was commonly used in earlier studies (for instance Neumann and von Hagen, 2002) is subject to endogeneity given the non-

random selection into IT. This arises from two sources: (i) correlation between high inflation and IT (specification bias) and (ii) the tendency for regression to the mean from high previous inflation. Ball and Sheridan (2004) address the endogeneity problem by estimating specification (5.1′) which controls for initial performance. Doing so, the authors conclude that there is no evidence that IT matters for economic performance in OECD countries. In an update of this research, Ball (2010) finds that IT results in a significant reduction in inflation, but the effect is relatively small.

Willard (2011) uses a number of identification approaches (instrumental variables, panel-fixed effects and a potential natural experiment) to estimate the effect of IT for a sample of OECD countries. The paper finds little evidence that inflation variability, inflation uncertainty, inflation volatility or inflation expectations fall with targeting, suggesting that IT does not matter. Importantly, the paper concludes that the similarity of the IV and OLS results indicates that while there may be some endogeneity bias, it is not large.

Gertler (2005) in a comment on Ball and Sheridans's work contests the validity of the above conclusions noting for instance that it is possible that part of the effect of the IT adoption could be captured by the lagged performance measure included on the right hand side which remains significant. Thus the identification problem remains unresolved. Similarly, Wu (2004), applying a multi-period DiD estimation technique to quarterly CPI inflation rates from 1985-2002 for 22 OECD countries and controlling for initial performance, concludes that IT countries experience a decrease in their average inflation rates that is not due to a reversion to mean process.

Gonçalves and Salles (2008) extend the analysis in Ball and Sheridan (2004) estimating equation (5.1′) for a subset of 36 emerging market economies. They find completely opposite results to those of Ball and Sheridan (2004) for the OECD countries, showing that inflation targeting matters in the case of their sample. Switching to inflation targeting reduces average inflation and volatility of output growth by 2.5 and 1.4 percentage points respectively. The authors thus conclude that the results of Ball and Sheridan (2004) may have

been influenced by 'selection bias' given that most advanced countries started inflation targeting with strong macroeconomic fundamentals.

Mishkin and Schmidt-Hebbel (2007), in their bid to control for endogeneity of inflation targeting, use an instrumental variables approach based on quarterly data for 21 advanced countries and 13 emerging market economies. They regress inflation on an inflation targeting dummy and past inflation and also control for country and time fixed effects. They find, as in the previous studies, that inflation targeting has no effect in the advanced countries but large effects (some three times those in Gonçalves and Salles (2008)) are found in the case of emerging market economies. However, Ball (2010) questions the results of Mishkin and Schmidt-Hebbel (2007) on the grounds of validity of the instrument used for the inflation targeting dummy: the lagged inflation targeting dummy. This is potentially problematic since the factors affecting the inflation targeting dummy also affect the lagged inflation targeting dummy which is therefore correlated with the error term.

To deal with the self-selection and endogeneity of IT, a number of studies have used the propensity score matching (PSM) approach in evaluating the performance of inflation targeting across countries. The idea here is to compare the performance of inflation targeting and non-inflation targeting countries that are similar along other dimensions (i.e. pairing treatment and control groups that are similar in terms of observable characteristics). Specifically, the approach involves two steps, namely estimation of propensity scores to measure the conditional probability of inflation targeting adoption and an estimation of the average effect of treatment on the treated (ATT). In the first stage the probability is specified as:

$$p(X) = \Pr(D = 1|X) = E(D|X) \qquad (5.2)$$

where D={0,1) is a treatment (IT) dummy that takes the value of 1 if a country implements IT and 0 otherwise; *X* is a matrix of pre-adoption characteristics.

In the second stage, the ATT is estimated based on the following equation:

$$\alpha \equiv \mathrm{E}\{\mathrm{Y_{1i}} - \mathrm{Y_{0i}}|\mathrm{D_i} = 1\} = \mathrm{E}[\mathrm{E}\{\mathrm{Y_{1i}}|\mathrm{D_i} = 1, \mathrm{P(X_i)}\} - \mathrm{E}\{\mathrm{Y_{0i}}|\mathrm{D_i} = 0, \mathrm{P(X_i)}\}|\ \mathrm{D_i} = 1] \qquad (5.2')$$

where Y_{1i} and Y_{0i} are potential inflation outcomes in two counterfactual situations: with (IT applied) and without (no IT applied).

The key assumption in this case is that conditioning on these observable characteristics, assignment to inflation targeting can be viewed as 'random', and thus this controls for self-selection. As it is, validity of this approach is potentially undermined if selection into inflation was driven by unobserved characteristics. Papers that have adopted this approach include Lin and Ye (2007, 2009) and Vega and Winkelried(2005). Lin and Ye's results are consistent with earlier results that inflation targeting matters in emerging market economies but not in the advanced countries. However, using a larger dataset comprising 109 countries, Vega and Winkelried(2005) find significance for both emerging and advance countries.

From the foregoing discussion, it is clear that the evidence on inflation targeting remains inconclusive and there are hardly studies that go beyond 2008 (see Table 5.2), when the resilience of IT was first tested. Moreover, Table 5.2 shows, to our knowledge, that no previous study has included more than four lower-income countries, and none has tested whether IT is less effective in lower income countries than in emerging markets. There is thus a paucity of evidence in the case of LICs. To the best of our knowledge, Gemayel *et al.* (2011) and Bleaney and Francisco (2016) are the only papers that have made some attempt to study the effect of IT in LICs. Gemayel *et al.* (2011) apply DiD method and panel regression to test whether the adoption of IT affects macroeconomic performance in LICs. However, in the face of significant data constraints, the authors admit that their sample of LICs, including Ghana and Armenia is too small to draw reliable conclusions. Similarly, Bleaney and Francisco (2016) study the effect of IT on inflation in SSA. The study finds no significant effect of IT reducing inflation. Again, their sample of IT countries included only two countries – Ghana and South Africa (and only Ghana is a lower-income country).

Moreover, there are many weaknesses that have been identified with the previous methodologies which potentially bias the results. For instance the DiD technique which has been widely applied in assessing the effect of IT comes with a number of drawbacks, namely: 1) difficulty in assigning post and pre-adoption

periods since this varies by country; 2) defining post-intervention period for non-targeters remains blurred – studies (including Ball and Sheridan, 2004; Batini and Laxton, 2006; Gonçalves and Salles, 2008) use average date of adoption for targeters – use of common intervention date induces bias - Samarina *et al*. (2013) show that the choice of start date for IT is non-trivial; 3) assumes time trends prior to the adoption of inflation targeting is not important. This assumption is violated if countries self-select into inflation targeting based on their past experiences with inflation or other macroeconomic outcomes (Samarina and Sturm, 2014). Moreover, the DiD and PSM are generally based on cross section and thus do not exploit important information such as time varying and country fixed effects.

We therefore adopt panel data techniques to take account of both time and country fixed effects while accounting for past performance. This study extends the previous research along many dimensions. The use of a much broader sample that includes LICs will enable us to split the sample into three distinct country groups, namely high income (HICs), EMEs and LICs, which will enable us to examine more closely heterogeneity across these different country-groups. Further, we include observations through the financial crisis of 2008-2010 as well as carefully controlling for exchange rate regime flexibility across the countries, since pegs tend to be associated with lower inflation, which given the large number of countries and the long period considered in our sample, is potentially important. We check the robustness of our results by analysing different IT start dates that have been noted in the literature as well as other important controls (for instance currency crisis).

Table 5.2: Empirical Studies and their Results

Study	**Countries**	**No. of countries (No. of IT countries)** ***[No. of LIC IT countries*****]**	**Time period**	**Method**	**Result**
Mishkin and Schmidt-Hebbel (2007)	Advanced/ Emerging	34(21) ***[2]***	1989–2004	Difference-in-differences, panel estimations	No effect (for advanced), negative (for emerging)
Vega and Winkelried (2005)	Advanced/ emerging	109(23) ***[2]***	1990–2004	Propensity score matching	Negative*
de Mendonça and de Guimarães e Souza (2012)	Advanced/ developing	180(29) ***[3]***	1990–2007	Propensity score matching	No effect (for advanced), negative (for developing)
Samarina *et al.* (2013)	Advanced/ developing	84(29) ***[4]***	1985–2011	Difference-in-differences, Propensity score Matching	No effect (for advanced), negative (for emerging and developing)
Advanced countries only					
Neumann and von Hagen (2002)**	Advanced	9(6) ***[none]***	1978–2001	Difference-in-differences	Negative
Ball and Sheridan (2004)	Advanced	20(7) ***[none]***	1985–2001	Difference-in-differences	No effect
Lin and Ye (2007)	Advanced	22(7) ***[none]***	1985–1999	Propensity score matching	No effect
Ball (2010)	Advanced	20(9) ***[none]***	1985–2007	Difference-in-differences	Very small effect
Willard (2012)	Advanced	21(8) ***[none]***	1985–2002	Panel estimations	No effect

Notes: *A negative effect on inflation means that IT implementation significantly reduces the inflation level.
**Neumann and von Hagen (2002) do not take the initial level of inflation into account.
***Combined EMEs and a few LICs as a proxy for low-income countries.

Table 5.2 continued					
Study	**Countries**	**No. of countries (No. of IT countries) *[No. of LIC IT countries*]**	**Period**	**Method**	**Result**
Emerging and developing countries					
Batini and Laxton (2006)	Emerging	44(13) ***[2]***	1985–2004	Difference-in-differences	Negative
Gonçalves and Salles (2008)	Emerging	36(13) ***[2]***	1980–2005	Difference-in-differences	Negative
Lin and Ye (2009)	Emerging	52(13) ***[2]***	1985–2004	Propensity score matching	Negative
Brito and Bystedt (2010)	Emerging	46(13) ***[2]***	1980–2006	Dynamic panel model	Negative
Gemayel *et al.* (2011)	Low income***	57(10) ***[4]***	1990–2008	Difference-in-differences, panel estimations	Negative
Bleaney and Francisco (2016)	sub-Saharan Africa	45(2) ***[1]***	1996-2013	Panel probit model	No effect

Notes: *A negative effect on inflation means that IT implementation significantly reduces the inflation level.
**Neumann and von Hagen (2002) do not take the initial level of inflation into account.
***Combined EMEs and a few LICs as a proxy for low-income countries.

5.3 Theory of Inflation Targeting

The main objective of this section is to present the standard theoretical model used in the literature in analysing optimal monetary policies under which inflation targeting leads to lower average inflation. The model is based on Svensson (1997b) which extends the literature on commitment and discretionary policies developed by Kydland and Prescott (1977) and Barro and Gordon (1983) to the case of IT. Svensson (1997b) shows that assigning an explicit inflation target to an independent central bank can reduce or eliminate the inflation bias inherent in discretionary policies and thus yield a second best equilibrium.

5.3.1 Theoretical Model

In line with the literature (Barro and Gordon, 1983; Svensson, 1997b), it is assumed that the Central Bank sets its policy by minimizing a standard quadratic loss function (L). The loss is a function of the deviation of inflation (π_t) and output (y_t) from their respective social preferences: π^* and $y^* + \kappa$, where $\pi_t{}^*$ is the inflation target and y^* is the natural level of output. This is given as:

$$L = \frac{1}{2}[(\pi_t - \pi_t{}^*)^2 + \chi(y_t - y^* - \kappa)^2] \qquad (5.3)$$

where χ, κ are positive constants. χ represents the weight the policymaker places on output relative to inflation. The presence of $\kappa > 0$ has been justified in the literature as representing the policymaker's desire to increase output above the natural level of output y^*, because the latter is assumed to be inefficiently low as a result of distortions. It may also reflect possible political pressure on the monetary authorities to pursue accommodative policies to raise output above potential. This is the source of the inflation bias.

On the supply side of the economy, output is assumed to be determined by an expectations-augmented Phillips curve, the slope of which (for simplicity) is normalized to one as:

$$y_t = y^* + (\pi_t - \pi_t{}^e) - \epsilon_t, \qquad \epsilon_t \sim N(0, \sigma^2) \qquad (5.4)$$

where π_t^e is the rate of inflation at period *t* expected by the private sector at period *t-1* and ϵ_t is a random supply shock. Equation (5.4) shows that deviations of output from its natural rate, y^*, arise from surprise inflation $(\pi_t - \pi_t^e)$ and or exogenous shocks to output ϵ_t. Specifically, output exceeds the natural level if realized inflation is above the rate expected by the private sector. This may be due to the fact that surprise inflation reduces real wages which raises the level of employment and in turn, stimulate output in the short term.

To complete the characterization of the stylized model, it is further assumed that inflation expectations built in the period $t-1$ are given by:

$$\pi_t^e = E_{t-1}(\pi_t) \qquad (5.5)$$

where E_{t-1} is the mathematical expectations operator based on information available at period $t-1$. The key assumption is that private sector forms their expectations (for instance set their wages and prices) before inflation is realised. Thus, in terms of timing in the model, at the beginning of period *t*, private agents form their expectation about the inflation rate in period *t*; then the supply shock, ϵ_t is realised; and, knowing private agents' subjective expectation, and realising the actual value of the supply shock, the central bank chooses an actual inflation rate.

Svensson (1997b) shows that in the absence of output persistence as in the model above, assigning an explicit inflation target to an independent central bank can reduce or even eliminate the inflation bias inherent in discretionary policies.[45] To show this, we begin by providing the solution under discretion and then follow it up with the inflation targeting solution.

Discretion

Under discretion, the central bank does not pre-commit to a policy path but desires to stabilize both inflation and output, the former at $\pi^*$and the latter at $\kappa + y^*$, which exceeds natural level of output by κ. Private agents are assumed

[45] With output persistence, a somewhat more complicated solution that includes not only average inflation bias, but also a state contingent stabilization bias also arises (see Svensson, 1997b).

to be rational and fully understand the incentives facing the policymaker. Put differently, private agents expect higher ('surprise') inflation than the socially optimal level. The optimal solution under discretion is therefore derived by minimizing the social loss function, L with respect to π_t, subject to (5.4) and (5.5). That is:

$$\min_{\pi_t} L = \frac{1}{2}[(\pi_t - \pi_t^*)^2 + \chi(\pi_t - \pi_t^e - \epsilon_t - \kappa)^2] \quad (5.6)$$

This results in the following first order condition:

$$\frac{\partial L}{\partial \pi_t} = 0 \rightarrow (\pi_t - \pi_t^*) + \chi(\pi_t - \pi_t^e - \epsilon_t - \kappa) = 0$$

$$\pi_t = \frac{\pi_t^* + \chi\pi_t^e + \chi\epsilon_t + \chi\kappa}{1 + \chi} \quad (5.7)$$

But from (5.5), expectations are assumed to be determined as $\pi_t^e = E_{t-1}(\pi_t)$. Therefore,

$$\pi^e = E_{t-1}(\pi_t)$$

$$= E_{t-1}\left[\frac{\pi_t^* + \chi\pi_t^e + \chi\epsilon_t + \chi\kappa}{1 + \chi}\right] \quad (5.8)$$

Since the expectation of supply shock is zero and private agents make a forecast of period t inflation at the beginning of period, (5.8) simplifies to:

$$\pi_t^e = \pi_t^* + \chi\kappa \quad (5.9)$$

Equation (5.9) shows that, under discretionary policies, private agents' inflation expectations comprise two elements, namely the social preference rate of inflation, (π_t^*) and a constant inflation bias term ($\chi\kappa$) arising from the fact that private agents are rational and fully anticipate the policymaker's incentives.[46] Importantly, the size of the bias is increasing in the desire to raise output above

[46] This is because the ex-ante optimal policy path is not time-consistent (Barro and Gordon, 1983)

its natural level κ, and in the relative weight on output stabilization relative to inflation χ.

Substituting equation (5.9) into equation (5.7) yields the equilibrium solution under discretion as:

$$\pi_t{}^{d} = \pi_t{}^{*} + \chi\kappa + \frac{\chi}{1+\chi}\epsilon_t \qquad (5.10)$$

where the superscript '*d*' denotes discretion. $\chi\kappa$ represents the inflation bias emanating from failure to credibly commit to a particular policy path. There is no impact on output on average since on average the shock is zero and inflation equals its expectation, so that on average $y_t = y^*$.[47]

Much of the literature developed by Kydland and Prescott (1977) and Barro and Gordon (1983) and later extended by various authors, has been devoted to finding solution to this inflation bias, including inflation targeting which was recently proposed. Among others, Rogoff (1985) suggests delegation of monetary policy to a conservative central banker, that is, one that places a larger relative weight to the cost of inflation than society. Specifically, in the setup presented here, the central bank will be minimising a modified version of (5.6) with χ^R ($< \chi$), which represents the Rogoff weight-conservative central banker's weight on output stabilization. In this case, the inflation bias in equation (5.10) is now $\chi^R\kappa$, which is lower relative to $\chi\kappa$. The solution is thus given in equation (5.11) as:

$$\pi_t{}^{d} = \pi_t{}^{*} + \chi^R\kappa + \frac{\chi^R}{1+\chi^R}\epsilon_t \qquad (5.11)$$

However, as noted variously in the literature, this solution distorts stabilization of the real economy and amounts to a suggestion of a trade-off between credibility and flexibility. Specifically, substituting (5.10) and (5.9) into (5.4) yields:

$$y_t = y^* + \frac{\chi}{1+\chi}\epsilon_t - \epsilon_t$$

[47] Since $y_t = y^* + (\pi_t - \pi_t{}^e) - \epsilon_t = y^* + \left[\left(\pi_t{}^* + \chi\kappa + \frac{\chi}{1+\chi}\epsilon_t\right) - (\pi_t{}^* + \chi\kappa)\right] - \epsilon_t$ and because on average $\epsilon_t = 0$, this yields $y_t = y^*$ on average.

$$= y^* - \frac{1}{1+\chi}\epsilon_t \qquad (5.12)$$

where the variance of y_t is given as:

$$\mathrm{Var}(y_t) = \left(\frac{1}{1+\chi}\right)^2 \sigma_\epsilon^2 \qquad (5.12')$$

An analogous expression for the variance of y_t under the Rogoff solution can be derived as:

$$\mathrm{Var}(y_t) = \left(\frac{1}{1+\chi^R}\right)^2 \sigma_\epsilon^2 \qquad (5.12'')$$

Since $\chi^R < \chi$, $(5.12'') > (5.12')$, implying that output is more variable under the Rogoff solution.

On the other hand, Walsh (1995) proposes an optimal performance contract that specifies the central banker's remuneration as a linear function of realized inflation. The relevant minimization problem can be specified as:

$$\min_{\pi_t} L = \frac{1}{2}[(\pi_t - \pi_t{}^*)^2 + \chi(\pi_t - \pi_t{}^e - \epsilon_t - \kappa)^2] + f\pi_t$$

The optimal solution from this minimisation problem is:

$$\pi_t{}^d = \pi_t{}^* + \chi\kappa + \frac{\chi}{1+\chi}\epsilon_t - f \qquad (5.13)$$

where f represents the cost to the central banker (possibly a dismissal in case inflation exceeds a certain threshold) which must equal $\chi\kappa$, the inflation bias in equilibrium. While this solution provides a means of eliminating the inflation bias, a few difficulties have been identified regarding its feasibility. For instance, there exists the possibility that a lower inflation which translates to higher benefits for the central banker could be correlated with lower output and therefore higher unemployment, a possibly vexed issue to the public and one that would be potentially difficult to implement. This is particularly likely in a situation where there is no compelling reason for the central bank to deliver the low inflation a la inflation targeting.

Inflation Targeting

Inflation targeting has also been proposed as a means of dealing with the inflation bias problem. Under this framework, the central bank is assigned an explicit inflation target with institutional backing (for instance instrument independence) necessary to deliver the target. The framework blends features of discretion and commitment. In practice, discretion under inflation targeting arises because it allows for optimal response to shocks with possibility of short term deviation from the target. On the other hand, with strong commitment to delivering the target, which is often legislated, the regime also retains aspects of policies under commitment. The transparency regarding the target and "*constrained discretion*" under IT therefore make it possible to anchor private agents' expectations (Bernanke *et al.* (2001)). Thus, IT allows for flexibility in the stabilization of both inflation and output.

Svensson (1997b) shows theoretically that government, by assigning an inflation target ($\pi_t{}^T$) to the central bank, where $\pi_t{}^T < \pi_t{}^*$, can reduce or eliminate the inflation bias problem. Thus, by replacing $\pi_t{}^T$ with $\pi_t{}^*$ in the social loss function, the central bank is minimising a modified loss function in which the minimization problem becomes:

$$\min_{\pi_t} L = \frac{1}{2}[(\pi_t - \pi_t{}^T)^2 + \chi(\pi_t - \pi_t{}^e - \epsilon_t - \kappa)^2] \qquad (5.14)$$

The first order condition is:

$$\frac{\partial L}{\partial \pi_t} = 0 \rightarrow (\pi_t - \pi_t{}^T) + \chi(\pi_t - \pi_t{}^e - \epsilon_t - \kappa) = 0$$

$$\pi_t = \frac{\pi_t{}^T + \chi\pi_t{}^e + \chi\epsilon_t + \chi\kappa}{1 + \chi} \qquad (5.15)$$

From (5.5), expectations are formed as $\pi_t{}^e = E_{t-1}(\pi_t)$. Therefore,

$$\pi^e = E_{t-1}(\pi_t)$$

$$= E_{t-1}\left[\frac{\pi_t^{T} + \chi\pi_t^{e} + \chi\epsilon_t + \chi\kappa}{1+\chi}\right] \qquad (5.16)$$

And since the expectation of supply shock is zero and private agents make a forecast of period t inflation at the beginning of period, this simplifies to:

$$\pi_t^{e} = \pi_t^{T} + \chi\kappa \qquad (5.17)$$

The resulting solution under inflation targeting, π_t^{IT} becomes:

$$\pi_t^{IT} = \pi_t^{T} + \chi\kappa + \frac{\chi}{1+\chi}\epsilon_t \qquad (5.18)$$

where the superscript '*IT*' denotes inflation targeting. Equation (5.18) shows that if appropriately specified, a credibly low inflation target under inflation targeting can deliver the socially optimal rate – the *second-best* outcome even under discretion with no impact on output. Specifically, to achieve this, π_t^{T} must in this case be specified as:

$$\pi_t^{T} = \pi_t^{*} - \chi\kappa \qquad (5.19)$$

and by substituting (5.19) into (5.18) and taking expectation of π_t^{IT}, this yields the socially optimal inflation rate as:

$$E(\pi_t^{IT}) = E\left[\pi_t^{*} + \frac{\chi}{1+\chi}\epsilon_t\right] = \pi_t^{*} \qquad (5.20)$$

Thus, assigning a lower inflation target to an independent central bank eliminates the inflation bias, and yields lower average inflation. Moreover, there is no impact on output on average. This compares with the outcomes under the 'pure' discretionary regime where an inflation bias and in turn a higher average inflation arise. This is the theory we test empirically in the following sections, especially as applies to the case of lower income countries – a segment that is yet to be considered in the literature.

5.4 Empirical Methodology and Data

5.4.1 Methodology

This section sets out the empirical strategy for testing the theoretical model presented in the preceding section. In general, the interest in this chapter is providing a comparative performance of inflation targeting across a broader range of country-groups over time. Given that IT adoption is often not an exogenous choice, but might be related to unobservable country-specific characteristics and time trends which cannot be accounted for in cross-sectional methodologies such as the DiD which has been widely applied in the literature, we apply panel data methodology in order to take account of these unobservable characteristics.[48] A panel regression also allows us to control for other factors such as currency crises that may affect the inflation rate in a particular year. Moreover, the use of the large panel dataset allows for the effect of IT in LIC to be assessed separately.

Assuming $\pi_t^T + \chi\kappa = \pi_t^*$ as specified in (5.19) and assuming that π_t^*, χ and κ are identical across countries, the theory predicts the following[49]:

- With no IT:

$$\pi_{i,t} = \pi^* + \chi\kappa + error\ terms \qquad (5.21)$$

- With IT:

$$\pi_{i,t} = \pi^* + error\ terms \qquad (5.21')$$

Or in general,

$$\pi_{i,t} = \pi^* + \chi\kappa - \boldsymbol{\beta ITdummy} + error\ terms \qquad (5.21'')$$

where $\boldsymbol{\beta} = \chi\kappa$. $IT\ dummy$ is the inflation targeting-regime dummy which is set equal to 0 for periods without inflation targeting and 1 for periods of inflation targeting; $IT\ dummy_{i,t}$ is equal to 0 for all nontargeters for all periods.

To capture persistence of inflation and likely reversion to the mean, we include a lagged inflation term ($\pi_{i,t-1}$) in the regression. We also include other

48 Inclusion of time and country fixed effects allow us to capture factors such as global variations in inflation and unobserved country characteristics.

49 We also estimate with country fixed effects which allows for the possibility that χ and κ are different across countries.

control variables, $\boldsymbol{X}_{i,t}$ and control for time and country fixed effects to account for global factors and country specific factors. Thus, we specify:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \boldsymbol{\beta IT\ dummy_{i,t}} + \boldsymbol{X}'_{i,t}\Psi + \eta_i + \delta_t + error\ terms \quad (5.22)$$

where $\boldsymbol{X}_{i,t}$ represents a vector of control variables (to be discussed later) and η and δ are the country fixed effect and time fixed effect respectively. The lagged inflation term, $\pi_{i,t-1}$ is expected to be always positive and significant, reflecting the persistence of inflation shocks.

To investigate the effects of IT in LICs, we apply equation (5.22) to the sub-sample of LICs, alongside the sub-samples of HICs and EMEs for comparison. Our interest is to test the hypothesis that $\boldsymbol{\beta} = 0$, that is IT does not matter.

Next, to highlight how inflation effects of IT in LICs may differ from the ones in EMEs, we use the pooled samples of these income groups, and examine if the IT effects are significantly different between these groups. Specifically, we estimate this variant of equation (5.22):

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \boldsymbol{\beta} IT\ dummy_{i,t} * \text{LIC}\ dummy_i + \boldsymbol{\gamma} IT\ dummy_{i,t} * \text{EME}\ dummy_i + \delta IT\ dummy_{i,t} * \pi_{i,t-1} + X'_{i,t}\Psi + \eta_i + \delta_t + error\ terms \quad (5.22')$$

where LIC $dummy_i$ (EME $dummy_i$) takes one if a country is categorised as LIC (EME), and zero if the country is EME (LIC). To control for the effects of initial inflation on IT effects, the IT dummy is also interacted with initial inflation, $\pi_{i,t-1}$. Thus, a comparison of the coefficients β and γ tells us if the effect of IT on inflation differs across income levels for a given level of initial inflation while controlling for the other factors in the vector $X_{i,t}$.

Once IT effects in LICs are examined, we then consider the role of institutions as a possible factor which differentiates them from the effects in EMEs. Why is an institutional quality relevant when it comes to IT performance? This is because the presence of an unconstrained government is likely to be associated with the issue of fiscal dominance (the subordination of monetary

policy to fiscal requirements), which, in turn, impairs central bank's ability to conduct monetary policy in a way consistent with IT. Thus, institutions affecting government accountability potentially matter, through their effects on the degree of fiscal dominance. Further, incorporating the possible relevance of exchange rate flexibility in the role of institutions, we estimate the following equation with the *three-way* interactions (among IT scheme, institutional quality, and exchange rate regimes) for the pooled sample of LICs and EMEs.

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta\ IT\ dummy_{i,t} + \gamma\ Strong\ inst_{i,t} + \omega\ Float_{i,t} + \varphi\ IT\ dummy_{i,t} * Strong\ inst_{i,t} + \theta\ IT\ dummy_{i,t} * Float_{i,t} + \kappa\ Strong\ inst_{i,t} * Float_{i,t} + \lambda\ IT\ dummy_{i,t} * Strong\ inst_{i,t} * Float_{i,t} + \mu\ IT\ dummy_{i,t} * \pi_{i,t-1} + X'_{i,t}\Psi + \eta_i + \delta_t + error\ terms \quad (5.22'').$$

$Strong\ inst_{i,t}$ is a dummy variable taking one when country *i* is characterised by strong institutions in period *t*, zero otherwise (i.e., weak institutions). Institutions are strong (as opposed to weak), when the relevant institutional proxies (including democratic accountability, as elaborated below) are above the median of all the observations in the pooled sample. Notice that this dummy is varying over time, when, for example, a country shows an upward long-run trend in the quality, moving from zero to one. Next, $Float_{i,t}$ takes one when exchange rate schemes are float (as estimated by Bleaney and Tian, 2017), and zero when soft peg is adopted or there is no legal tender of their own. This variable also shows time variations. Thus, by interacting all the three time-varying variables ($IT\ dummy_{i,t}$, $Strong\ inst_{i,t}$, and $Float_{i,t}$), equation $(5.22'')$ allows us to see how the role of institutions in the IT effects on inflation may differ across different exchange rate regimes. Note that we still control for the role of initial inflation in IT effects, by adding the interaction between initial inflation and IT dummy.

A potential issue with the specifications above relates to possible endogeneity arising from possible correlation between the time-invariant country characteristics (fixed effects) and the explanatory variables. In particular, it has been shown that the within groups estimator of a dynamic panel

data models is biased even in large samples, under asymptotic sequences where the number of time periods is fixed and the number of countries is large (Nickell, 1981). Consequently, other approaches, typically instrumental variables-based methods (including the generalized method of moments (GMM)) were developed to take account of this potential endogeneity (Anderson and Hsiao, 1982; Arellano and Bond, 1991; Hsiao *et al.* 2002; Hsiao and Tahmiscioglu, 2008). A weakness of these estimators however is that they are only consistent under small time (*T*) dimension and large number of cross section units (*i)* asymptotics (Bruno, 2005).[50] Moreover, recent evidence in the literature shows that the bias in dynamic panel models is mitigated in panels where *T* is long enough, the case in this study. Hahn and Kuersteiner (2002) and Alvarez and Arellano (2003) for instance show that the bias computed by Nickell is negligible when the number of time periods is large relative to the number of cross sectional units. The intuitive reason is that increasing *T* in the dynamic panel data model increases the number of instruments affecting the finite-sample properties of the GMM estimator, whereas the maximum likelihood (ML) estimator becomes consistent as *T* grows.

Moreover, we note an important difference between the empirical model applied in this chapter and those in chapters 2 and 3 where we analyse the fiscal deficit – inflation nexus. An important control in both cases is the quality of institutions, and since institutional quality evolves only slowly (i.e. little time variation), we split the data into strong and weak institutions in both chapters in an attempt to analyse the role of institutions.[51] However, in chapters 2 and 3, we applied a heterogeneous panel data methodology that also allowed for cross-country heterogeneity because all countries in the sample have data on fiscal balance and over an extended time span, which made it possible to apply such a methodology. In contrast, this chapter, the model contains a dummy variable for IT which is zero throughout the sample for countries that have never switched to

[50] To elaborate, using difference and system GMM developed by Holtz-Eakin *et al.* (1988), Arellano and Bond (1991), and Blundell and Bond (1998) is not suitable in this context because the (relatively) large time dimension tends to increase the number of instruments exponentially, which in turn makes it difficult to check the validity of instruments (Roodman, 2009).

[51] A number of studies have followed this approach in the analysis of institutions (for instance see Acemoglu *et al*. (2008)).

IT, and that means those countries would have to be excluded from the sample if the methods used in chapters 2 and 3 were used in this chapter. Then the sample of countries would be too small to split the sample by institutional quality, as in chapter 2. Therefore it seems better to use fixed effects methods in this chapter. Moreover, since some previous research on IT has applied this methodology on different samples (Mishkin and Schmidt-Hebbel, 2007; Gemayel *et al.* 2011), the approach similarly allows us to be comparable with these studies.

5.4.2 Data

Our data set consists of annual CPI inflation rates on 159 countries over the period 1985 to 2013, probably the broadest sample on studies of the effect of IT. There are 31 IT countries in the sample, out of which 8 are high income countries, 12 EMEs and 11 low income countries.[52] For this study, countries classified as high income are countries classified by the World Bank as high income or high-income OECD countries; EMEs are those classified as upper middle-income countries while the LICs are countries classified as lower middle income and low-income countries. Inflation is measured as annual log difference of the consumer price index in percent (that is inflation=100*Δlogcpi). The data for inflation is sourced from the World Bank World Development Indicators (WDI). Information on IT country classification is based on IMF classification (International Monetary Fund, 2014, p.6) and the various country's central bank websites.

Exchange rate regime flexibility plays a crucial role in determining a country's inflation dynamics as shown by Catão and Terrones (2005).[53] Therefore, we control for exchange rate regime flexibility across countries. The

[52] We note however that the number of countries reduces to 137 and with 25 IT countries due to the omission of hyper-inflation countries and the lack of data on some of the other controls (e.g. currency crisis and the exchange rate regime flexibility).

[53] As highlighted by Orphanides (2001), the type of exchange rate schemes should have a critical bearing as a prerequisite for successful IT framework. This is because when IT targeters use nominal exchange rates as another anchor (in addition to inflation expectations), as in the case under fixed exchange rates, it deprives the independence of monetary policy conduct on its own.

exchange rate regime flexibility classification data is based on Bleaney and Tian (2017) with 1 representing no legal tender, 2 for peg and 3 for float. In addition, we control for the possible effects of currency crises across countries since these are likely to impact inflation dynamics in these countries (see Bleaney *et al.* 2016). The currency crises data is sourced from Bleaney *et al.* (2016). Other macroeconomic variables used in the study include real GDP per capita growth and general government fiscal balance. We exclude extreme growth (g) figures defined as $-15 > g > 15\%$ per annum from the per capita growth regressions and Kuwait from the analysis of fiscal balance because of extreme fiscal balance figures in the country (in excess of -150% of GDP). The data for these variables was obtained from the WDI.

We also examine the effects of institutional quality on IT performance across countries. We focus on two measures of institutional quality: Polity2 scores from the Polity IV project (Marshall *et al*. 2013), and the International Country Risk Guide (ICRG) index. The Polity2 is one of the most popular measure of a country's political regime and aims to capture how democratic the political regime is. It is measured on a scale of -10 (completely autocratic) to +10 (completely democratic). Higher scores on the scale represent more participation of the citizens in the governance process and thus more democratic and accountable government. As an alternative, we use data from the ICRG, a monthly publication of Political Risk Services (PRS). This is a measure of the risks of doing business in a country, and addresses issues of interest to business corporations and potential investors. We use the Democratic Accountability index which ranges from 0 to 6. Higher scores imply higher levels of democratic accountability of the country. This is a measure of how responsive government is to its people. We use these two institutional variables as proxies for the overall institutional setting under which policies are conducted.

5.5 Empirical Results

This section presents results of the panel estimates of the effect of IT across the different country-groups. We begin by providing a brief discussion of the global trends in inflation as a prelude to the results.

5.5.1 Stylised Facts

Broadly, in line with what has been termed *"The Great Moderation"* in the literature, inflation performance (both in terms of levels and volatility) generally improved across all countries from the mid-1980s. The improvement in inflation performance was however uneven across countries, both targeters and non-targeters; and also even among targeters. Inflation targeters on average, experienced much faster declines in inflation, although these countries also had much higher levels of inflation than non-targeters, a phenomenon Ball and Sheridan (2004) referred to as *regression to the mean*. Figure 2 plots trends in median inflation across all countries, divided into whether a country is implementing IT or otherwise from 1985 to 2013. As shown in the figure, median inflation in IT countries declined from 14.7 percent in 1985 to 2.7 percent in 2013 while for non-IT, the decline has been more measured from some 6 percent to about 2.7 percent. While volatility has similarly reduced in the post IT adoption period across all countries, there is some evidence of improved resilience to shocks to inflation in IT countries as shown by the response to inflation during the global food and energy price shocks of 2007-08, thanks to the increased exchange rate regime flexibility associated with the framework.

Figure 5.3, which plots trends in median inflation across all IT countries according to income level, shows that most of the improvement in inflation performance in IT countries came from EMEs and LICs, as inflation was already generally low in high-income countries at the time of IT adoption. These trends are broadly supported by Table 5.3 which provides some information on basic statistics on the key variables according to country group classifications: before IT adoption, after IT adoption and whether a country is high income, EME or LIC. Panel A of Table 5.3 for instance provides information on the means,

volatility, minimum and maximum values as well as number of observations on inflation for the whole sample and for countries according to level of income. In panel B, we provide this information separately for IT countries, dividing them into before and after IT adoption. We provide similar information for non-targeters based on the mean adoption dates for the respective IT countries' samples. We exclude countries with hyperinflation, defined as those with average inflation for the sample period exceeding 30 percent. In general, the level and volatility of inflation declined over the sample period. In panel A, the mean inflation of 3.2 percent for all HICs for the entire period was just about one-third of the average inflation in EMEs and LICs, which had broadly similar rates, except with much higher volatility in EMEs.

In terms of performance before and after IT adoption (panel B), both mean and volatility of inflation declined across all country-groups, albeit at a much faster pace in EMEs and LICs targeters where inflation was also much higher in the double digits prior to IT adoption. On the other hand, while non-targeters experienced declines in both the mean and volatility of inflation, this was at a more measured pace, naturally again reflecting the fact that inflation was much lower in these countries.

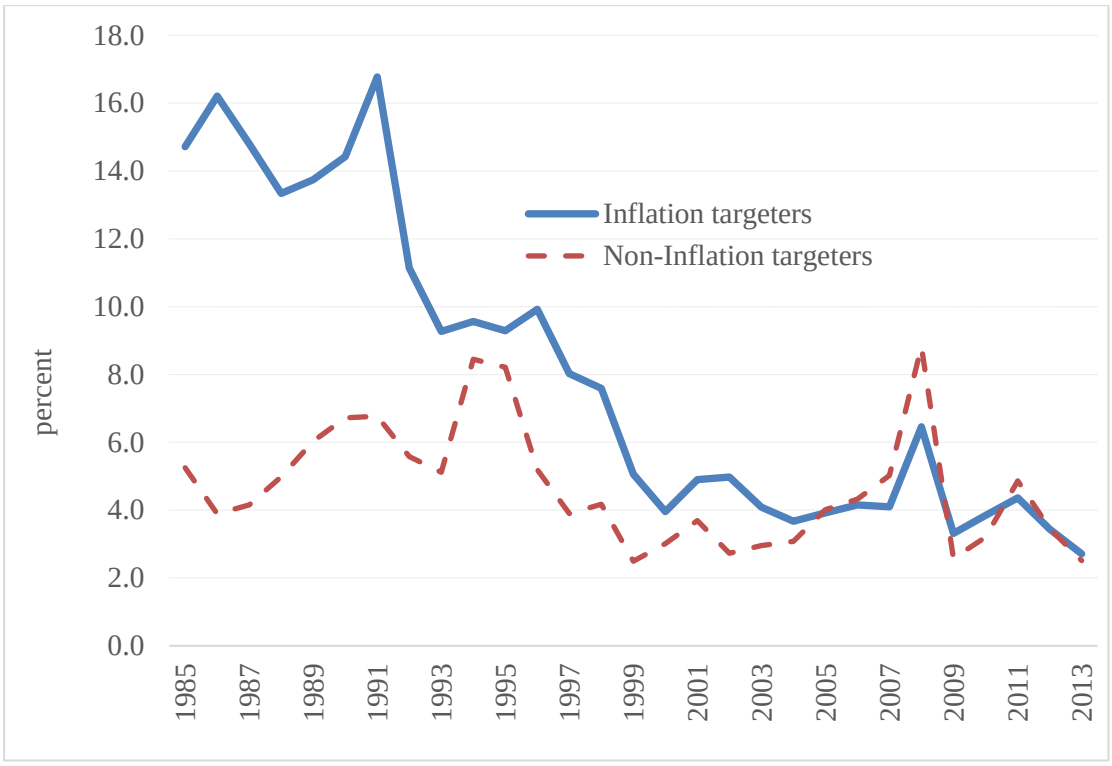


Figure 5.2: Median Inflation Rates in Targeters and Nontargeters: All Countries (1985 - 2013)

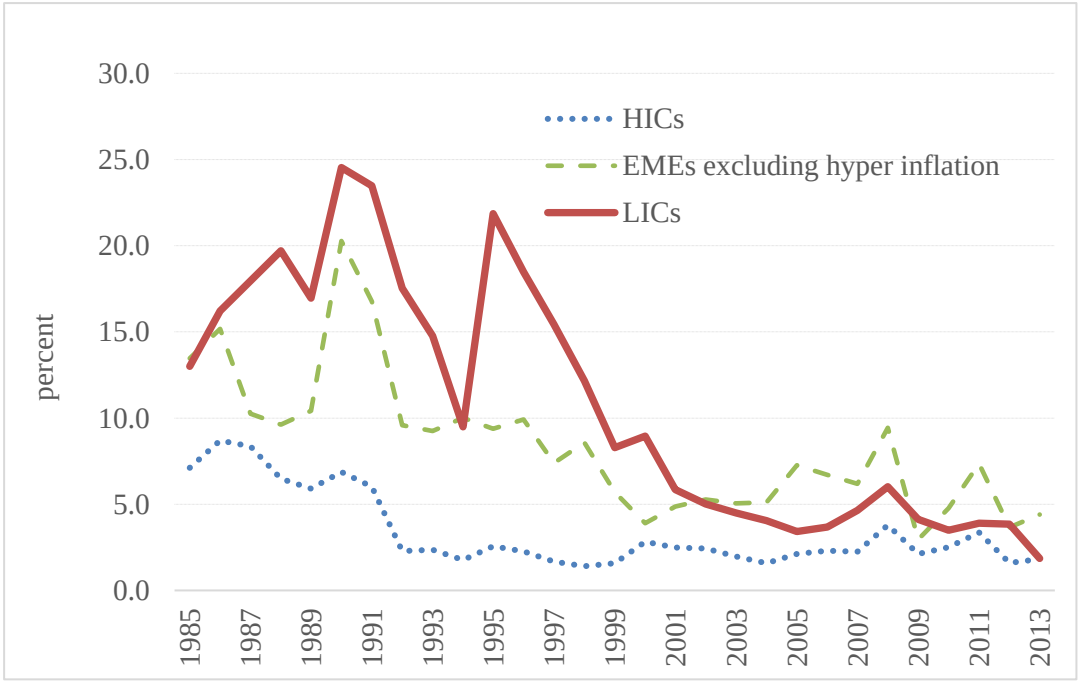


Figure 5.3: Median Inflation Rates in Targeting Countries

Table 5.3: Basic Descriptive Statistics on Inflation (1985 - 2013)

Sample group	obs	mean	volatility†	min	max
Panel A.					
All Countries (full sample)	3922	7.8	14.7	-40.4	354.8
High income	1096	3.2	5.3	-5.0	139.8
Emerging markets	913	9.5	20.9	-19.4	298.4
Lower income	1913	9.5	14.3	-40.4	354.8
Panel B.			*IT vrs. Non-IT period*		
	obs	**mean**	**volatility†**	**min**	**max**
All IT countries					
before	406	15.9	26.8	-40.4	354.8
after	347	4.1	3.3	-0.9	23.6
High income					
before	71	9.5	17.2	1.0	139.8
after	157	2.7	2.3	-0.5	11.9
Emerging markets					
before	106.0	21.8	25.2	0.8	188.0
after	107.0	4.7	2.6	0.1	11.7
Lower income					
before	229	15.1	29.4	-40.4	354.8
after	83	5.9	4.5	-0.9	23.6
All Non-IT countries ††					
before (1985-2001)	1744	8.8	16.5	-19.4	298.4
after (2002-2013)	1425	5.0	5.2	-20.0	45.2
High income					
before (1985-1995)	308	3.8	3.4	-3.3	20.7
after (1996-2013)	560	2.1	2.1	-5	14
Emerging markets					
before (1985-2001)	391	11.4	27.7	-19.4	298.4
after (2002-2013)	309	4.7	4.3	-10.3	31.5
Lower income					
before (1985-2006)	1176	9.7	11.9	-20.0	130.3
after (2007-2013)	425	6.9	5.8	-9.4	36.7

Notes: Countries classified as high income countries are those classified by the World Bank as high and high OECD countries; EMEs are those classified by the World Bank as upper middle income countries; countries classified as lower income countries are those classified by the World Bank as low and lower middle. †Volatility is measured as the standard deviation. †† For non-targeters the cut-off for before and after dates are based on the mean dates for their respectives targeters using the strict starting dates (see appendix table for more details). Data excludes hyperinflation countries defined as countries with average annual inflation for the sample period exceeding 30 percent..

Table C5.2 in the appendix C provides similar information on per capita growth, fiscal performance (fiscal balance) and countries' exchange rate flexibility schemes. The table shows that per capita growth has remained robust in EMEs and LICs even after IT adoption, consistent with most empirical findings that IT adoption has no adverse impact on output. Regarding fiscal performance, as expected, fiscal policy as measured by mean fiscal balance was much weaker in LICs compared with HICs and EMEs. The mean fiscal balance of -2.7 percent

of GDP in LICs for the whole period was almost twice that in HICs and compares with the -1.9 percent recorded in EMEs for the period. However, fiscal policy improved somewhat in LICs following IT adoption, while for EME targeters, the fiscal balance deteriorated although inflation significantly declined. The fiscal deterioration in EMEs may possibly reflect increased issue of domestic bonds as credibility improved in these countries following IT adoption. Fiscal policy remained similar in HICs targeters both before and after IT adoption. On exchange rate policy, EMEs have in general, less exchange rate flexibility schemes than other country groups, although flexibility significantly increased post-targeting, possibly reflecting the desire to anchor expectations on the inflation targets.

5.5.2 Regression Results

Table 5.4 shows our main results for the estimation of equation (5.22). The table shows the results of a panel regression model of inflation over the period 1985-2013. The sample is split into high-income countries, emerging markets and lower-income countries. For each sub-sample the model is estimated with time and country fixed effects. The last column of Table 5.4 shows the effect of running the regression for lower-income countries on a shorter sample starting in 1998, because these countries were slower to adopt IT. Given the wide disagreement in the literature on the actual dating of IT across countries, we also present results for loose IT as robustness in the appendix.[54]

The first two columns of Table 5.4 essentially confirm previous results for high-income countries and emerging markets.[55] The coefficient of the IT dummy is always negative and significant for EMEs, and is much larger than for HICs, where it is only significant at the 10% level. Specifically, the estimated

[54] Given the wide disagreement in the literature on the actual dating of IT across countries, we present results for loose IT start dates as given in Samarina et al. (2013). According to Samarina et al. (2013), *loose* or soft IT is when a country announces inflation targets without a strong commitment to achieving them as other nominal anchors are used simultaneously. On the other hand, strict IT is when a central bank uses a single target and is credibly committed to achieving the target.

[55] Many EMEs experienced very high inflation rates over the sample period which could bias the results. To take account of this, we exclude hyperinflation countries, which are countries with average inflation rate of over 30 percent over the sample period. By this criterion, 3 IT countries and 7 non-IT countries are excluded from the analysis.

coefficient of -8.5 with a *t*-statistic of -2.96 for the IT dummy for EMEs is some five times as large as the coefficient for high income countries. The last two columns show that for LICs. For these countries, the coefficient of the IT dummy is more similar to that for HICs (it is always smaller than -2) and smaller than for EMEs. The lagged inflation variable is always highly significant, which means that inflation is persistent; it also implies that the estimated long-run effect of IT adoption is greater than the short-run effect indicated by the IT coefficient, by a factor of $\mathbf{1}/(\mathbf{1}-\boldsymbol{b})$, where $\boldsymbol{b}$ is the coefficient of lagged inflation. Because $\boldsymbol{b}$ is particularly high for EMEs, the difference in the estimated long-run IT effect between EMEs and the rest is even greater than the difference in the estimated short-run effect. The other control variables are not significant for HICs and EMEs, but they often are for LICs. The exchange rate regime flexibility variable is positive and highly significant in the case of the LICs, implying that more flexible regimes are associated with higher inflation as expected. This underscores the role of exchange rate regime flexibility in the inflation dynamics across these countries. A currency crisis is similarly always associated with significantly higher inflation.

Thus the results above suggest that high-income IT countries experienced some decline in the rates of inflation, albeit small and broadly insignificant. This is consistent with the findings of Ball and Sheridan (2004), who attribute all the impact to mean reversion, and Ball (2010) who found small effects from IT across countries. The generally small and insignificant effect of IT in high income countries possibly reflects the fact that these countries adopted IT when inflation was already very low and stable (as shown in Figure 5.3 and Table 5.3) and perhaps with significantly high level of credibility. Moreover, the large effects of IT in EMEs documented in the literature, was also established.[56] Further, we have shown that IT LICs have not experienced significantly lower inflation compared to their pre-IT performance and this is generally similar to the case of HICs.

[56] This has been have been attributed largely to gains in credibility of monetary policy in EMEs following IT adoption.

We test the robustness of the above results in a number of ways. First we re-estimate the equation for the respective samples based on the *loose* IT start dates. The by repeating the estimation based on the loose IT start dates. The results remain qualitatively similar to those provided in Table 5.4 (see Tables C5.3). Further, we test whether these results are driven by just one or only a few countries. We do this by estimating the equation omitting one country at a time for the respective samples. The results remain robust and show that the estimated IT effects are broad-based across the countries (see Tables C5.4 and C5.5 in the appendix C).

Table 5. 4: Testing the Inflation Targeting Effect by Level of Development

Dependent variable: inflation (100*Δlogcpi)	**High income**	**Emerging markets**	**Low income**	**Low income (1998-2013)**
	Model 1	*Model 2*	*Model 3*	*Model 4*
	includes country and time fixed effects			
	Based on Strict IT adoption dates			
IT dummy	-1.742*	-8.526***	-0.180	-1.269
	(-1.94)	(-2.96)	(-0.18)	(-1.09)
Lagged inflation	0.334***	0.399***	0.395***	0.222***
	(4.89)	(6.45)	(4.86)	(4.77)
ExR regime flexibility	0.764	4.354	1.690**	1.315***
	(1.50)	(1.30)	(2.42)	(3.19)
Currency crisis†	0.0985	4.780	2.676***	1.491***
	(0.39)	(1.69)	(3.74)	(3.19)
Intercept	0.276	-4.688	2.638	0.486
	(0.23)	(-0.68)	(1.14)	(0.47)
N(IT countries)	34(8)	32(7)	71(10)	71(10)
N x T	716	786	1672	963
R^2	0.63	0.39	0.45	0.44
RMSE	1.9	12.2	7.0	4.3

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. The sample period is 1985 to 2013 except where stated otherwise. Countries classified as high income are those classified by the World Bank as high and high OECD countries. EMEs (LICs) are those classified by the World bank as upper middle-income (low or lower middle-income) countries. ExR regime flexibility is exchange rate regime based on Bleaney and Tian (2017) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float. Strict IT is when a central uses a single target and is credibly committed to achieving the target. †see Bleaney *et al.* (2016). Excludes hyperinflation countries - that is countries with average inflation above 30 per cent.

Finally, we estimate the equation (eq. 5.22) for the different country-groups based on an expanded set of controls. Specifically, given the significant role of the exchange rate regime flexibility variable as established above under LICs, we include separate variables for hard-pegs, peg parity change (devaluations) and floats to test the role of these different exchange rate regimes. In addition, we include the currency crisis dummy and its lag in the estimation to control for such crises. The inclusion of these extra controls improves the fit of the model.

Table 5.5 again confirms the results in the preceding Table. IT is most effective in lowering inflation in EMEs but not HICs and LICs, albeit with some improvement in the case of the latter. Regarding the role of the different exchange rate regimes, the hard-peg dummy has a negative coefficient as expected in LICs, though it is only significant at the 10% level. The peg parity change (devaluation) dummy has a positive and significant sign in the case of EMEs and LICs but it is small and only significant 10% and with the opposite sign in the case of HICs. Thus, devaluations are associated with higher inflation in EMEs and LICs. Its lag has no impact in any of the country-groups. In the case of the flexible rate regime, as expected, the float dummy always has a positive coefficient which is significant in the case of LICs but not in EMEs and HICs. The currency crisis dummy and its lag coefficients are positive and significant in EMEs and LICs as expected although the effect of the lagged currency crisis dummy is higher in the case of LICs.

In short, our results corroborate the findings in previous studies that IT has large and significant effects in EMEs but only small and generally insignificant impact in lowering average inflation in HICs. Moreover, the present study which has extended the analysis to cover the experience of LICs as a separate group, *crucially* finds that IT has small and broadly insignificant effects in LICs. Therefore, together with the previous findings, IT has *non-monotonic* effect on lowering inflation across country-groups with different levels of per capita GDP: IT is effective in EMEs but less so in HICs and LICs. Note also that the root mean square error is much smaller for HICs than for the rest, which suggests that their inflation is drawn from a different distribution; for this reason, we omit HICs from the pooled samples used in the remainder of the chapter.

Table 5.5: Inflation Targeting Effect by Level of Development including Separate Variables for Hard Pegs, Devaluations and Floats (1985 - 2013)†

Dependent variable: inflation (100*Δlogcpi)

	High income *Model 1*	**Emerging markets** *Model 2*	**Low income** *Model 3*	**Low income (1998-2013)** *Model 4*
	includes country and time fixed effects			
IT dummy	-1.790**	-7.755***	-0.501	-1.930*
	(-2.05)	(-3.14)	(-0.57)	(-1.68)
Lagged inflation	0.332***	0.434***	0.379***	0.188***
	(4.98)	(6.21)	(4.79)	(4.20)
Hard-peg dummy			-6.872*	0.062
			(-1.69)	(0.13)
PegParity change dummy	-0.675*	4.226**	2.892***	-0.004
	(-1.75)	(2.29)	(3.20)	(-0.01)
Lagged pegParity change dummy	0.300	-0.659	0.126	-0.507
	(0.66)	(-0.49)	(0.15)	(-0.88)
Float dummy	0.670	5.593	1.867***	0.997**
	(1.38)	(1.56)	(3.70)	(2.41)
Currency crisis††	0.111	4.844*	2.403***	1.406***
	(0.44)	(1.80)	(3.64)	(2.83)
Lagged currency crisis	0.0407	3.610**	3.171***	2.209***
	(0.19)	(2.41)	(5.72)	(3.53)
Intercept	1.907***	1.028	4.835***	4.717***
	(3.84)	(0.62)	(2.67)	(5.33)
N(IT countries)	34(8)	32(7)	71(10)	71(10)
N x T	714	782	1667	1025
R^2	0.64	0.38	0.48	0.20
RMSE	1.9	12.0	6.8	4.4

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Models include country and time fixed effects. Countries classified as high income are those classified by the World Bank as high and high OECD countries; Emerging market (low income) countries are upper middle (low and lower middle) income countries. †Based on strict adoption dates; excludes hyperinflation. ††see Bleaney *et al.* (2016).

5.5.3 Inflation Targeting in Emerging Markets and Lower Income Countries Compared

Next, we test formally whether or not the effect of IT on inflation is different across EMEs and LICs, given that both country-groups had broadly similar inflation experience prior to IT adoption.[57] To accomplish this, we estimate equation (eq. 5.22′) using a pooled sample of EMEs and LICs, and including all the controls as in Table 5.5. This specification allows the IT coefficient to be different in EMEs and LICs.

Table 5.6 uses the pooled sample of EMEs and LICs to confirm the impression given in Tables 5.4 and 5.5 that IT is significantly less effective in LICs than in EMEs. The IT dummy interacted with the LIC dummy has a significant positive coefficient, indicating a significant difference in the IT effect. What can explain this result – that IT is most effective in countries at intermediate levels of per capita GDP? One possibility that is suggested by the model of policy reform of Acemoglu *et al*. (2008) is that the countries with the weakest institutions have difficulty in implementing inflation targeting properly, whereas those with stronger institutions have less difficulty. When institutions are very strong, however, low inflation can be achieved with or without IT, so the IT effect is small both when institutions are very weak and when they are very strong. This model potentially explains the pattern of results in Tables 5.4 and 5.5, provided that it can be shown that the IT coefficient varies with institutional quality as expected. We explore this further in the following sections.

[57] We omit HICs because their inflation has been much less volatile.

Table 5.6: Results for a Pooled Sample of EMEs and LICs (1985 - 2013)

Dependent variable: inflation (100*Δlogcpi)		
	Model 1	*Model 2*
	includes country and time fixed effects	
IT dummy	-3.878**	-6.517**
	(-2.39)	(-2.07)
IT dummy x LIC dummy		7.482***
		(2.65)
Lagged inflation	0.404***	0.403***
	(7.07)	(7.23)
IT dummy x lagged inflation		-0.220*
		(-1.91)
Hard peg dummy	-5.766*	-5.806*
	(-1.67)	(-1.70)
pegParity change dummy	3.180***	3.182***
	(3.99)	(3.99)
Lagged pegParity change dummy	-0.0103	-0.117
	(-0.01)	(-0.17)
Float dummy	2.613***	2.776***
	(2.82)	(2.98)
Currency crisis	2.918***	2.887***
	(3.60)	(3.61)
Lagged currency crisis	3.234***	3.231***
	(5.43)	(5.53)
Constant	4.004***	3.991***
	(2.80)	(2.81)
N(IT countries)	103(17)	103(17)
N x T	2449	2449
R^2	0.41	0.41
RMSE	8.8	8.8

Notes: See notes under table 5.5.

5.5.4 Interpretation of Results

Inflation Targeting in Emerging Market Economies and Lower Income Countries: Role of Institutions

The preceding section shows that the effect of IT on inflation is non-monotonic across the different country-groups. The question then is what explains such differential effects across countries? We follow Acemoglu *et al.* (2008) and attempt to explain the observed differences in IT effectiveness in EMEs and LICs based on differences in institutional quality in these countries. Our hypothesis is as follows. In HICs, institutions are of high quality and low inflation can be achieved with or without IT. In other countries, low inflation cannot be achieved without IT, but IT is only effective when institutions are not too weak, as is often the case in LICs.

To test the role of institutional quality, we need to interact the IT coefficient with some measure of institutional quality that has a wide country coverage. We use Democratic Accountability from the ICRG and polity2 scores from the Polity IV project of Marshall *et al.* (2013). These institutional quality variables broadly measure how democratic the political systems are across the countries. We focus on these two measures of institutional quality to proxy how involved the citizens are in the policy process. In the case of the ICRG index, we focus on this measure because it shows the political risks in the business environment of a country. We omit the economic and financial risk components because they could be argued to be endogenous to inflation. The Democratic Accountability index component of the ICRG ranges from 0 to 6, where higher scores represent higher levels of democratic accountability of the country (that is how responsive government is to its people). The Polity2 index concentrates on political structures and aims to capture how democratic the political regime is; it is measured on a scale of -10 (completely autocratic) to +10 (completely democratic). Higher scores on the scale represent more participation of the citizens in the governance process.

We expect the effect of IT in reducing inflation to be stronger in the case of higher polity2 scores. This is because the performance of IT hinges largely on the ability of the policymaker to anchor inflation expectations of private agents.

Increased involvement of the citizenry in the governance process (and indeed, the policy process) is likely to enhance the performance of IT. Specifically, we interact the IT dummy with the institutional proxies and also include the other controls as before.

Table 5.7 provides the results of the effects of IT on inflation conditional on institutional quality, using the pooled sample of EMEs and LICs. As in the previous tables, the lagged dependent variable and exchange regime variables with the exception of hard peg and lagged parity change are statistically significant and with the expected signs. The coefficient of the IT dummy interacted with the democratic accountability from the ICRG in Model 1 is -1.58, with a *t*-statistic of -1.54, and in Model 2, which is based on polity2 score, its coefficient is -0.71 with a *t*-statistic of -1.44. Thus the sign is negative, as expected, but the variables are not statistically significant.

An alternative representation, instead of using the actual democratic accountability from the ICRG and Polity2 score, is to construct a dummy variable that is equal to one when these variables are above some threshold value, and zero otherwise. The threshold that we use is the median value of the sample. Models 3 and 4 of Table 5.7 show the results of using this dummy variable. In Model 3 (democratic accountability), the interaction of this variable with the IT dummy has a coefficient of -1.58 with a *t*-statistic of -1.20, but in Model 4 (Polity2 score), the coefficient is -2.88 with a *t*-statistic of -2.30, which is significant at the 5% level. In short, the results in Table 5.7 show that the effectiveness of IT is somewhat greater with stronger institutions, albeit not robust across different institutional measures.

Table 5.7: Role of Institutions in the Pooled Sample of EMEs and LICs

Dependent variable: inflation (100*Δlogcpi)	*Model 1*	*Model 2*	*Model 3*	*Model 4*
	includes country and time fixed effects			
IT dummy	5.783	2.783	-0.931	-0.463
	(1.41)	(0.95)	(-0.47)	(-0.29)
Lagged inflation	0.486***	0.402***	0.489***	0.402***
	(7.73)	(6.98)	(7.68)	(7.00)
IT dummy x lagged inflation	-0.228	-0.162	-0.173	-0.128
	(-1.51)	(-1.13)	(-1.06)	(-0.80)
Hard peg dummy	-2.843	-5.403	-3.143	-5.390
	(-1.19)	(-1.57)	(-1.35)	(-1.55)
pegParity change dummy	3.257***	3.103***	3.243***	3.178***
	(3.52)	(3.71)	(3.51)	(3.72)
Lagged pegParity change dummy	-1.128	-0.231	-1.084	-0.249
	(-1.43)	(-0.33)	(-1.36)	(-0.34)
Float dummy	3.116***	2.708***	3.069***	2.713***
	(2.74)	(2.80)	(2.69)	(2.79)
Currency crisis	3.565***	3.000***	3.616***	3.061***
	(3.62)	(3.57)	(3.65)	(3.59)
Lagged currency crisis	3.737***	3.306***	3.784***	3.345***
	(5.19)	(5.29)	(5.22)	(5.26)
Democratic accountability_icrg	-0.252			
	(-0.80)			
IT dummy x dem_acc_icrg	-1.576			
	(-1.54)			
Polity2		0.036		
		(0.67)		
IT dummy x polity2		-0.712		
		(-1.44)		
Strong inst. dummy(Dem acc_icrg)‡			-0.004	
			(-0.01)	
IT dummy x strong inst. dummy(Dem acc_icrg)			-1.582	
			(-1.20)	
Strong inst. dummy(polity2)‡				1.310
				(1.63)
IT dummy x strong inst. dummy(polity2)				-2.875**
				(-2.30)
Constant	3.628**	4.156***	2.888**	3.650**
	(2.55)	(2.71)	(2.00)	(2.36)
N(IT countries)	72(16)	94(17)	72(16)	94(17)
N x T	1695	2206	1695	2190
R2	0.43	0.42	0.43	0.42
RMSE	9.9	9.2	10.0	9.3

Notes: See notes under table 5.5. ‡Assignment into strong (weak) institutions is based on whether in a particular year, a country's observation is above (below) the sample median of the institutional variable across all countries.

Exchange Rate Regime Flexibility and Inflation Targeting

Next, we attempt to explain the difference in the results between EMEs and LICs based on the particular exchange rate regime. While the different qualities of institutions within non-HICs prompt us to consider the effect of IT on inflation in LICs as a separate group, one caveat is in order. That is, whether or not institutions play a role in the effects of IT is likely to depend on other factors affecting IT performance. In particular, as highlighted by Masson *et al.* (1998), the type of exchange rate schemes should have a critical bearing as a prerequisite for successful IT framework. This is because if nominal exchange rates pegs are used as an anchor to keep inflation down, this constrains monetary policy.[58] Therefore, under fixed exchange rates, whether or not institutions can eliminate fiscal dominance may be of a second-order relevance, since there is smaller room for monetary policy to be independence to begin with. Thus, we also pay particular attention to exchange rate regimes in place.[59]

We first test for an exchange rate regime effect, without regard to institutions, by adding a float dummy and its interaction with the IT dummy to the model, again using the pooled sample of EMEs and LICs. The results are shown under Model 1 in Table 5.8. The float dummy interacted with the IT dummy has a negative coefficient that is significant at the 1% level. However, because as Table 5.1 shows, most lower-income countries that have adopted IT have also had floating exchange rates, this may not help much in explaining why IT is less effective in LICs. To investigate this, Model 2 adds a lower-income dummy and a LIC dummy interacted with the IT dummy to the regression. The inclusion of the float dummy interacted with the IT dummy does make some difference to the coefficient of the LIC dummy interacted with the IT dummy that was shown in Table 5.6, but not a great deal. In Table 5.8 Model 2, this coefficient is +6.73 with a *t*-statistic of 2.42, compared with +7.48 with a *t*-statistic of 2.65 in Model 2 of Table 5.6.

[58] Masson *et al.* (1998) also point out the freedom from fiscal dominance as another key prerequisite for successful IT performance.
[59] While considering the strict IT adoption dates often precludes the case where a central bank pursues exchange rates as a nominal anchor, the data reveals that exchange rates are often categorised as soft peg even after the strict adoption dates. Therefore, it is still critical to pay an explicit attention to exchange rate flexibility.

Table 5.8: Role of Exchange Rate Regime Flexibility and Low Income in the Pooled Sample of EMEs and LICs (1985 - 2013)

Dependent variable: inflation (100*Δlogcpi)	*Model 1*	*Model 2*
	includes country and time fixed effects	
IT dummy	0.627	-3.999
	(0.37)	(-1.25)
Lagged inflation	0.403***	0.402***
	(7.10)	(7.22)
IT dummy x lagged inflation	-0.150	-0.236**
	(-1.05)	(-2.10)
IT dummy x LIC dummy		6.728**
		(2.42)
Hard peg dummy	-5.623*	-5.724*
	(-1.68)	(-1.70)
pegParity change dummy	3.257***	3.228***
	(4.03)	(4.02)
Lagged pegParity change dummy	-0.0575	-0.130
	(-0.08)	(-0.19)
Float dummy	2.948***	2.949***
	(2.94)	(2.94)
IT dummy x floats dummy	-4.696***	-2.613**
	(-2.84)	(-2.05)
Currency crisis †	2.926***	2.894***
	(3.61)	(3.61)
Lagged currency crisis	3.256***	3.240***
	(5.44)	(5.51)
Constant	3.883***	3.927***
	(2.71)	(2.76)
N(IT countries)	103(17)	103(17)
N x T	2449	2449
R^2	0.41	0.41
RMSE	8.8	8.8

Notes: See notes under table 5.5.

Finally, we estimate equation $(5.22'')$ using the pooled sample of EMEs and LICs (that is, including all the controls as before, and the float dummy and institutional proxies and their interactions with the IT dummy simultaneously to test the relative explanatory power of these variables on the performance of the

IT regime). We allow the conditional effect of institutions on IT to be different depending on whether a country has a pegged regime or floating rate regime by including the interactions of the IT dummy and institutional quality dummy with the floats dummy in the estimation.

The results from the regression are provided in Table 5.9. To simply the presentation, we present results where the institutional proxies enter as dummy variables (again using democratic accountability and polity2 scores as in Models 3 and 4 of Table 5.7) where assignment into strong or weak institution is based on a threshold defined by the sample median as before.[60]

In Table 5.9, the interaction of the IT dummy with both the floating dummy and strong institutions coefficients are much higher and more significant (-2.26 with a *t*-statistic of -1.59 in the case of democratic accountability, and -4.08 with a *t*-statistic of -2.73 in the case of polity2 scores). The respective long-run coefficients are $\frac{-2.255}{1-0.487} = -4.40$, and $\frac{-4.076}{1-0.402} = -6.82$. These are quite a bit larger than the equivalent long-run coefficients of -3.10 and -4.81 for democratic accountability and polity2 scores respectively in Table 5.7 which considered only institutions. In short, there is some evidence that institutions matter for the success of IT especially when we take account of the fact that IT is only effective in a floating exchange rate regime.

[60] Results based on the use of the institutional variables as continuous variables yield qualitatively similar results as shown in Table 5.7.

Table 5.9: Role of Exchange Rate Regime Flexibility and Institutions in the Pooled Sample of EMEs and LICs (1985 - 2013)

Dependent variable: inflation (100*Δlogcpi)	*Model 1*	*Model 2*
	includes country and time fixed effects	
IT dummy	2.041	0.898
	(1.26)	(0.51)
Lagged inflation	0.487***	0.402***
	(7.62)	(7.03)
IT dummy x lagged inflation	-0.217	-0.181
	(-1.62)	(-1.31)
Hard peg dummy	-2.930	-5.234
	(-1.30)	(-1.55)
pegParity change dummy	3.375***	3.294***
	(3.56)	(3.80)
Lagged pegParity change dummy	-1.124	-0.304
	(-1.42)	(-0.41)
Float dummy	3.543***	3.097***
	(2.80)	(2.94)
IT dummy x floats dummy	-3.263	-0.985
	(-1.66)	(-0.70)
Currency crisis†	3.606***	3.066***
	(3.66)	(3.60)
Lagged currency crisis	3.793***	3.354***
	(5.23)	(5.27)
Strong inst. Dummy (Dem acc_icrg)††	-0.0771	
	(-0.12)	
IT dummy x floats dummy x strong inst. Dummy (Dem acc_icrg)	-2.255	
	(-1.59)	
Strong inst. dummy(polity2)		1.290
		(1.63)
IT dummy x floats dummy x strong inst. Dummy (polity2)		-4.076***
		(-2.73)
Constant	2.789*	3.527**
	(1.93)	(2.27)
Wald test (institutions, ex rate regime)ɧ	[0.006]	[0.004]
N(IT countries)	72(16)	94(17)
N x T	1695	2190
R^2	0.43	0.42
RMSE	9.9	9.2

Notes: See notes under table 5.5. ††Assignment to strong institutions is based on the median of the individual country sample means which is constant across the years. ɧ tests the null hypothesis of equality of IT effects under floating with strong institutions and IT effects under floating with weak institutions. *P*-values in square brackets.

5.5.5 Inflation Targeting and Other Macroeconomic Variables

Inflation Targeting and Growth Performance

There is no obvious theoretical reason why IT should affect average growth. Nonetheless, previous literature has also explored the impact of IT on growth. The rationale has typically been to test for whether IT, by providing little scope for discretion, does not unnecessarily constrain growth. On the other hand, others have argued that by reducing inflation, IT improves the investment climate, which can raise investment and thus growth. Thus, the effect of IT on growth is a matter of empirical investigation. Most previous studies find no robust impact of IT on growth (Ball and Sheridan, 2004). We revisit this issue by analysing the potential impact of IT on per capita GDP growth. We exclude from the estimations growth outliers (g) defined as $-15<g<15$ % per annum. The results, provided in Table 5.9 support the evidence in previous work that IT has small and insignificant effects on per capita growth in all country groups (Ball, 2010).

Table 5.10: Panel Estimation Results of the Effect of Inflation Targeting on Growth across Countries (1985 - 2013)†

Dependent variable: per capita growth (100*Δlog per capita)

	High income	**Emerging markets**	**Low income**	**Low income (1998-2013)**
	Model 1	*Model 2*	*Model 3*	*Model 4*
	includes country and time fixed effects			
IT dummy	0.828*	0.180	-1.134*	-0.301
	(1.96)	(0.29)	(-1.72)	(-0.33)
Lagged per capita growth	0.336***	0.192**	0.188***	0.150***
	(8.21)	(2.27)	(5.67)	(3.35)
ExR regime flexibility	0.203	-0.385	0.0314	0.189
	(0.80)	(-0.79)	(0.11)	(0.80)
Intercept	1.563*	3.851***	0.113	0.849
	(1.71)	(2.92)	(0.14)	(1.37)
N(IT countries)	39(8)	33(7)	72(11)	72(11)
N x T	979	798	1807	1125
R^2	0.38	0.27	0.15	0.13
RMSE	2.4	3.5	3.4	2.8

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Models include country and time fixed effects. Countries classified as high income countries are those classified by the World Bank as high and high OECD countries; Emerging market (low income) countries are upper middle (low and lower middle) income countries. † Based on strict adoption dates; the estimations growth outliers (g) defined as -15<g<15% p.a.

Fiscal Discipline and Inflation Targeting

Does IT lead to fiscal discipline? It can be argued that by placing more emphasis on inflation control, IT can potentially lead to improvement in fiscal policy by constraining seigniorage revenues to the fiscal authorities. This is probably more important in cases where there are binding constraints on government debt and where the ability to borrow from private sources is limited, as is often the case in LICs which are the focus of this research. Table 5.10 provides the results for the effect of IT on fiscal balance. The coefficient on the IT dummy is consistently insignificant except for the EMEs where, puzzlingly, it is significant but also with the 'wrong' expected sign. A close examination of Table C5.2 in appendix C however supports this result as IT EMEs recorded

some marginal deterioration in the fiscal balance after IT, and relative to non-IT EMEs countries. It is possible that the extra credibility afforded by IT allowed these countries to issue domestic bonds, enabling them to finance larger fiscal deficits than before.[61]

Table 5.11: Panel Estimation Results of the Effect of Inflation Targeting on Fiscal Balance (1985 - 2013)†

Dependent variable: fiscal balance (GG overall balance /GDP)

	High income	**Emerging markets**	**Low income**	**Low income (1998-2013)**
	Model 1	*Model 2*	*Model 3*	*Model 4*
	includes country and time fixed effects			
IT dummy	0.0314	-1.066**	-0.0616	0.0350
	(0.03)	(-2.06)	(-0.15)	(0.07)
Lagged fiscal balance	0.599***	0.521***	0.333***	0.202***
	(19.49)	(7.95)	(5.01)	(3.42)
ExR regime flexibility	0.429	0.166	-0.309	-0.264
	(0.68)	(0.92)	(-1.11)	(-1.03)
Intercept	-2.837	-2.540*	-2.861***	-1.824**
	(-1.10)	(-1.97)	(-3.05)	(-2.54)
N(IT countries)	36(8)	37(11)	75(11)	75(11)
N x T	0.52	0.36	0.24	0.18
R^2	3.7	4.1	3.2	3.2
RMSE	808	766	1443	1102

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Models include country and time fixed effects. Countries classified as high income countries are those classified by the World Bank as high and high OECD countries; Emerging market (low income) countries are upper middle (low and lower middle) income countries. Fiscal balance is general government overall balance. † Based on strict adoption dates; we excluded Kuwait had unusually large jumps in fiscal balance in a few years and was therefore omitted from the estimation.

[61] We excluded Kuwait had unusually large jumps in fiscal balance in a few years and was therefore omitted from the estimation.

5.6 Conclusion

Recent theoretical work by Svensson (1997b) shows that IT reduces the inflationary bias associated with the dynamic inconsistency problem in monetary policy and leads to lower inflation. Previous empirical studies, conducted mainly on the experience of HICs and EMEs, shows that IT has been effective in lowering inflation in EMEs but not in HICs where inflation was already low and stable alongside strong monetary policy credibility. The framework remains relatively new in LICs, so there is a paucity of evidence on its performance in these countries. This chapter fills this lacuna using an expanded dataset that allows for the study of LICs' experience as a separate group.

Applying a panel data methodology that allows for the control of unobservable country specific characteristics and time trends and after controlling for a number of important variables, our results show that the effect of IT is non-monotonic across the different country-groups by level of development, namely: that IT has only a small and generally insignificant effect in HICs but large and statistically significant effects in reducing inflation in EMEs consistent with previous studies; and crucially, much weaker effects in LICs. The question of what drives the differential effects across countries between EMEs and LICs was explored. It was found that the quality of institutions matters for the effectiveness of IT, especially when considered under a floating rate regime.

Appendix C

Table C5.1: List of IT Countries

	Income level classification[1]		Date		
Country	*World Bank*	*This study*	*IMF †*	*Loose ††*	*Strict ††*
Australia	HIC_OECD	High	1993	1993	1994
Canada	HIC_OECD	High	1991	1991	1995
Iceland	HIC_OECD	High	2001	2001	2003
New Zealand	HIC_OECD	High	1989	1990	1993
Norway	HIC_OECD	High	2001	2001	2001
Sweden	HIC_OECD	High	1995	1993	1995
United Kingdom	HIC_OECD	High	1992	1992	1993
Israel	HIC	High	1992	1992	1997
Brazil[ƒ]	UMC	Emerging markets	1999	1999	1999
Colombia	UMC	Emerging markets	1999	1991	1999
Czech Republic	UMC	Emerging markets	1997	1998	1998
Hungary	UMC	Emerging markets	2001	2001	2001
Korea, Rep.	UMC	Emerging markets	2003	1998	2001
Mexico	UMC	Emerging markets	2001	1999	2001
Peru	UMC	Emerging markets	2002	1994	2002
Poland	UMC	Emerging markets	1998	1998	1999
Romania[ƒ]	UMC	Emerging markets	2005	2005	2005
Serbia	UMC	Emerging markets	2006	2006	2006
South Africa	UMC	Emerging markets	2000	2000	2001
Turkey[ƒ]	UMC	Emerging markets	2006	2002	2006
Albania	LMC	Low	2009	2009	2009
Armenia	LMC	Low	2006	2006	2006
Georgia	LMC	Low	2009	2009	2009
Guatemala	LMC	Low	2005	2005	2005
Indonesia	LMC	Low	2005	2005	2006
Moldova	LMC	Low	2009	2009	2009
Paraguay	LMC	Low	2013	2013	2013
Philippines	LMC	Low	2002	2001	2002
Thailand	LMC	Low	2000	2000	2000
Ghana	LIC	Low	2002	2002	2007
Uganda	LIC	Low	2011	2011	2011

Notes: 1. The country income level classification is according to the World Bank (2010) and classification in adopted in this study; HIC_OECD is high income OECD country, UMC is upper middle income country, LMC is lower middle income country and LIC is low income country. † IMF (2014) and country central bank websites. †† Loose or soft IT is when a country announces inflation targets without strong commitment to achieving them with other nominal anchors used simultaneously; strict IT is when a central uses a single target and is credibly committed to achieving the target (see Samarina et al., 2013; various central bank websites). ƒ. Hyperinflation (average inflation >30%) countries

Table C5.2: Basic Descriptive Statistics on Per Capita Growth, Overall Fiscal Balance, Exchange Regime Flexibility and Institutional Proxies (1985 - 2013)

	Per Capita growth‡		Fiscal balance‡ ††		Exchange Rate Regime Flexibility†††		Democratic Accountability (ICRG)		Polity2	
Sample group	**mean**	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**
Panel A.										
All Countries (full sample	2.0	4.0	-2.2	5.4	2.1	0.7	4.0	1.6	3.4	6.7
High income	1.6	3.1	-1.4	6.5	2.1	0.7	4.9	1.7	7.2	6.5
Emerging markets	2.6	4.4	-1.9	5.8	2.0	0.7	4.4	1.3	6.0	5.3
Lower income	2.0	4.2	-2.7	4.3	2.1	0.6	3.2	1.3	0.8	6.1
Panel B.					***IT vrs. Non-IT period***					
	mean	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**	**mean**	**volatility†**
All IT countries										
before	2.7	4.3	-2.3	4.3	2.5	0.5	4.1	1.5	5.1	5.4
after	2.2	2.9	-1.9	4.4	2.8	0.4	5.4	0.9	8.8	1.9
High income										
before	1.7	2.3	-0.6	4.4	2.6	0.5	5.8	0.6	9.9	0.3
after	1.6	2.3	-0.6	5.7	2.9	0.3	5.9	0.2	10.0	0.2
Emerging markets										
before	2.1	4.7	-1.7	3.1	2.5	0.5	4.4	1.1	6.2	4.1
after	2.2	2.6	-2.9	2.6	2.9	0.2	5.3	0.9	8.7	1.1
Lower income										
before	3.2	4.5	-3.2	4.3	2.5	0.5	3.4	1.3	3.6	5.7
after	3.5	3.8	-2.8	2.7	2.6	0.5	4.3	0.9	7.0	2.6
All Non-IT countries ††††										
before (1985-2001)	1.7	4.2	-3.0	5.1	2.0	0.6	3.6	1.6	1.6	7.2
after (2002-2013)	2.2	3.7	-1.5	5.9	1.9	0.7	4.0	1.7	3.4	6.3
High income										
before (1985-1995)	2.3	3.3	-3.6	6.2	2.1	0.5	4.5	1.5	6.5	7.2
after (1996-2013)	1.3	3.2	-1.0	6.8	1.7	0.6	4.6	2.0	6.1	7.3
Emerging markets										
before (1985-2001)	2.5	4.7	-2.8	6.0	1.8	0.7	3.9	1.2	5.3	5.7
after (2002-2013)	2.9	4.4	-0.9	6.6	1.8	0.7	4.4	1.5	5.3	6.0
Lower income										
before (1985-2006)	1.5	4.3	-2.8	4.6	2.0	0.6	3.0	1.3	-0.7	6.0
after (2007-2013)	2.6	3.3	-2.5	3.7	2.1	0.7	3.5	1.2	2.3	5.2

Notes: Countries classified as high income countries are those classified by the World Bank as high and high OECD countries; EMEs are those classified by the World Bank as upper middle income countries; countries classified as lower income countries are those classified by the World Bank as low and lower middle. ‡ We exclude extreme growth (g) figures defined as -15<g<15 % p.a.; and Kuwait because of extreme fiscal balance figures (in excess of -150% of GDP. †Volatility is measured as the standard deviation. †† General government overall balance. †††Exchange rate regime flexibility is exchange rate regime based on Bleaney and Tian (2014) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float. †††† For non targeters the cut-off for before and after dates are based on the mean dates for their respectives targeters using the strict starting dates (see appendix table for more details).

Table C5.3: Testing the inflation targeting effect by level of development

Dependent variable: inflation (100*Δlogcpi)

	High income	**Emerging markets**	**Low income**	**Low income (1998-2013)**
	Model 1	*Model 2*	*Model 3*	*Model 4*
	Based on Loose IT adoption dates			
IT dummy	-1.821***	-9.220***	-0.338	-1.272
	(-2.76)	(-3.14)	(-0.32)	(-1.03)
Lagged inflation	0.332***	0.398***	0.395***	0.223***
	(5.00)	(6.49)	(4.86)	(4.81)
ExR regime flexibility	0.796	4.442	1.691**	1.297***
	(1.53)	(1.32)	(2.43)	(3.10)
Currency crisis†	0.105	4.882*	2.676***	1.495***
	(0.41)	(1.73)	(3.73)	(3.19)
Intercept	0.237	-4.866	2.636	0.518
	(0.19)	(-0.70)	(1.14)	(0.49)
N(IT countries)	34(8)	32(7)	71(10)	71(10)
N x T	716	786	1672	963
R^2	0.63	0.40	0.45	0.44
RMSE	1.9	12.2	7.0	4.3

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. The sample period is 1985 to 2013 except where stated otherwise. Countries classified as high income are those classified by the World bank as high and high OECD countries. EMEs (LICs) are those classified as upper middle-income (low or lower middle-income) countries. ExR regime flexibility is exchange rate regime based on Bleaney and Tian (2017) classification where higher numbers represent more flexible regimes including 1 for no legal tender 2 for peg and 3 for float. Under loose or soft IT, a country announces inflation targets without strong commitment to achieving them as other nominal anchors used simultaneously. †see Bleaney *et al.* (2016). Excludes hyperinflation countries - that is countries with average inflation above 30 per cent.

Table C5.4: Effect of Omitting Individual Countries in EMEs Sample†

Dependent variable: inflation (100*Δlogcpi)		
	Model 1	*Model 2*
Country Omitted	*includes country and time fixed effects*	
	Based on Strict IT adoption dates	
None		
IT dummy	-7.133**	-8.289**
	(-2.31)	(-2.69)
CZE		
IT dummy	-7.548**	-8.938***
	(-2.37)	(-2.76)
POL		
IT dummy	-4.709*	-5.694**
	(-1.93)	(-2.49)
COL		
IT dummy	-7.280**	-8.289**
	(-2.05)	(-2.27)
ZAF		
IT dummy	-8.402**	-9.865***
	(-2.55)	(-2.97)
HUN		
IT dummy	-7.616**	-8.808**
	(-2.16)	(-2.41)
MEX		
IT dummy	-6.722*	-7.613**
	(-1.87)	(-2.10)
KOR		
IT dummy	-8.615**	-9.806***
	(-2.70)	(-2.96)
SRB		
IT dummy	-6.653*	-8.289**
	(-1.97)	(-2.69)

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Sample is from 1985-2013. Countries classified as EMEs are those classified by the World bank as upper middle income countries. † Hyperinflation countries are countries with average inflation above 30 per cent. The estimations are done taking eliminating one country at a time.

Table C5.5: Effect of Omitting Individual Countries in LICs Sample†

Dependent variable: inflation (100*Δlogcpi)

	Model 1	*Model 2*
Country Omitted	*includes country and time fixed effects*	
	Based on Strict IT adoption dates	
None		
IT dummy	-0.233	-0.443
	(-0.25)	(-0.46)
PRY		
IT dummy	-0.218	-0.442
	(-0.23)	(-0.45)
MDA		
IT dummy	0.0953	-0.0767
	(0.10)	(-0.08)
IDN		
IT dummy	-0.184	-0.343
	(-0.18)	(-0.33)
GTM		
IT dummy	-0.00721	-0.238
	(-0.01)	(-0.23)
GEO		
IT dummy	-0.162	-0.403
	(-0.16)	(-0.39)
ARM		
IT dummy	-0.729	-0.938
	(-0.94)	(-1.18)
ALB		
IT dummy	-0.263	-0.592
	(-0.26)	(-0.58)
UGA		
IT dummy	-0.527	-0.843
	(-0.53)	(-0.86)
GHA		
IT dummy	0.272	0.0726
	(0.31)	(0.08)
PHL		
IT dummy	-0.407	-0.599
	(-0.39)	(-0.56)
THA		
IT dummy	-0.614	-0.694
	(-0.62)	(-0.67)

Notes: Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Sample is from 1985-2013. Countries classified as lower income countries are those classified by the World Bank as low and lower middle. † Hyperinflation countries are countries with average inflation above 30 per cent.

Table C5.6: Effect of Inflation Targeting after Controlling Separately for Hard Pegs and Floats and for Various Crises (1985 - 2013)†

Dependent variable: inflation (100*Δlogcpi)				
	High income	**Emerging markets**	**Low income**	**Low income (1998-2013)**
	Model 1	*Model 2*	*Model 3*	*Model 4*
	includes country and time fixed effects			
IT dummy	-1.402	-7.957***	-0.171	-1.841
	(-1.63)	(-2.83)	(-0.18)	(-1.56)
Lagged inflation	0.316***	0.392***	0.385***	0.210***
	(5.35)	(6.71)	(4.87)	(4.64)
Hard-peg dummy			-7.212	0.697
			(-1.56)	(1.40)
PegParity change dummy	-0.912**	4.950**	3.301***	0.269
	(-2.26)	(2.49)	(3.33)	(0.37)
Lagged pegParity change dummy	0.314	-0.252	-0.00547	-0.786
	(0.57)	(-0.15)	(-0.01)	(-1.29)
Float dummy	0.702	5.542	2.155***	1.310***
	(1.47)	(1.53)	(3.87)	(2.96)
Debt crisis dummy		6.313*	7.382	1.922
		(1.84)	(1.42)	(0.60)
Banking crisis dummy	0.709	0.648	0.277	4.921
	(1.17)	(0.27)	(0.24)	(1.39)
Currency crisis dummy	0.230	4.782*	2.584***	1.321**
	(0.75)	(1.71)	(3.63)	(2.39)
Intercept	2.611***	2.257	6.051***	5.111***
	(4.61)	(1.22)	(3.27)	(5.12)
N(IT countries)	26(8)	30(7)	67(10)	67(10)
N x T	540	732	1565	967
R^2	0.68	0.40	0.47	0.18
RMSE	1.9	12.6	7.1	4.5

Notes: Model 1 includes time fixed effects; model 2 includes country and time fixed effects. Figures in parentheses are robust t-statistics; *, ** ,*** indicate significance at 10%, 5% and 1% respectively. Countries classified as high income countries are those classified by the World bank as high and high OECD countries; Emerging market (low income) countries are upper middle (low and lower middle) income countries. Excludes hyperinflation. † Based on strict adoption dates.

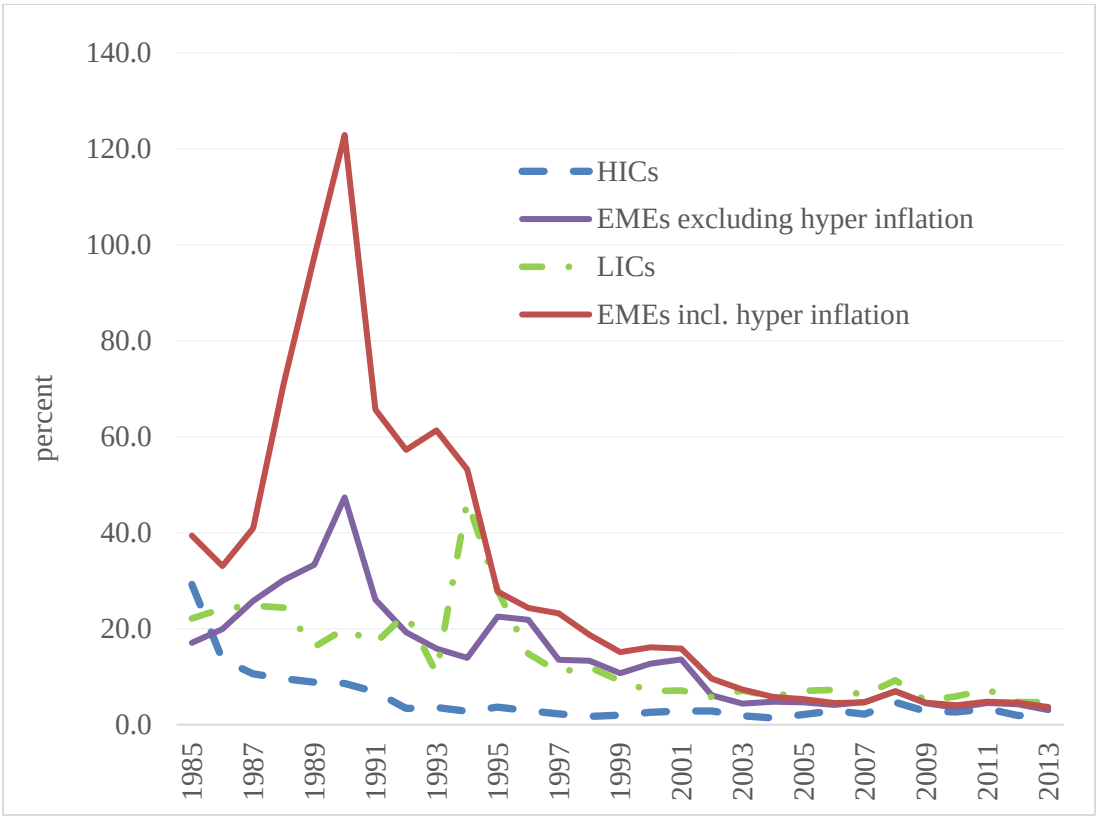


Figure C5.1: Average Annual Inflation Rates in Inflation Targeting Countries by Income Levels (1985 - 2013)

Chapter 6

Inflation Targeting in Ghana: An Empirical Evaluation of Policy Decisions

6.1 Introduction

Since New Zealand adopted inflation targeting (IT) in 1990, the framework has become popular for the conduct of monetary policy in many countries (see previous chapter). Evidence from previous studies shows that the framework has been successful in lowering inflation in emerging market economies but not in advanced countries where inflation was already low alongside strong institutions (de Mendonça and de Guimarães e Souza, 2012; Gonçalves and Salles, 2008; Lin and Ye, 2007, 2009; Mishkin and Schmidt-Hebbel, 2007; Samarina, *et al.* 2013; Vega and Winkelried, 2005). In the previous chapter, we extended the analysis to the experience of lower-income countries, that is, countries classified by the World Bank as low or lower-middle income. That chapter, while confirming the findings in the previous studies, shows that IT has not been as successful in lowering inflation in lower-income countries (LICs) as in EMEs, in part reflecting differences in institutional quality and the degree of exchange rate regime flexibility. These studies typically examined the extent to which inflation converges to the set targets (alongside other macroeconomic targets in some instances).

This chapter evaluates the performance of IT in Ghana by examining whether the setting of interest rates is as recommended by theory to make IT successful. Ghana has been less successful than other countries in bringing inflation under control under its IT regime. The country adopted IT in 2002, making it the first low-income country and second in Sub-Saharan Africa (SSA) (after South

Africa) to do so.[62] Although the country has implemented the framework for some fifteen years, inflation has remained in double digits and highly volatile. Inflation targets were met in only two years (13.3%) out of the fifteen years; and, compared to all other IT countries, Ghana continues to record the highest rates of inflation (figure 6.1). Figure 6.1 plots inflation rates across IT countries at the end of 2016 and the average rates over the period 2012 – 2016. As shown clearly, Ghana registered the highest rate of inflation at the end of 2016 (more than double the level in the next highest IT country (Brazil)), and the situation remains similar when viewed over a longer time span. The central bank of Ghana may have been unsuccessful in its application of IT because monetary policy has not been implemented as recommended by theory, or it may have been as recommended but ineffective for other reasons. We investigate this by estimating policy reaction functions for the central bank of Ghana.

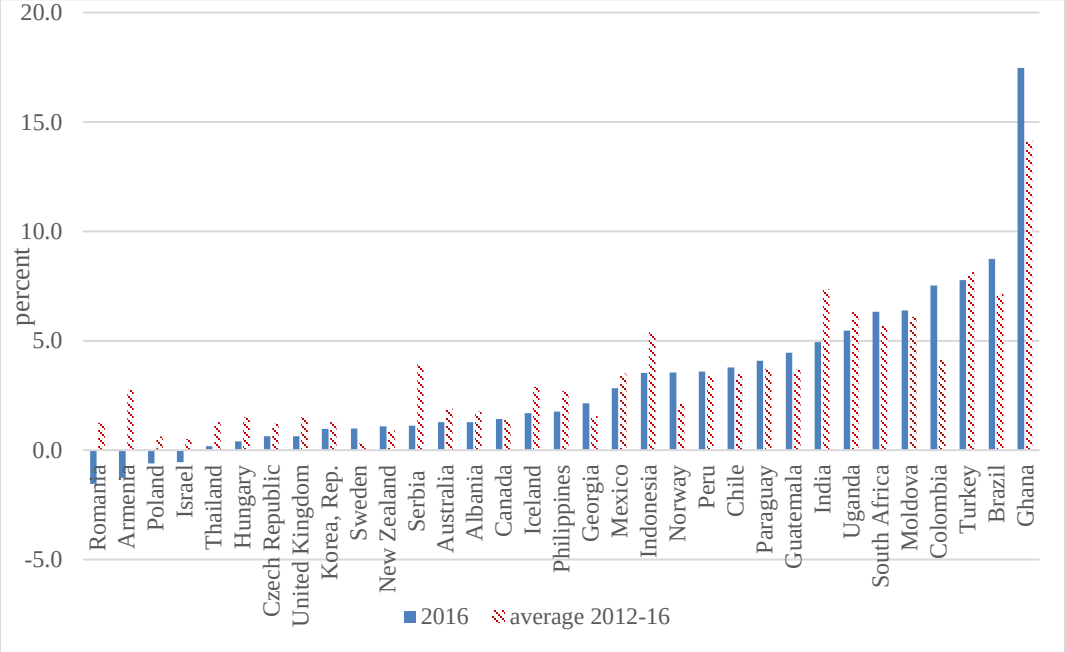


Figure 6.1: Inflation in Inflation Targeting Countries

The time inconsistency literature argues that a purely discretionary policy setting leads to higher long-run inflation (Kydland and Prescott, 1977; Barro and

[62] Formal announcement was however not made until May 2007, and Ghana is generally regarded as following a loose IT regime from 2002 to 2007, and a strict one after 2007.

Gordon, 1983). In such circumstances, a credible commitment by the central bank to maintain price stability through specific inflation targets can reduce the inflation bias from monetary policy (Svensson, 1997b). In this setting, decisions of the central bank regarding deployment of its key policy instrument play a central role in the success or otherwise of IT. Svensson (1999) for instance describes IT as "decision making under discretion" where central banks follow a "targeting rule" by which they set interest rates to reduce the deviation between the conditional inflation forecast (the "intermediate target" of policy) and the inflation target to zero over the target horizon. Moreover, Taylor (1993) argues that raising the real interest rate in response to inflationary pressures (what has come to be known as the *Taylor principle*) can prevent self-fulfilling bursts of inflation. The Taylor principle implies that the nominal interest rate responds by more than the increase in the inflation rate.

There are many studies that have analysed the conduct of monetary policy along these lines, typically under the so-called Taylor rule or its variants for the industrial countries and EMEs. Essentially, this entails analysing how the central bank adjusts its policy rate in relation to inflation and output shocks under the IT framework (Taylor, 1993; Clarida *et al.* 1998; de Brouwer and Gilbert, 2005; Muñoz Torres and Shepherd, 2014). The rationale is that the credibility of IT and thus its performance is likely to be enhanced if the central bank's behaviour is consistent with its stated objectives. On the other hand, credibility is likely to be affected by arbitrary policy reactions from the central bank, possibly reflecting a less than full autonomy in the implementation of its policies.

In general, the findings show that countries that have adopted IT typically place more weight on achieving their inflation targets than other objectives of policy (for instance output stabilization or increased employment) by responding strongly to inflation shocks; and tend to react to expected future inflation (Clarida *et al.* 1998; Amato and Gerlach, 2002; de Brouwer and Gilbert, 2005; Mishkin and Schmidt-Hebbel, 2007; Taguchi and Kato, 2011). Despite the crucial role of central behaviour in determining the success or otherwise of IT, surprisingly, there has not been any systematic empirical analysis of how monetary policy is set in Ghana; and indeed,

there is a general paucity of evidence in low-income countries implementing IT. This probably reflects the fact that the framework is relatively new in these countries. This chapter therefore seeks to contribute to the literature by empirically characterizing the experience of the central bank of Ghana under its IT framework. To the best of our knowledge, no similar work has yet been done for Ghana.

We aim to systematically examine how the central bank of Ghana responds to inflation and output shocks and, whether this has changed after formally announcing strict IT in 2007. Moreover, we examine whether the Bank reacts to variables other than inflation and output gaps (for instance exchange rates). We analyse whether or not the Bank responds to food and non-food price shocks differently, a potentially important issue in the case of low-income countries where food (which is subject to sizeable supply-side shocks) constitutes a higher share of the consumption basket (Pourroy *et al.* 2016).

Moreover, unlike most previous studies, we apply a variety of models, comprising both discrete choice and standard linear models, in the analysis to examine both the factors determining the probability of adjusting the policy rate and also the size of the response. Dolado *et al.* (2000) apply similar methods in their examination of the experience of Germany, France, Spain and the USA (see Table 6.1). The possibility of asymmetric behaviour, whereby the central bank responds differently to positive and negative inflation shocks is also investigated.

Proceeding in this way, we obtain several interesting results concerning the conduct of monetary policy in Ghana over the period 2002 – 2017, when the Bank of Ghana (BoG) was using a short-term interest rate as its policy instrument under the inflation targeting framework. We find that the reaction function in Ghana is remarkably similar to that estimated for countries where monetary policy is regarded as successful. Since 2010 real interest rates have been consistently positive, and the estimated long-run reaction of interest rates to inflation shocks is well above the theoretically recommended threshold of one. Moreover, the details of the inflation response are also consistent with theory. More notice is taken of non-food price inflation, which is more persistent than food price inflation, and therefore a better

indicator of future inflation. More notice is also taken of expected inflation as revealed by the Bank's regular survey of business than of historical inflation. The speed of adjustment is similar to that in the advanced countries. The findings naturally raise the question of why inflation has not been closer to the Bank's target despite the apparently sound monetary policy reactions. We find some evidence that Ghana still has a fiscal dominance problem that may be affecting inflation expectations.

The rest of the chapter is organized as follows: Section 6.2 reviews previous studies and clarifies this paper's contribution. Section 6.3 presents a contextual overview of Ghana's monetary policy framework while section 6.4 sets forth the empirical analyses, introducing the data and the methodology. The empirical results are presented in section 6.5 while section 6.6 summarises the findings of the chapter and concludes.

6.2 Monetary Policy Rules and Inflation Targeting: Theory and Evidence

The analysis of monetary policy rules has been an important topic for macroeconomic policy research, generally from both theoretical and empirical perspectives. Since Taylor (1993) proposed the simple monetary policy rule linking adjustment of the short-term interest rate by the monetary authorities to fluctuations in inflation and output gaps, various extensions have been made to this model. Typically, these extensions have been in respect of providing microeconomic foundations to the Taylor rule or incorporation of evolution of expected inflation and output gaps as well as investigation of asymmetric behaviour on the part of the central bank in the setting of its key policy instrument(s).

Taylor (1993), develops a simple monetary policy rule in which the short-term interest rate is set as a linear function of measures of the current inflation rate and its target and the current gap between real output and its potential as:

$$i_t^* = \bar{\imath} + \alpha_\pi(\pi_t - \pi^*) + \alpha_x x_t \qquad (6.1)$$

where i_t^* is the Taylor-rule prescribed short-term interest rate; $\bar{\imath} = r^* + \pi^*$ is the long-term ("equilibrium") nominal interest rate, i.e., the rate that prevails when both inflation and output gaps are zero; r^* denotes the equilibrium real interest rate and π^* is the desired long-run, or "target" inflation rate; π_t is the inflation rate in period t; and x_t denotes the output gap defined as: $y_t - y_t^*$, where y_t is the current level of output and y_t^* is the potential level of output that would prevail if prices and wages were perfectly flexible (i.e. the percent deviation of real GDP from its potential level) in period t. α_π and α_x are respectively the weights on the inflation gap and output gap, and for these, Taylor assumed 1.5 and 0.5 respectively. Crucially, if $\boldsymbol{\alpha_\pi > 1}$, interest rates react by more than any inflation shock which implies that real interest rates are increased when inflation rises, a point that has been stressed by Taylor (1993, 1999). Termed the *Taylor principle* in the literature, the principle implies that the nominal interest rate responds more than proportionately to inflation shocks to prevent self-fulfilling bursts of inflation. Taylor similarly suggested 4 percent for $\bar{\imath}$, made up of a value of 2 percent for both r^* and π^*. Taylor (1993) shows that this simple rule fits the behaviour of the Fed policies between 1987 – 1992 well.

Several authors have provided microfoundations for the model. Svensson (1997b, 1999), Clarida *et al.* (1999) and Woodford (2001, 2003) for instance show that a linear symmetric interest rate rule as in the Taylor rule represents the best policy response to the observed macroeconomic fluctuations to maximize the welfare of society.

Many recent discussions on monetary policy rules however argue for specifications in which the central bank's adjustment of the policy rate depends on forecasts or more broadly some measure of future evolution of inflation and the output gap. Clarida *et al.* (1998, 1999, 2000), Dolado and María-Dolores (2000) and Svensson (2003) for instance extend the simple interest rule proposed by Taylor (1993) to include expected future movements in inflation and the output gap in order to capture the presence of sizeable lags and uncertainty in the transmission of

monetary policies. Clarida *et al.* (1998, 1999, 2000) and Dolado and María-Dolores (2000) specify the following version of the Taylor rule:

$$i_t^* = \bar{\imath} + \alpha_\pi[E(\pi_{t+k}|I_t) - \pi^*] + \alpha_x[Ex_t|I_t] \qquad (6.2)$$

Where π_{t+k} is the central bank's inflation forecast or expected inflation rate in period $t+k$, I_t is the information set about the state of the economy in period t and the transmission mechanism of monetary policy. E is the conditional expectations operator. Clarida *et al.* (1998, 1999, 2000) consider $k = 1$ and generate expected inflation from an econometric model. An alternative is to use survey data if available (Gorter *el al.* 2008).

By implication, the ex-ante real interest rate can be specified as:

$$r_t = i_t - E\pi_{t+k}|I_t \qquad (6.3),$$

with a long-run equilibrium real rate of $\bar{r} = \bar{\imath} - \pi^*$. Substituting (6.3) into (6.2) yields:

$$r_t^* = \bar{r} + (\alpha_\pi - 1)[E(\pi_{t+k}|I_t) - \pi^*] + \alpha_x[Ex_t|I_t] \qquad (6.4)$$

Equation (6.4) shows that the target real interest rate will diverge from its natural rate in response to deviation of inflation and output from their targets.

Like Taylor (1993, 1999), Clarida *et al.* (1998, 1999, 2000) note that if $\alpha_\pi > 1$ and $\alpha_x > 0$ in equation (6.4), then policies are likely to be stabilizing. On the other hand, if $\alpha_\pi < 1$ and $\alpha_x < 0$, then policies will be destabilizing and accommodative of inflation and output shocks. Moreover, the specification nests the simple model proposed by Taylor in the sense that if current inflation as opposed to

forecast or expected inflation offers a significant statistic for inflation, then the rule reduces to the Taylor rule.[63]

In practice, central banks tend to smooth changes in the policy rate since abrupt and disorderly changes can impair credibility. Smoothening may also serve as a precautionary measure given significant lags and uncertainty in the policy space. To capture this, it is assumed that the actual policy rate adjusts to the target rate in the following:

$$i_t = \rho i_{t-1} + (1-\rho) i_t^* + v_t \qquad (6.5),$$

where ρ is the smoothing parameter and v is a random term assumed to be serially uncorrelated. Clarida *et al.* (1998) derive an estimable version of the above model by defining: $\beta = \bar{\imath} - \alpha_\pi \pi^*$, which, by combining equations (6.2) and (6.5) yields:

$$i_t = (1-\rho)\beta + (1-\rho)\alpha_\pi [E(\pi_{t+k}|I_t) + (1-\rho)\alpha_x [Ex_t|I_t] + v_t \qquad (6.6)$$

Finally, the unobservable forecast variables can be eliminated from Equation (6.6), by rewriting the policy rule in terms of the realized variables as:

$$i_t = (1-\rho)\beta + (1-\rho)\alpha_\pi \pi_{t+k} + (1-\rho)\alpha_x x_t + \varepsilon_t \qquad (6.7)$$

where the error term, ε_t, depends on v_t and the forecast errors of inflation and the output gap as:

$$\varepsilon_t = -(1-\rho)\{\alpha_\pi [\pi_{t+k} - E(\pi_{t+k}|I_t] + \alpha_x [x_t - Ex_t|I_t]\} + v_t \qquad (6.8)$$

In terms of evidence, there has long been enormous interest in empirical evaluation of the performance of policy rules by researchers and policymakers across different countries or country-groups. These have however been largely confined to examining the experience of the industrial and emerging markets.

[63] Orphanides (2001) note that the specification involving forecast inflation has some advantages over the specification by Taylor in that it allows the central bank to respond to future inflation Moreover, it is not clear from the Taylor rule if the central bank is responding to the output gap independently of concern for future inflation.

Broadly, there has been evidence in support of the *Taylor principle* as most studies report coefficients for the inflation gap higher than one especially from the early 1980s (Taylor, 1999). Table 6.1 gives a summary of some of the early and recent relevant studies in this regard. The table provides information on the period and countries covered, the method used and specification as well as the estimates in cases other than the discrete choice models.

Taylor (1999) for instance provides estimates for US monetary policy for two different time spans. Based on ordinary least squares, the coefficient for inflation gap for the period 1960 – 1979 was 0.81, which means that real interest rates declined on average in response to a positive inflation shock during this period. On the other hand, for the post-1979 period, the estimates were not only in line with the Taylor principle, but remained remarkably close to the choice of weights in Taylor's 1993 original work. Taylor (1999) therefore concludes that the Fed did not adhere to this principle before 1979 and this failure may well have been responsible for the greater U.S. macroeconomic instability during the 1960s and 1970s.

Judd and Rudebusch (1998), in a specification that incorporates a dynamic structure, confirm Taylor's estimates for the US monetary policy albeit with a somewhat higher weight for the output gap than Taylor's estimates. In a series of studies, Clarida *et al.* (1998, 2000) focus on the experience of a number of industrial countries based on forecast inflation. Clarida *et al.* (1998) for instance focus on six major industrial countries: the G3 comprising Germany, Japan, and United States and the E3 including France, Italy, and the United Kingdom. They use an instrumental variables procedure based on Generalized Methods of Moments (GMM) that includes expected inflation and lagged policy rates. The study concludes that the G3 countries followed an implicit form of IT since 1979 in that the central banks are "forward-looking", that is, they respond decisively to anticipated inflation shocks as opposed to past inflation. The coefficients for expected inflation shocks were all large and greater than one in the G3 countries as compared to the E3 where it was mostly lower than one. The study therefore argues that the success of the G3 in lowering and keeping inflation stable may be

attributable to this implicit IT policy. They conclude that IT may be superior to fixing exchange rates as a nominal anchor (as was prevalent in their sample period for the E3 countries). Similarly, Clarida *et al.* (2000) provide estimates based on expected inflation and interest rate smoothing that support the Taylor (1999) estimates for the US.[64]

In a more recent study, Gorter *et al.* (2008) provide estimates of monetary reaction functions for the Euro area using both actual data and survey data on expected inflation and the output gap and a non-linear least squares technique. Their findings show that the Euro area countries take expected inflation and output gaps into consideration in the implementation of policies.

A number of studies have been conducted on the experience of emerging market economies. Aizenman *et al.* (2011) for example use a panel data methodology to study the case of eleven EMEs implementing IT and five non-IT countries. The study shows that IT emerging markets appear to follow a "mixed strategy" in which both inflation and real exchange rates are important determinants of policy interest rates. The response to real exchange rates, however, is more constrained under IT than in non-IT regimes.

Similarly, Taguchi and Kato (2011) analyse the case of five Asian economies, including four IT and one non-IT countries. Like Clarida *et al.*(1998), they apply GMM based on specifications with expected inflation and also past inflation for each country to analyse the pre- and post-IT periods of the IT countries compared with the non-targeter – Malaysia. They find that Korea considers anticipated inflation in setting its policy rate and that this may have supported its success in stabilizing inflation. On the other hand, Thailand and Indonesia react to past inflation with little impact on stabilizing inflation while Philippines and Malaysia had no clear strategy.

[64] Orphanides (2001) contests the above findings on grounds that they are based on revised data and not data available to the Fed at the time of the decisions, the use of which yields different results.

Dolado *et al.* (2000) investigate possible asymmetric behaviour of four central banks (including three from the Euro area – France, Germany and Spain and the Fed) in the implementation of interest rates policies using GMM and ordered probit models. They find stronger reaction to upswings relative to downswings in inflation, while for output, only the Fed responded strongly to recessions.

In sum, there is a growing international literature on central bank reaction functions, especially in the case of the industrial and emerging market economies. In general, in the context of IT, these studies show that IT central banks tend to react decisively to inflation shocks (typically with a coefficient greater than 1) and also tend to consider future inflation in setting interest rates Clarida *et al.* 1998; Maria-Dolores (2000) and Taguchi and Kato (2011).

Although there has been significant and growing interest in central bank reaction functions, surprisingly little empirical work has been done in Ghana, the first low-income country and second in sub-Saharan Africa (after South Africa) to adopt IT after some fifteen years of implementing the framework. Bawumia *et al.* (2008) is probably the only study on Ghana. The study uses a dynamic OLS specification and data covering the period 2002 – 2008 to examine the interest rate decisions of the Monetary Policy Committee (MPC) of the Bank. The authors find that the MPC's decisions tilted more towards output considerations than inflation, rationalized as possibly reflecting effects of the domestic energy crisis alongside the major financial and economic crisis of 2007/2008 (Bawumia, 2010). The conclusion may also possibly reflect the use of past inflation as opposed to expected future inflation which appears to play a crucial role in the MPC's interest rate decisions (see section 6.3 ahead). Besides, the period of the study covers only the first thirty meetings of the MPC, essentially excluding much of the period when the central bank announced "strict" IT.

Against this background, this study systematically examines the behavoiur of monetary policy in Ghana using both current and forecast inflation over the period from 2002 through May 2017. The aim is to assess the consistency of the decisions of the MPC and its IT framework.

The contribution of this chapter can be seen in the context of the following. First, only a few empirical studies focus on central bank reaction functions in low-income countries (notably, those by Aizenman *et al.* (2011) and Taguchi and Kato (2011)) consider a few lower-income countries in their samples and the evidence remains scanty and generally inconclusive. Secondly, perhaps, importantly, we test if monetary policy responds differently to food and non-food price shocks. Inflation in some goods and services may be more persistent than in others, and therefore a better indicator of future inflation. For example, Bank of Ghana also uses a measure of "core inflation" that excludes energy and utility prices because they are set administratively. None of the studies above considers the possibility of differential reaction of monetary policy to food and non-food price inflation. But, as Pourroy *et al.* (2016) observe, poorer countries require more attention to food prices owing especially to the higher share of food in consumption basket and the food good composition.[65] This makes response to food inflation shocks in poorer countries an important issue for policymakers as this can significantly impact effectiveness of IT in these countries. Finally, the empirical characterization of the monetary policy reaction function in Ghana constitutes an important contribution to the policy space in the country. To the best of our knowledge, no similar work has yet been done for Ghana.

[65] Because of the potentially political implications. But it does not mean that monetary policy should focus on them since they tend to be transitory. Monetary policy is rather more effective in controlling the more persistent components of the CPI basket (i.e. non-food prices).

Table 6.1: Selected Studies of Monetary Policy Reaction Functions and their Estimates

Study/period	Country(ies)	Method	Specification	Estimates/Result					
				α_π	(s.e.)	α_x	(s.e.)	ρ	(s.e.)
Taylor (1999)			Contemporaneous inflation and output gaps						
1960–1979	US	OLS		0.81	(0.06)	0.25	(0.05)		
1987–1997	US			1.53	(0.16)	0.77	(0.09)		
Judd-Rudebusch (1998)			Contemporaneous inflation and output gaps						
1979–1987	US	OLS		1.46	(0.26)	1.53	(0.80)	0.56	(0.12)
1987–1997	US			1.54	(0.18)	0.99	(0.13)	0.72	(0.05)
Clarida et al. (2000)			Expected inflation and output gaps						
1960–1979	US	GMM		0.83	(0.07)	0.27	(0.08)	0.68	(0.05)
1979–1996	US			2.15	(0.40)	0.93	(0.42)	0.79	(0.04)
Clarida et al. (1998)			Expected inflation and output gaps						
1979:3 - 1993:12	Germany	GMM		1.31	(0.09)	0.25	(0.04)	0.91	(0.01)
1979:4 - 1994:12	Japan			2.04	(0.19)	0.08	(0.03)	0.93	(0.01)
1979:10 - 1994:12	US			1.79	(0.18)	0.07	(0.06)	0.92	(0.03)
1979:6 - 1990:10	England			0.98	(0.09)	0.19	(0.04)	0.02	(0.01)
1983:5 - 1989:12	Fance			1.13	(0.06)	0.88	(0.04)	0.95	(0.01)
1981:6 - 1989:12	Italy			0.90	(0.04)	0.22	(0.08)	0.95	(0.01)
Dolado et al. (2000)			Expected inflation and output gap with real exchange rate, M3 and US interest rate added as controls						
1980:08 1997:12	Germany	GMM and ordered probit		1.45	(0.63)	0.28	(0.13)		
1988:07 1997:12	France			0.41	(0.14)	0.13	(0.07)		
1989:05 1997:12	Spain			0.53	(0.20)	0.45	(0.33)		
1979:01 1997:12	US			1.21	(0.32)	0.9	(0.41)		

Continued next page…..

Table 6.1 continued

Study/period	Country(ies)	Method	Specification/key variables	Estimates/Result					
				α_π	(s.e.)	α_x	(s.e.)	ρ	(s.e.)
Gascoigne and Turner (2004) 1997:06 - 2003:03	UK	Ordered probit & logit	Contemporaneous inflation and output gaps	Bank of England responds to current output growth but not inflation					
Gorter et al.(2008) 1997:1 - 2006:12 (ex-post data)	Euro Area	Nonlinear least squares	Ex-post data and survey data on expected inflation and output gaps	0.09	(0.53)	0.37	(0.24)	0.54	(0.11)
1997:1 - 2006:12 (survey data)				1.39	(0.53)	1.52	(0.22)	0.43	(0.11)
Taguchi and Kato (2011)	South Korea	GMM	Expected inflation and output gap	0.84	(0.32)	0.25	(0.10)		
	Indonesia			0.13	(0.53)	1.04	(0.64)		
	Thailand			-0.52	(0.09)	0.02	(0.04)		
	Philippines			-0.03	(0.10)	0.15	(0.19)		
	Malaysia			0.06	(0.04)	-0.06	(0.04)		
Aizenman et al. (2011)	Eleven IT countries and five non-IT countries	Panel data	Expected inflation and output gap with real exchange rate and reserve change as controls						
IT				0.22	(0.12)	0.03	(0.03)	0.84	(0.02)
Non-IT				0.01	(0.01)	0.02	(0.05)	0.76	(0.03)
Torres and Shepherd (2014) 1996:1 - 2007:12	Mexico	Probit, logit, ordered probit & logit	Contemporaneous and expected inflation and output gaps	Bank of Mexico is forward-looking in setting the corto; exchange rate significant					

6.3 Ghana's Monetary Policy: Contextual Overview

In this section, we describe the objectives of the Bank of Ghana and how it operates. The objective is to provide a contextual overview with the view to aiding interpretation of the empirical results.

6.3.1 Background

The central bank of Ghana - the Bank of Ghana (BoG), has since 1957, when Ghana gained independence, been charged with the responsibility of conducting monetary policy, credit and currency policy. The Bank of Ghana was formally established by the Bank of Ghana Ordinance (No. 34) of 1957. Initially focused on developmental issues, the central bank has witnessed various legislative changes culminating in a refocusing the mandate of the Bank to its current core objective of price stability under the Bank of Ghana Act, 2002 (Act 612) and its amendments in 2016 (Bawumia, 2010).[66]

6.3.2 Mandate of the Bank

The main objective of the Bank's monetary policy is to ensure *price stability* – low inflation, and subject to that, to support the Government's economic objectives including those for growth and employment (BoG website: www.bog.gov.gh). Price stability is defined by the government's inflation target, a target that is typically explicitly stated in the budget statements for each fiscal year.[67] Thus, the objective recognizes the role of price stability in fostering economic stability more generally, and in providing the right conditions for sustainable growth in output and employment. The Bank of Ghana Act 612 (2002) made the Bank

[66] As with other countries, implementation of monetary policy in Ghana has undergone a number of phases, evolving from the controlled regime (with the use of direct instruments) to the use of indirect instruments under the monetary targeting arrangements and currently inflation targeting. The objective of monetary policy – price stability – has remained basically unchanged over time although the degree of emphasis has differed across time. The rationale for shifting from one regime to another has typically reflected a less than satisfaction with the status quo and the quest to improve the conduct of monetary policy.

[67] Before 2014, the targets were often revised to reflect developments in the economy. However, as the authorities recognised that this rather does not help in anchoring inflation expectations, the target was fixed from 2014.

independent to set interest rates. The Bank is accountable to Parliament and the wider public.

6.3.3 Inflation Targeting and Inflation Performance in Ghana

The Bank of Ghana formally adopted inflation targeting (IT) in May 2007, making it the first low-income country and second country in Sub-Saharan Africa (after South Africa) to do so. Although the official announcement was made in 2007, the country had actually started to implement the framework from 2002 during which period further institutional and operational reforms were undertaken to support the framework.[68] The Bank of Ghana was in part, motivated by the passage of the Bank of Ghana Act of 2002, that granted it operational independence, and by the less than satisfactory performance of the then policy framework based on monetary targeting Bawumia *et al.* (2008).

Under the inflation targeting framework, BoG aims at delivering the assigned medium-term inflation target (currently 8±2 percent). This rate is set jointly by the fiscal and monetary authorities, and is expressed in terms of an annual rate of change of the overall consumer price index (CPI).

Although the Bank is not bound by law to explain developments to the Ministry of Finance or to Parliament if the target is not achieved, the Governor of the Bank of Ghana may be summoned by the Finance Committee of Parliament to explain developments within the economy. In practice, the Bank does not target the 8±2 percent inflation at all costs as shocks can cause short-term deviations from the target. When these shocks occur, the Bank is expected to steer interest rates so that inflation can be brought back to the target within a reasonable period of time without creating undue instability in the economy.[69] Moreover, as stated above, the Bank is similarly mandated to pursue policies conducive to growth and prosperity of the

[68] Restructuring of the petroleum sector, opening it up to private sector participation, to remove a major source of quasi-fiscal problems as well as its attendant deleterious impact on the banking system.

[69] The time horizon is not explicitly stated in the Law but it is generally taken to be anything between one to three years.

citizens. This makes the central bank's approach a flexible inflation targeting regime, because while the central bank's main focus is inflation stabilization, it does consider other objectives.

In practice, the conduct of monetary policy is vested in the hands of a Monetary Policy Committee (MPC), established under section 27 of the Bank of Ghana Act 2002, (Act 612). The MPC sets the main monetary policy instrument – the Monetary Policy Rate (MPR) – at its bi-monthly meetings to deliver the inflation target.[70] Chaired by the Governor of the Bank, the MPC typically meets over a two-day period, followed by a press conference on the third day during which a press statement about the decision and general developments is released to the media.[71] The meeting dates for each year are fixed in advance for each ensuing year to allow for predictability by the financial markets. Decisions are made by a vote of the Committee on a one-person one-vote basis, with each member required to clearly articulate why their decision may be the preferred option. The final decision is reached by consensus as disagreements are not announced. In general, policies are tightened when the Committee observes that the upside risks to inflation outweigh the downside risks. Conversely, the Committee loosens monetary policy if downside risks to inflation or poor output performance dominate.

Table 6.2 below provides a summary of the last fifteen MPC decisions and the factors that have influenced the decisions. The MPR was raised four times for a cumulative 600bps and similarly cut four times for a cumulative 500bps. As the Table shows, inflation and output concerns play the prominent role in the setting of the policy rate. Uncertainty in the global economic environment and its effects on the economy, via the impact on the balance of payments for instance are also considered. For virtually all decisions, inflation and inflation expectations, exchange rate dynamics and the current and prospective pace of economic activity have played a prominent role in the setting of the policy rate. In particular, the policy rate is

[70] The MPC consists of seven members – five from the Bank of Ghana and two external members appointed by the Minister of Finance.
[71] The press release is immediately posted on the Bank's website while the transcript of the press conference and more detailed monetary policy and financial stability reports are published later.

raised when these factors pose risks to inflation and output and cut or left unchanged when conditions are favourable.

Table 6.2: Recent Bank of Ghana Monetary Policy Committee Decisions

Decision date	Decision	Current MPR (%)	Reason(s) for decision
Feb. 18, 2015	No change	21.0	*1. Uncertainty in global environment and volatilities in the financial markets; 2. Lower international commodity prices; 3. Pickup in economic activity in Q4; 4. Improved business and consumer sentiments; 5. Lingering energy sector challenges; 6. IMF deal expected to boost investor confidence; 7. Rise in food inflation ahead of the lean season; 8. Rising core inflation (i.e. CPI inflation excluding energy and utility prices).*
May 13, 2015	+1%	22.0	*1. Elevated inflation and inflation expectations; 2. Significant exchange rate pass-through, 3. Upward adjustment in energy and utility prices; 4. Core inflation rising; 5. Challenges in the energy sector, fiscal consolidation, depreciation of the currency weighing down on economic activity; 6. Business sentiments softened but consumer confidence rose; 7. Volatile commodity prices*
July 15, 2015	+3%	24.0	*1. Headline and core inflation continued to rise since the last MPC meeting; 2. Still elevated inflation expectations; 3. Local currency recovered strongly against the major currencies in July 2015; 4. Fiscal consolidation; 5. Vulnerable domestic growth conditions and the impact of the energy crisis; 6. Volatile commodity prices and weak global growth prospects;*
Sept. 14, 2015	+1%	25.0	*1. Persisting inflation pressures; 2. Elevated inflation expectations; 3. Core inflation rising; 4. Significant uncertainty in the domestic FX market; 5. Slower pace of growth; 6. Fiscal consolidation; 7. Adverse effects of elevated volatility in financial markets, uncertainty as to the timing and impact of expected tightening in the Fed's monetary policy and declining commodity prices on the balance of payments and in turn the inflation outlook.*
Nov. 16, 2015	+1%	26.0	*Moderate increase in inflation; inflation expectations far above the medium term target; Core inflation rising; Worsening external financial conditions; Expected increase in utility tariffs; Need to reinforce the relative stability in the FX market; Slower economic activity and growth but expected improve with improvement in energy situation; Fiscal policy within the programme target; Declining commodity prices; High upside risks to the inflation, with a likelihood of a further drift away from the medium term target*

Source: Bank of Ghana. *Core inflation is CPI inflation excluding energy and utility prices

Table 6.2 continued

Decision date	Decision	Current MPR(%)	*Reason(s) for decision*
January 25, 2016	0	26.0	*1. Core inflation rising; 2. Slower pace of growth though expected to rebound with improvement energy situation; 3. Tight monetary and fiscal policy stance; 4. Weak consumer confidence, 5. Weak commodity prices and a slack in global growth; 6. Relatively stable exchange rate*
March 21, 2016	0	26.0	*1. Improvement in the pace of economic activity; 2. Positive consumer and business sentiments; 3. Improvement in energy situation; 4. Increased oil and gas production; 5. Fiscal consolidation; 6. Uncertainties regarding crude oil prices may pose significant risks; 7. Significant volatilities in the commodities and financial markets and tight external financing conditions; 8. Relative stability in the forex market; 9. Risks to inflation and growth outlook balanced.*
May 16, 2016	0	26.0	*1. Broadly positive growth outlook; 2. Faster pace of consolidation; 3. Subdued global growth outlook and tightening financing conditions; 4. Exchange rate stability; 5. Risks to inflation and growth as balanced*
July 18, 2016	0	26.0	*1. Low commodity prices; 2. Relative stability of the local currency and expected improvement in liquidity on the foreign exchange market; 3. Risks to inflation and growth as balanced*
Sept 19, 2017	0	26.0	*Moderation in headline inflation but high still high relative to the medium term target. 2. Stable exchange rate; 3. Expected tighter fiscal consolidation; Lower growth,*
November 21, 2016	-0.5	25.5	*1. Global economy remains fragile with uncertainties; 2. Inflation and underlying inflation declining; 3. Exchange rate stable weak and below trend growth conditions; 4. Declining commodity prices and disruptions in oil and gas production; 5. Fiscal consolidation efforts.*
January 23, 2017	0	25.5	*1. Declining headline, core inflation and inflation expectations; 2. Sharp exchange rate depreciation and its expected impact on inflation; 3. Persistent increases in food inflation and 4. Fiscal slippage of the previous year. 5. Modest growth conditions but with positive prospects; 6. Uncertainties in the global environment.*
March 27, 2017	-2	23.5	*1. Underlying inflation pressures have eased considerably; 2. Growth is likely to remain significantly below potential*
May 22, 2017	-1	22.5	*1. Economic activity picked up but still below potential; 2. Improved business sentiments and easing credit stance; 3. Increased oil production; 4. Expected fiscal consolidation; 5. Headline inflation and inflation expectations trending downwards and exchange rate is stable. Downside risks to growth outweigh the upside risks to inflation in the outlook*
July 18, 2017	-1.5	21.0	*1. Improving economic activity and fiscal policy measures in budget expected to provide further impetus to growth; 2. Inflation declining with stability of the exchange rate expected to reinforce price stability; 3. Low inflation expectations.*

Source: Bank of Ghana. *Core inflation is CPI inflation excluding energy and utility prices

Performance of inflation over the period has been mixed. In general, meeting the targets has been elusive, notwithstanding substantial revisions in some instances.[72] Within a few months after the formal announcement of IT, the global food and energy price shocks of 2007 and early 2008 pushed inflation up. And as these shocks began to unwind in 2008, expansionary fiscal policy created further inflationary pressures. Monetary policy was therefore tightened to dampen the inflationary pressures in a bid to prevent them from spiraling out of control. The developments had followed a period of sustained declines in inflation from over 30 percent in 2003 (when subsidies on domestic petroleum prices were removed) to 10.2 percent in August 2007.

After stabilizing for an extended period (2009 – 2012), inflation again surged in late 2012 when significant fiscal expansion and challenges emanating from weak export commodity prices and their adverse impact on the balance of payments resulted in significant exchange rate depreciation. This significantly pushed up non-food inflation, which together with increased inflation expectations, resulted in a protracted period of tightening by the central bank from between 2012 and 2016. As inflation expectations eased, and fiscal consolidation was being restored under an IMF supported programme, the central bank again began to ease its tight policy stance from Q1 2017 to support real sector activity as real GDP growth rate had significantly decelerated to an almost two-decade low of 3.7 percent in 2016 (Bank of Ghana, 2017).

Thus, establishing and maintaining low and stable inflation remains a significant challenge for monetary policy management in Ghana, some fifteen years after implementing the IT regime (figures 6.2 and 6.3). Figure 6.2 which plots trends in inflation and its components and the exchange rate (defined as local currency per USD, so that an increase is a depreciation) shows that inflation remains high, volatile and typically in double digits. While both food and non-food prices influence the inflation dynamics in the same direction, from mid-2010, non-food prices played a

[72] These revisions have been seen as problematic in the sense that they can hamper the ability of the central bank to anchor expectations.

more prominent role in driving inflation, resulting in significant divergence between food and nonfood inflation. This largely reflected the large exchange rate depreciation during the period. Figure 6.3 shows that the MPR was tightened significantly in response to these exchange and inflation shocks.

In terms of relative performance with other countries, figure 6.4 compares Ghana's inflation performance to a number of selected IT countries. As the figure shows, although inflation declined somewhat from the high levels in the early 2000s, the country continues to record highest rates of inflation and inflation volatility compared with other IT countries. Such problems, which are not uncommon in the inflation-reduction phase of IT, may not necessarily imply that the framework is not working, but possibly reinforces the argument for flexible implementation of IT. Nonetheless, it raises a number of fundamental issues relating to the concerns about the suitability of IT in the country. In a setting of poor policy credibility (possibly from poor past performance) or more generally the ability of the central bank to implement independent policies in the face of significant economic uncertainty and volatility. As noted earlier, if agents do not believe that the monetary authority will be successful in achieving the inflation target, it will be difficult to anchor private sector expectations with respect to wage and pricing of contracts under IT and for the framework to work well. *Even* worse is when the central bank's decisions are arbitrary and not consistent with (theoretical) expectations under the IT framework. We therefore estimate policy reaction function for Ghana to test if poor performance emanated from the nature of policy decisions implemented under the framework.

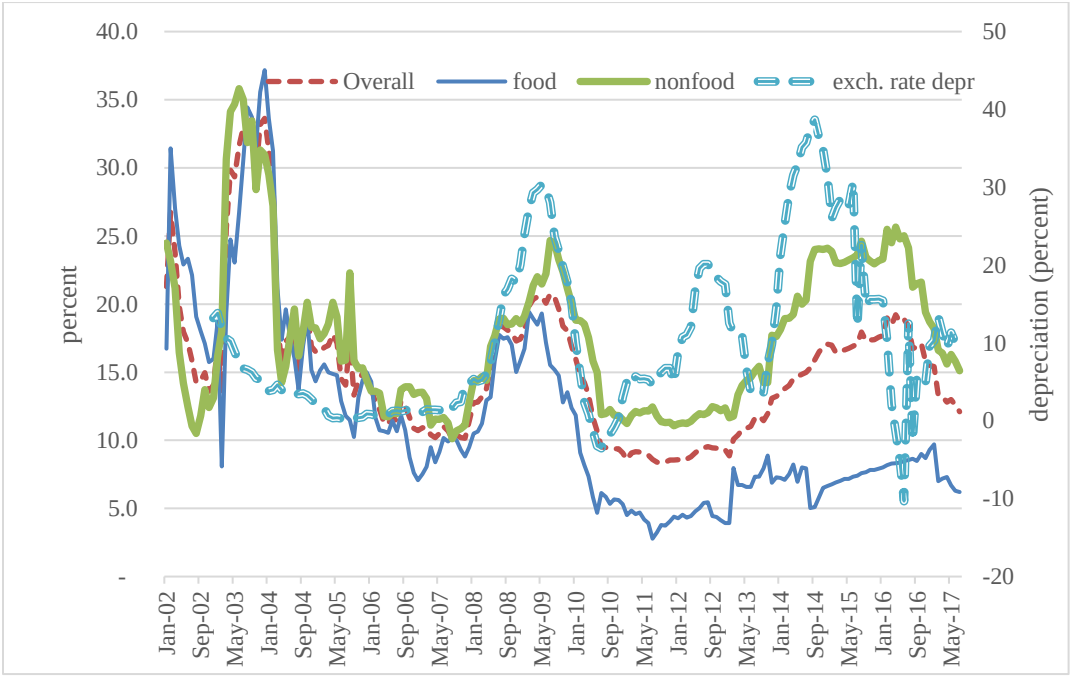


Figure 6.2: Inflation and its Components and Exchange Rate Depreciation

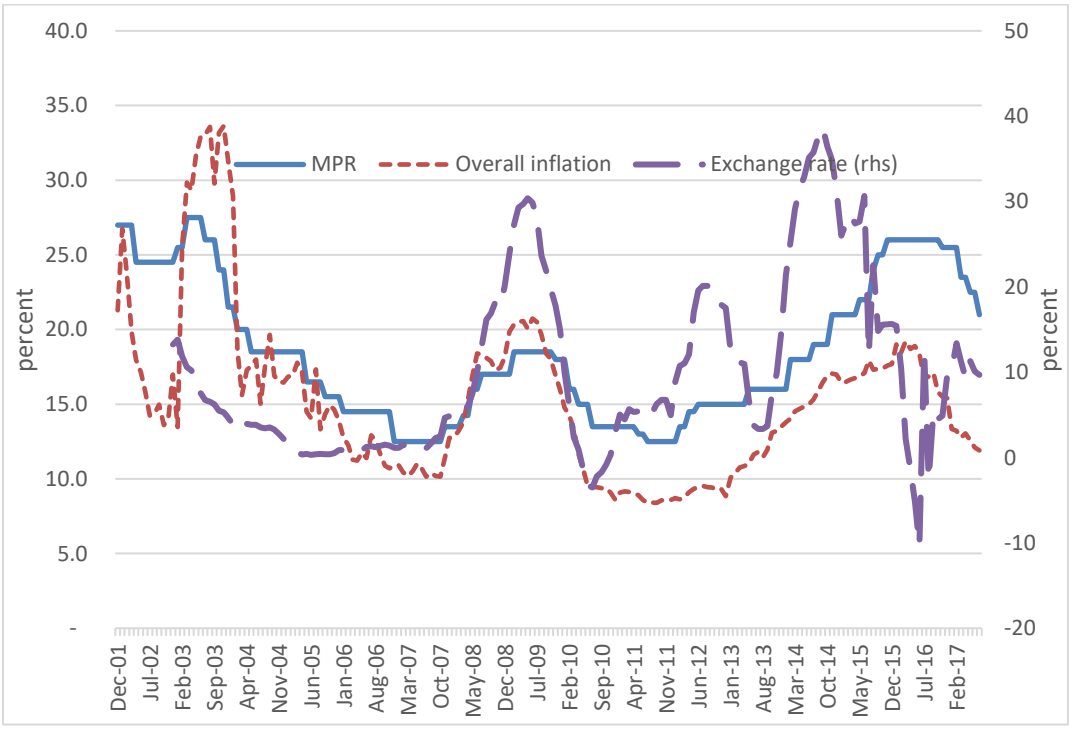


Figure 6.3: MPR, Inflation and the Nominal Exchange Rate Depreciation

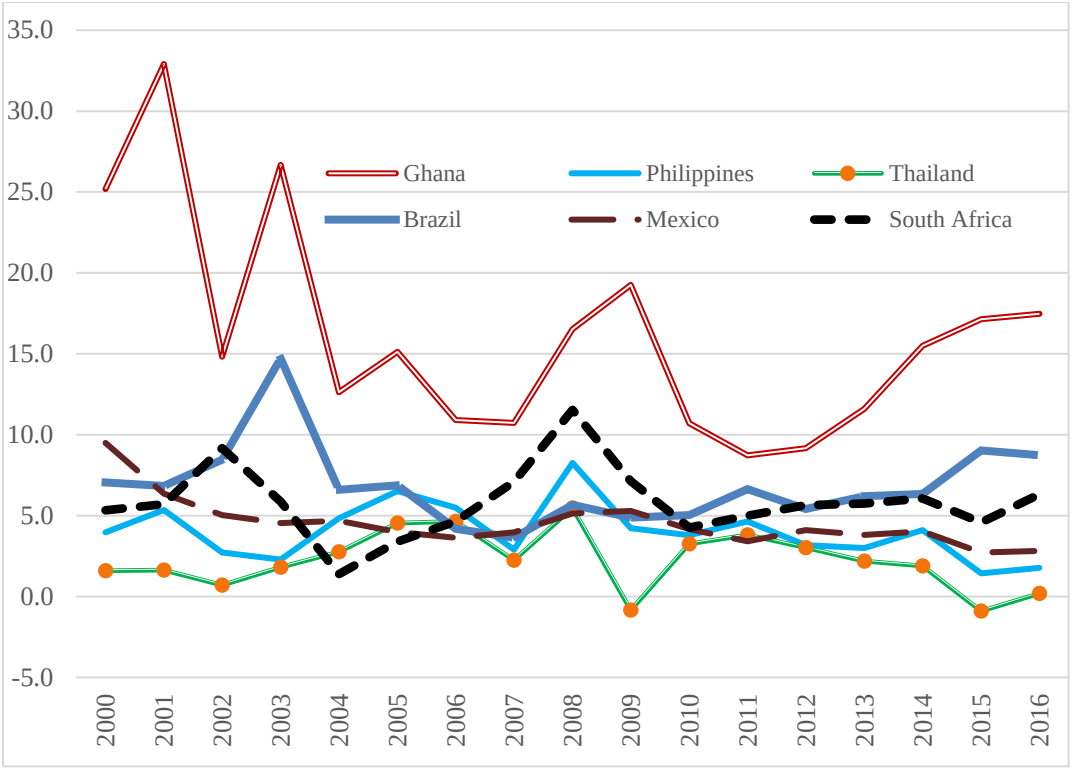


Figure 6.4: Inflation Trends in Ghana and Selected Inflation Targeting Countries

6.4 Empirical Methodology and Data

Our empirical methodology is based on estimating reaction functions for the Bank of Ghana using discrete choice models to analyse the determinants of the probabilities associated with various decisions under its IT regime. To ensure comparison of the 'sign' and 'size' of the estimates with previous studies on monetary reaction functions using standard linear techniques, we also provide OLS estimates of the reaction function for Ghana.[73] As noted earlier, The estimation of central bank reaction functions began with Taylor (1993, 1999) and was further developed by Clarida *et al*. (1998, 2000), amongst others

[73] Generalized method of moments (GMM) estimates are provided in the appendix as robustness checks for the OLS estimates.

6.4.1 The Model

The basic idea is that the central bank sets the policy interest rate (i_t) in reaction to deviations of inflation (π_t) from its target rate (π_t^*), and some measure of the output gap (y_t). Since in practice interest rates tend to be adjusted somewhat gradually, a distinction is made between the actual interest rate and the target rate (i_t^*). The target rate is assumed to be determined as follows:

$$i_t^* = \alpha_\pi(\pi_t - \pi_t^*) + \alpha_y y_t \qquad (6.9)$$

Equation (6.9) shows that the target rate changes in response to the inflation and output gaps. The positive parameters α_π and α_y respectively measure the weight that the central bank places on the deviations of inflation from its target and output from its potential. Theory suggests that the response to the inflation deviation (α_π) should be greater than one, because what matters to aggregate demand (consumption and investment) is the real, not nominal, interest rate. That is, when inflation increases, the central bank, if it wants to lower aggregate demand and output, needs to raise the real interest rate.

The actual interest rate tends to adjust gradually in all countries, and is assumed to be a weighted average of its lagged rate and the target rate:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + \varepsilon_t \qquad (6.10)$$

where $0 < 1-\rho \leq 1$ represents the speed of adjustment. Substituting (6.9) into (6.10) and subtracting the lagged interest rate from both sides yields:

$$\Delta i_t = (1-\rho)\alpha_\pi(\pi_t - \pi_t^*) + (1-\rho)\alpha_y y_t - (1-\rho)i_{t-1} + \varepsilon_t \qquad (6.11)$$

When equation (6.11) is estimated, the inflation coefficient is just the short-run response, which is a combination of the adjustment speed, $1-\rho$ and the long-run response of the target rate to inflation, α_π. In particular, where the adjustment speed

is slow (of the order of 0.1 for most countries), the short-run coefficient will be many times smaller than the implied long-run effect (see Clarida *et al*., 1998, for example).

As pointed out by many studies (for instance Clarida *et al.* 1998, 2000; Dolado *et al.* 2000; Gorter *et al.* 2008), in the presence of sizeable lags and uncertainty about the transmission mechanism of monetary policy, it is appropriate to allow nominal interest rates to react not only to the current but also to expected future deviations of inflation from its target and output from their long-run potential. As seen in Table 6.2, it appears that the Bank of Ghana's monetary policy decisions are closely linked to inflation expectations in particular. Thus, the estimated equation becomes:

$$\Delta i_t = (1-\rho)\alpha_\pi(E_t\pi_{t+k} - \pi_t^*) + (1-\rho)\alpha_y y_t - (1-\rho)i_{t-1} + \varepsilon_t \qquad (6.12)$$

where E denotes the expectation operator. In equation (6.12), the investigator has to make a choice about how to measure inflation expectations. For example they could be derived from surveys of consumers and firms, or from the central bank's own forecasts. In Ghana, the central bank conducts a regular survey of business expectations, as described below, and that is the measure used here.

Other variables might also be included in monetary policy reaction functions. In the case of Ghana, we add the lagged change in the policy rate as well as its level, and we also include the rate of depreciation of the bilateral exchange rate against the US dollar (*X*). The former is to account for the persistence in the change in the policy rate, and the latter is to account for a change in import prices in domestic currency. Then, equation (6.11) (based on current inflation) becomes:

$$\Delta i_t = \beta(\pi_t - \pi_t^*) + \gamma y_t + \varphi i_{t-1} + \delta\Delta i_{t-1} + \psi\Delta X_t + \varepsilon_t \qquad (6.13)$$

where coefficients, β, γ and φ are a composite of parameters (see above). All the coefficients except for φ are expected to be positive. Likewise, equation (6.12) (using inflation expectations) becomes:

$$\Delta i_t = \beta(E_t\pi_{t+k} - \pi_t^*) + \gamma y_t + \varphi i_{t-1} + \delta\Delta i_{t-1} + \psi\Delta X_t + \varepsilon_t \qquad (6.14)$$

When we estimate equations (6.13) and (6.14), the dependent variable may be treated as a continuous variable, or as a discrete variable with three possible values (increase, no change or decrease).[74] In the case where the dependent variable is discrete, the equation is testing only whether the interest rate is moved in a certain direction in response to the independent variables, and it provides no estimate of the magnitude of that response. We provide estimates for both specifications. Further, motivated by reasons for actual monetary policy decisions made by the Bank of Ghana (Table 6.2), for equation (6.13), we consider not only headline current inflation but also components of inflation (core, food, and non-food inflation). Since the target inflation rate is announced and varies over time, we use the difference between the actual (or expected) and target inflation rates as a regressor. The estimation is done for the period 2002(11) to 2017(05) covering the period when the central bank of Ghana implemented an IT framework.

6.4.2 Data

The data used in this study are sourced mainly from the Bank of Ghana (BoG), and start from the inception of the Monetary Policy Committee (MPC) process in 2002 through its 76th meeting in May 2017. The choice of this sample period is determined by the following factors. First, there is ample evidence stating that BoG started to have autonomous control over monetary policy in 2002 with the passage of the BoG Act 2002, (Act 612), granting the Bank independence in the conduct of monetary policy, in contrast with the more accommodating stance in the earlier period (Bawumia, 2010). Moreover, independence to implement monetary

[74] A number of studies, including the recent study of Muñoz Torres and Shepherd (2014) use limited dependent variable techniques to model interest rate setting.

policy paved the way for the adoption of IT in the country.[75] The other factor relates to data constraints. High frequency real sector data in the country started to be developed and compiled by the Bank only from the early 2000s, which again coincides with the study period.[76]

Since the MPC's meetings are typically bi-monthly, we average the data from one meeting to the other in our analysis to gauge the drivers of these policy rate decisions. For instance, for a meeting in January, we average data available for December and January. The interest rate we use is the monetary policy rate (MPR) – the key interest rate set by the MPC at the meetings. These data are mainly sourced from BoG's website or where necessary, from the Ghana Statistical Service website. For the ordered logit and probit regressions, the data are coded as follows: 1 for a cut, 2 for no change and 3 for an increase. Inflation is the 12-month rate of increase in the consumer price index taken from the Ghana statistical service. We also use the food and non-food components of the index separately as well as core inflation (defined as headline inflation excluding energy and utility prices, for which the prices are set by the government).

As an alternative to actual inflation, we use inflation expectations from the business confidence survey reported by the Bank. Given the importance of this variable in the analysis, it may be instructive to shed a little more light on its computation. Broadly, the inflation expectations are derived from the question **"***What is your expectation about the rate of inflation by the end of the year 2017? (Please tick one only)", the options being: 1-9%, 10-15%, 16-20%, 21-25% and 26-30%.* This is one of several questions from a survey the Bank conducts before each round of MPC meeting across key business establishments across the country. Responses to this question are respectively weighted by the mid-points of the

[75] Prior to 2002, the Bank implemented a monetary targeting framework which renders any assessment of its behaviour based on the interest rate inappropriate (see section 6.3).
[76] The Ghana Statistical Service only started to produce quarterly GDP figures from 2006. In the absence of high frequency real sector data, BoG under its IT framework, developed, a monthly Composite Index of Economic Activity (CIEA) in 2002 to measure the pulse of the economy on real time. The index has been widely used both by country authorities (the Ministry of Finance) and external partners (including the IMF).

options provided (that is 5, 12.5, 18, 23 and 28) and summed to derive the business expectation of inflation for the period. To be specific, if in June 2017 the responses were respectively: 21.6% of the respondents choose the range 1-9%, 66% the 10-15% range, 8.8% the 16-20% range, 2% the 21-25% and 1% the 26-30%, the derived inflation expectation for that period will be 11.73%. The index so computed is then compared to the inflation target to derive the expected inflation gap.[77] The process is repeated for every MPC meeting in the course of a particular year, while the date is moved to a new date after the last meeting of year. Since the survey question on inflation expectations is about the actual inflation rate at the end of the year, this implies a shortening of the horizon between the first and final surveys for the year.[78] We test whether this shortening of the horizon in the course of the year makes a difference between the actual and expected inflation across the different quarters of the year. The results are provided are provided in Table D6.1 of appendix and show that there is no significant difference across the quarters.[79]

Output is proxied by the Bank of Ghana Composite Index of Economic Activity (CIEA), a monthly index that measures the level of economic activity. We compute the output gap as a deviation of the Hodrick-Prescott (HP) trend from the actual index[80]. The exchange rate data used are the monthly changes in the nominal Ghana cedi – dollar rates reported by the Bank. These data are also averaged in line with the MPC meetings. As measured, an increase in the exchange rate indicates depreciation of the Ghana cedi.

Finally, to assess whether or not BoG behaves asymmetrically (that is, reacts more strongly to upswings in inflation than downswings (see Dolado *et al.* 2000),

[77] Note that in recent times, the Bank also derives consumer and financial sector inflation expectations but the series for these do not go far back enough.
[78] In the context of equations (6.13) and (6.14), this means that the subscript for the future inflation rate, *k*, becomes smaller over months towards the end of the calendar year.
[79] Specifically, we have tested whether the inflation expectations coefficient has a seasonal pattern that reflects this shortening of the horizon, and have found that it does not.
[80] Hodrick and Prescott (1997) derive the HP trend by minimizing the following equation: $min_{\tau}\{\sum_{t=1}^{\tau}(y_t - g_t)^2 + \lambda\sum[(g_t - g_{t-1}) + (g_{t-1} - g_{t-2})]^2\}$, where y is output, g is growth and $y - g$ is the cyclical component.

we also use zero-one dummy variables for increases or cuts in the policy interest rate in the previous month to test for the possibility of interest rate asymmetries.

Figure 6.5 plots trends in inflation (actual, expected and targets) and the policy rate over the period December 2001 through July 2017. Inflation and inflation expectations have remained typically above the inflation target and the policy rate has normally been raised in response to these pressures. Figure 6.6 similarly plots trends in inflation and its components (food and non-food) for the same period. Clearly, non-food inflation has since the second half of 2007 driven the inflationary trends more, reflecting in some instances imported inflation from the significant depreciation of the local currency.

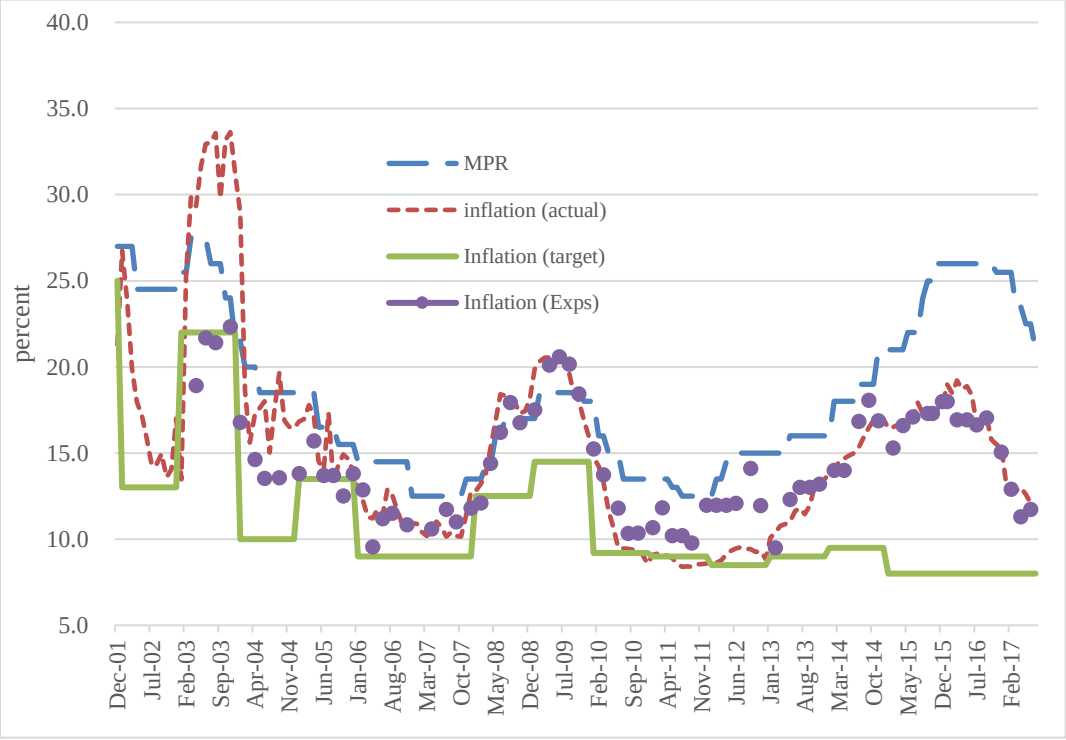


Figure 6.5: Inflation (actual, expectations and targets) and the Policy Rate

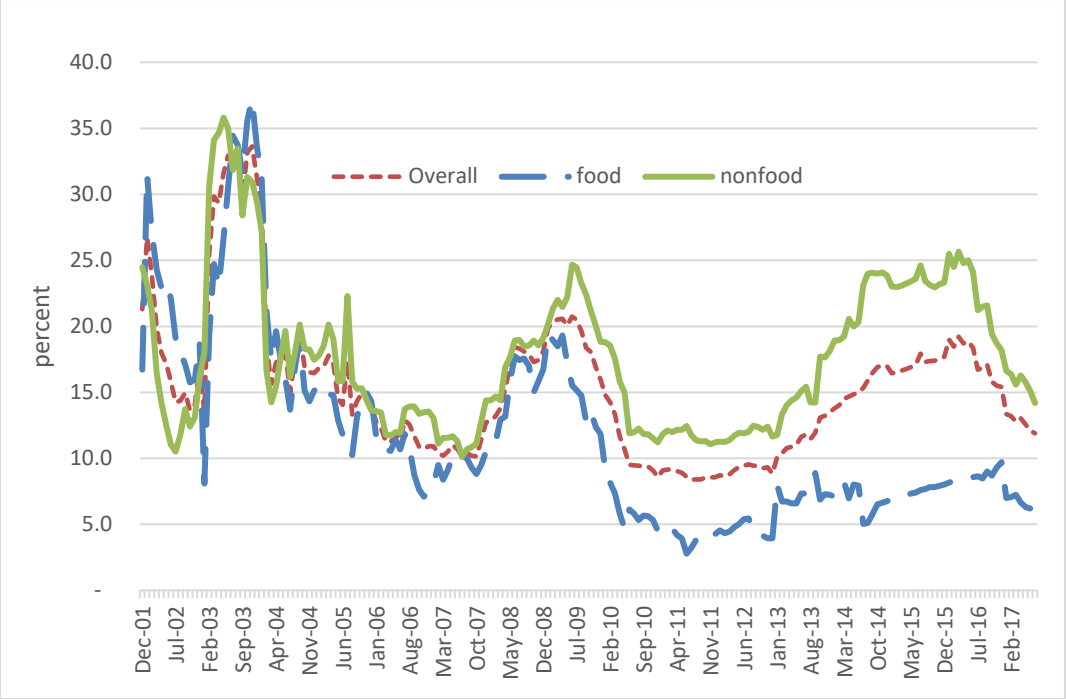


Figure 6.6: Overall, food and non-food inflation

Table 6.3 provides summary statistics of the variables. As can be seen from the Table, interest rates have typically been high in Ghana, with the central bank key interest rate, the monetary policy rate, ranging between 12.5 and 27.5 percent over the period of this study. The high interest rates in part reflected the high and volatile rates of inflation over the period (figure 6.5). Inflation averaged 15 percent, exceeding the target for the period by 4.1 percent, which alongside the high inflation volatility, has given rise to significantly high inflation expectations (as measured by businesses) also typically above the inflation targets. During the sample period, the MPC made 76 policy rate decisions, more than half of which were the decision to leave interest rates unchanged. For 18 percent of the time, the decision was to hike the policy rate while for 24 percent of the time, the policy rate was cut, both by between 50 and 250 basis points. What factors are behind these decisions? We examine the drivers of these decisions more closely in the following sections.

Table 6.3: Descriptive Statistics, 2002(11) - 2017(05)

Variable	*Mean or sample (%)*	*sd*	*min*	*max*
Policy rate	18.1	4.7	12.5	27.5
Changes	-0.1	0.9	-2.5	2.0
Distribution of MPR changes				
No change	**58 (%)**			
Increase	**18 (%)**			
by: 0.5	1.3 (%)			
by: 0.75	1.3 (%)			
by: 1	10.5 (%)			
by: 1.75	1.3 (%)			
by: 2	4.0 (%)			
Decrease	**24 (%)**			
by: -0.5	5.3 (%)			
by: -1	5.3 (%)			
by: -1.5	5.3 (%)			
by: -2	6.6 (%)			
by: -2.5	1.3 (%)			
Increase/Decrease	**42 (%)**			
Inflation				
actual	15.0	5.7	8.4	33.2
actual_food	10.9	6.9	3.2	35.6
actual_non-food	17.8	5.9	10.7	35.8
target	10.9	3.8	8.0	22.0
gap†	4.1	3.8	-8.5	11.2
expected (businesses)ɧ	14.5	3.2	9.5	22.3
gap_expected‡	3.9	3.0	-3.1	10.0
CIEA‼				
real index	267.7	112.5	107.0	463.6
output gap	-0.1	12.3	-26.2	23.7
output gap (log)	0.00	0.05	-0.09	0.11
Exch. rate (Ghana cedis per USD)	1.8	1.1	0.8	4.3
depreciation against USD (log diff)	0.02	0.05	-0.1	0.2
fiscal balance	-6.1	2.7	-11.5	-2.0
Observations	76			

Notes: Inflation gap is the difference between actual and target inflation. ɧ Inflation expectations of key business establishments across the country conducted and reported by Bog. ‡ is deviation of expected inflation from the target. ‼ Composite Index of Economic Activity.

6.5 Empirical Results

In this section, we present the estimation results of equations (6.13) and (6.14) using the interest rate decisions of 76 MPC meetings from November 2002 to May 2017. Three different models are presented. Model 1 is a simple OLS estimation of equations (6.13) and (6.14), whereas Models 2 and 3 respectively use ordered logit and ordered probit estimators. The dependent variable in all models is the change in the policy rate. For Model 1, this dependent variable is a continuous variable, while for Models 2 and 3, the dependent variable is a categorical variable, coded according to the following ordering: 1 for decrease, 2 for no change and 3 for an increase. These discrete choice models have been used in some previous work (for example, Muñoz Torres and Shepherd, 2014) and are useful for modeling the direction rather than the size of policy actions.[81] The goodness of fit is measured by the Adjusted R-squared or Pseudo R-squared and Pseudolikelihood ratio.

6.5.1 Baseline Estimation

As a baseline, we estimate the models in which the independent variables are the current inflation gap (current minus target inflation), the output gap as in Taylor (1999), the depreciation rate of the Ghana cedi against the United States Dollar, lagged policy rate changes and the lagged level of the policy rate (see equation (6.13)). Here, the current inflation gap is calculated using the headline (overall) current inflation rate. The prior expectation of both the inflation gap and output gap is that an increase in these gaps should trigger a hike in the policy rate (that is a positive coefficient).[82] Similarly, since an increase in the exchange rate represents depreciation (as defined), the coefficient is expected to be positive. We include the lagged dependent variable and its level (as explained earlier in section

[81] To clarify, the use of discrete choice models is justifiable particularly in the context where adjustments in the policy instrument occur in small steps, including the corto system in Mexican monetary policy (according to Muñoz Torres and Shepherd, 2014).
[82] In fact, the Taylor principle requires a more than proportionate change in response to inflation shocks so that real interest rates are increased. This is what is expected in the context of IT under standard under linear estimation techniques (Model 1).

6.4) to capture smoothing or stepping in adjustments of the policy rate and to control for historically high interest rates in Ghana.

The results are shown in Table 6.4. In Model 1, where the dependent variable is the actual interest rate change, all the variables have the expected signs, but they are generally not significant with the exception of lagged policy rate changes which is significant at the 1% level. The difference between 12-month actual inflation and the target has a positive coefficient that is not significant, and in magnitude it is only 0.001, which implies that in the short run nominal interest rates rise by only 0.1% of the magnitude of any positive inflation shock, and therefore real interest rates fall. To obtain the estimated long-run reaction of interest rates to an inflation shock, however, we have to divide 0.001 by minus one times the coefficient of the lagged policy rate, which is -0.03, and this yields a long-run coefficient of 0.033. Since the absolute magnitude of this coefficient, though positive, is virtually zero rather than being greater than one as suggested by the *Taylor principle*, this implies in the long run nominal interest rates rise by only 3.3% of the magnitude of any positive inflation shock, and therefore real interest rates fall. This suggests that the current inflation gap is not exerting much influence on the MPC decisions about the policy rate, a result that appears somewhat puzzling at first sight given that the Bank's primary objective is inflation stabilization under its IT regime. However, as will become clear later, it may possibly suggest that the Bank was basing its policy decisions on other measures of inflation (for instance forecast inflation rather than current inflation given the lags in the transmission mechanism of monetary policy). We return to this point later. The output gap and exchange rate depreciation also have positive coefficients, but they are not statistically significant. However, the lagged policy rate changes is significant at the 1% level, underscoring the role of inertia in the policy rate decisions.

In the second and third columns of Table 6.4, results are presented for an ordered logit and an ordered probit, with the dependent variable taking only three possible values: decrease (one), no change (two) and increase (three). The current inflation gap remains statistically insignificant, and with a negative sign. On the

other hand, the output gap and depreciation of the local currency broadly play a statistically significant role in determining the likelihood of changes in the monetary policy rate; and with the expected signs.

Table 6.4: OLS and Ordered Logit and Ordered Probit Estimates of Monetary Policy Reaction Function for Ghana (2002:11 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation less target[1]	0.001	-0.03	-0.02
	(0.01)	(-0.20)	(-0.23)
Output gap[2]	2.76	12.23**	7.37**
	(1.06)	(2.00)	(2.18)
Depreciation against USD[3]	4.00	14.08***	8.36***
	(1.65)	(2.75)	(2.74)
Lagged policy rate (%)	-0.03	-0.04	-0.02
	(-0.72)	(-0.36)	(-0.41)
Lagged policy rate change	0.38***	1.63***	0.97***
	(3.21)	(3.91)	(4.09)
Constant	0.34		
	(0.65)		
cut1			
Constant		0.88	0.59
		(0.49)	(0.66)
cut2			
Constant		4.74***	2.87***
		(2.60)	(3.16)
Adj R-square	0.24		
Pseudo R-squared		0.23	0.24
Pseudolikelihood	-87.08	-56.13	-55.45
Observations	75	75	75

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of actual inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter
3. Monthly change in local currency units/$ (+depreciation/-appreciation)

Further, we investigate whether increased commitment to anti-inflation policies through announcement of strict IT by the Bank since May 2007 has made any difference to the behaviour of the MPC. To do this, we construct a dummy variable that takes the value 1 from May 2007 when the announcement was made and 0 otherwise. We interact this dummy variable with the inflation gap to examine if the Bank changed its behaviour regarding inflation. The results are provided in Table 6.5, and show that the interaction term is highly significant in all models while the coefficients for the other variables remain broadly similar to those in table 6.4. The positive and statistically significant coefficient for the interaction term indicates that the likelihood of changing the policy rate in response to inflation shocks increased from May 2007 relative to the period before. For Model 1, this yields a long-run coefficient of 2.60, significantly above one, with the implication that monetary policy in Ghana is consistent with theoretical prescriptions for successful inflation targeting. Thus, the Bank adopted a more aggressive stance in its anti-inflation policies from May 2007. On the other hand, the coefficient for the inflation gap variable is now negative and generally insignificant, implying that inflation shocks played little role in the decisions of the MPC prior to May 2007.

Moreover, as in the earlier table, the lagged policy rate changes remains significant throughout, implying significant inertia in interest rates decisions. Following Gascoigne and Turner (2004) and Dolado *et al.* (2000), we shed more light on the nature of this inertial behaviour by investigating whether or not the BoG behaves asymmetrically (that is, reacts more strongly to upswings in inflation than downswings). We use zero-one dummy variables for increases or cuts in the policy interest rate in the previous month to test for the possibility of interest rate asymmetries. The results are provided in Table D6.2 in appendix D and show that the inertia is particularly significant when the Bank is on the policy easing cycle but not when policies are being tightened.

Table 6.5: OLS and Ordered Logit and Ordered Probit Estimates including Strict IT Dummy

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation less target[1]	-0.05	-0.20*	-0.11
	(-1.28)	(-1.83)	(-1.59)
Output gap[2]	3.54	17.20***	9.81***
	(1.38)	(2.65)	(2.72)
Depreciation against USD[3]	3.07	12.33**	7.25**
	(1.30)	(2.32)	(2.41)
Lagged policy rate (%)	-0.05	-0.14	-0.07
	(-1.38)	(-1.55)	(-1.35)
Lagged policy rate change	0.31**	1.47***	0.90***
	(2.38)	(3.07)	(3.41)
Strict IT dummy	-0.39	-1.82*	-0.96*
	(-1.10)	(-1.78)	(-1.71)
Strict IT dummy x Inflation less target	0.13**	0.42**	0.23**
	(2.00)	(2.37)	(2.30)
Constant	0.90		
	(1.33)		
cut1			
Constant		-2.04	-0.87
		(-0.99)	(-0.75)
cut2			
Constant		2.10	1.52
		(1.13)	(1.42)
Adj R-square	0.29		
Pseudo R-square		0.28	0.29
Pseudolikelihood	-83.71	-52.38	-52.10
Observations	75	75	75

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of actual inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter
3. Monthly change in local currency units/$ (+depreciation/-appreciation)

Since the preceding tables indicate that the Bank adopted a more aggressive stance to the fight against inflation from 2007, we now focus on this period in the next set of regressions in analyzing the behaviour of the Bank. We start by re-estimating the baseline regression from 2007 and repeating the exercise to analyse reaction to core inflation (defined as CPI inflation excluding energy and utility prices), food and non-food price shocks and reaction to expected inflation.

Table 6.6 provides the results of the baseline regression focusing on the period from May 2007 when strict inflation targeting was adopted. The difference between 12-month actual inflation and the target has a positive coefficient that is significant at the 5% level, but in magnitude it is only 0.147, which implies that in the short run nominal interest rates rise by only 15% of the magnitude of any positive inflation shock, and therefore real interest rates fall. The estimated long-run reaction of interest rates to an inflation shock is 1.47. Since this comfortably exceeds one, the implication is that monetary policy in Ghana is consistent with theoretical prescriptions for successful inflation targeting. The output gap and exchange rate depreciation also have positive coefficients, with the former being significant at the 10% level.

In the second and third columns of Table 6.6, results are presented for an ordered logit and an ordered probit. The coefficients are all more statistically significant than for Model 1 (indeed almost all are significant at the 5% level), which suggests that the model is better at explaining the direction than the magnitude of an interest rate change.

Table 6.6: OLS and Ordered Logit and Ordered Probit Estimates of Monetary Policy Reaction Function for Ghana (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation less target[1]	0.147**	0.443**	0.263**
	(2.18)	(2.35)	(2.43)
Output gap[2]	5.62*	21.23**	11.81**
	(1.77)	(2.10)	(2.21)
Depreciation against USD[3]	2.46	11.99*	6.97**
	(1.04)	(1.94)	(2.02)
Lagged policy rate (%)	-0.10*	-0.30**	-0.18**
	(-1.71)	(-2.19)	(-2.15)
Lagged policy rate change	0.10	1.41**	0.83**
	(0.80)	(2.13)	(2.27)
Constant	1.05		
	(1.34)		
cut1			
Constant		-2.75	-1.64
		(-1.15)	(-1.15)
cut2			
Constant		2.13	1.19
		(0.87)	(0.81)
Adj R-square	0.37		
Pseudo R-squared		0.34	0.35
Pseudolikelihood	-46.27	-32.43	-32.07
Observations	52	52	52

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of actual inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter
3. Monthly change in local currency units/$ (+depreciation/-appreciation)

6.5.2 Results Based on Core Inflation

Table 6.7 provides estimates for the response to core (underlying) inflation defined as headline inflation excluding energy and utility prices, for which the prices

are set by the government. As Table 6.2 indicates, core inflation is quite frequently mentioned by the bank in policy statements. Compared to Table 6.6, in the first column of Table 6.7 the inflation coefficient is slightly smaller (0.127 compared with 0.147) and the output gap coefficient larger (7.65 compared with 5.62). However, the coefficient of the lagged policy rate is also slightly smaller (-0.09 instead of -0.10), which means that the estimated long-run inflation coefficient of 0.127/0.09=1.41 is similar to that in Table 6.6. Discrete choice models (Models 2 and 3) give similar results to Table 6.6, confirming that the direction of policy decisions estimated using Model 1 is robust.

Table 6.7: Estimates Based on Core Inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation (core) less target[1]	0.127**	0.619***	0.335**
	(2.22)	(2.59)	(2.46)
Output gap[2]	7.65**	29.36***	16.80***
	(2.45)	(3.03)	(3.25)
Depreciation against USD[3]	3.58	18.14**	9.85**
	(1.42)	(2.41)	(2.55)
Lagged policy rate (%)	-0.09*	-0.45**	-0.24**
	(-1.70)	(-2.42)	(-2.31)
Lagged policy rate change	0.19*	1.78***	1.00***
	(1.92)	(2.88)	(3.01)
Constant	1.06		
	(1.43)		
cut1			
Constant		-4.69*	-2.41
		(-1.70)	(-1.55)
cut2			
Constant		0.52	0.47
		(0.22)	(0.33)
Adj R-square	0.34		
Pseudo R-squared		0.38	0.38
Pseudolikelihood	-47.27	-30.64	-30.72
Observations	52	52	52

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of core inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter

3. Monthly change in local currency units/$ (+depreciation/-appreciation)

6.5.3 Response to Food and Non-food Inflation

Next we test if monetary policy responds differently to food and non-food price shocks. Food tends to have a large weight in the consumer price index in low-income countries, which may make food prices politically sensitive, but it does not follow that monetary policy should focus on them. Since food price shocks are likely to be temporary, non-food prices may be a better measure of underlying inflation trends which monetary policy should target. In other words, non-food price inflation is likely to be more persistent than food price inflation.

Table 6.8 provides results allowing for a different response to food and non-food inflation shocks. It can be seen that non-food prices always have a much larger coefficient than food prices; in Model 1 the non-food price coefficient is four times as great as the food price coefficient, and in Models 2 and 3 only non-food prices are significant. These results suggest that the MPC recognizes that current non-food price inflation is more likely to persist into the future than food price inflation.

Table 6.8: Response to Food and Non-food Inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation_food less inflation target[1]	0.022	0.082	0.058
	(0.57)	(0.55)	(0.71)
Inflation_nonfood less inflation target[1]	0.091*	0.248*	0.143**
	(1.96)	(1.90)	(2.01)
Output gap[2]	6.19*	22.40**	12.43**
	(1.97)	(2.25)	(2.39)
Depreciation against USD[3]	2.39	11.93*	6.87**
	(1.01)	(1.90)	(2.00)
Lagged policy rate (%)	-0.08	-0.24*	-0.14*
	(-1.58)	(-1.95)	(-1.91)
Lagged policy rate change	0.11	1.44**	0.85**
	(0.80)	(2.18)	(2.32)
Constant	0.74		
	(1.07)		
cut1			
Constant		-1.61	-0.97
		(-0.76)	(-0.76)
cut2			
Constant		3.22	1.82
		(1.44)	(1.35)
Adj R-square	0.36		
Pseudo R-squared		0.34	0.34
Pseudolikelihood	-46.23	-32.70	-32.38
Observations	52	52	52

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of food or nonfood inflation from target inflation
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter

3. Monthly change in local currency units/$ (+depreciation/-appreciation)

6.5.4 Results Based on Expected Inflation

Following Gorter *et al.* (2008), we test if expected inflation and output play any important role in the decisions of the Bank of Ghana regarding the setting of its key policy rate. As in the preceding section, three models are estimated. However, we use forecast inflation proxied by inflation expectations of the business sector constructed by the central bank.[83] For the output gap, we use the deviation of the CIEA from its Hodrick-Prescott trend.[84]

The results are reported in Table 6.9. The short-run coefficient of the expected inflation gap is positive and highly significant in all models. In Model 1, the short-run expected inflation coefficient of 0.193 is some 30% greater than the 0.147 estimated for actual inflation in Table 6.6. With a lagged policy rate coefficient of 0.09, the estimated long-run coefficient is 0.193/0.09=2.14, substantially greater than for actual inflation in Table 6.6. This suggests that the Bank takes more notice of expected inflation than of historical 12-month inflation, in line with the frequent reference to inflation expectation in the press statements (Table 6.2). In Models 2 and 3, the expected inflation coefficient is about twice as large in Table 6.9 as in Table 6.6. The output gap has similar coefficients to Table 6.6, but depreciation against the US dollar is less significant, which suggests that it is a factor that is already taken into account in business expectations.

[83] Section 6.4 provides a comprehensive review of how this is computed.
[84] See section 6.4.

Table 6.9: OLS and Ordered Logit and Ordered Probit Estimates using Forecast Inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	***Continuous***	***1: decrease, 2: no change, 3: increase)***	
Inflation exp less target[1]	0.193**	0.910***	0.516***
	(2.56)	(2.62)	(2.96)
Output gap[2]	5.49*	19.77**	11.41**
	(1.91)	(2.03)	(2.20)
Depreciation against USD[3]	1.68	7.97	4.75
	(0.59)	(0.95)	(1.11)
Lagged policy rate (%)	-0.09**	-0.46**	-0.26***
	(-2.11)	(-2.57)	(-2.81)
Lagged policy rate change	0.04	1.03	0.63
	(0.33)	(1.40)	(1.59)
Constant	0.63		
	(1.26)		
cut1			
Constant		-4.09	-2.26
		(-1.53)	(-1.58)
cut2			
Constant		1.27	0.87
		(0.50)	(0.62)
Adj R-square	0.40		
Pseudo R-squared		0.40	0.41
Pseudolikelihood	-45.17	-29.61	-29.17
Observations	52	52	52

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of expected inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter
3. Monthly change in local currency units/$ (+depreciation/-appreciation)

6.5.5 Summary of results and discussion

Having estimated variants of monetary policy reaction functions for Ghana, our conclusion is that the Bank of Ghana's monetary policy decisions under formal inflation targeting (2007-2017) have not been significantly different from those of countries that are successful inflation targeters. Specifically, interest rates react in the long run more than in proportion to inflation shocks, and the MPC takes particular notice of the more persistent components of inflation (non-food inflation in particular) and of survey data on inflation expectations in its decisions. Results from discrete choice models indicate that the results are robust, at least in terms of the direction of monetary policy adjustments.

Then, the natural question is: if the Bank's policy reactions are consistent with successful IT performance, what explains the actual failure to reduce the average inflation rate? Although a formal investigation of this question is beyond the scope of this study, we present one conjecture here. Notice that what stands out in the case of Ghana is the Bank's apparent failure to anchor inflation expectations, which are substantially higher than official target inflation: Table 6.3 (above) shows that while the sample mean of target inflation is 10.9%, the mean of expected (and actual) inflation is 14.5% (15.0%). Figure 6.5 further highlights this deviation of expected inflation from the target, showing that inflation expectation has been persistently above the target. The indication is thus that private agents clearly do not find the target plausible, which, in turn, naturally makes it difficult for the Bank to reduce actual inflation.

However, why may private agents find that the target is not plausible? One conjecture is that agents may perceive that the Bank's prime objective of price stability is somewhat compromised irrespective of the Bank's sound reactions to various economic shocks. Specifically, in the light of the emphasis in the literature on the absence of fiscal dominance (i.e., the subordination of monetary policy to fiscal requirements) as a key pre-requisite for successful IT performance (cf. Masson et al., 1998), any hint of fiscal dominance may prompt agents to think that the Bank's pledge to control inflation is not credible. In Ghana the fiscal deficit

increased massively from below 5% of GDP in 2011 to over 11% of GDP in 2012, and this coincided with the beginning of a significant upward trend in both actual and expected inflation that lasted until 2015.

In Table 6.10 we present regression results where inflation expectations are regressed on current inflation, the output gap, exchange rate depreciation and the fiscal balance. As Figure 6.5 suggests, inflation expectations are highly correlated with the current inflation rate, and this is the only variable that is significant at the 5% level. The output gap and exchange rate depreciation have the expected positive signs, and depreciation is significant at the 10% level. In Model 1 the current-year and previous-year fiscal balance are included separately. The current-year balance has the expected negative coefficient, indicating that a higher deficit is associated with increased inflation expectations, and the previous-year balance has a positive coefficient of similar magnitude. This suggests that inflation expectations respond to the change in the fiscal balance, and this is the specification used in Model 2. The change in the fiscal balance has the expected negative sign, although it is not statistically significant.

There is thus some weak support for the hypothesis that Ghana still has a fiscal dominance problem, in spite of the adoption of inflation targeting, and that this has some influence on inflation expectations. We leave a formal investigation of this hypothesis to future work.

Table 6.10: Determinants of inflation expectations

Dependent variable: expected percentage inflation rate	Model 1	Model 2
Constant	4.090***	4.074***
	(6.13)	(7.80)
Current inflation	0.745***	0.745***
	(19.65)	(20.12)
Output gap	4.792	4.804
	(1.31)	(1.32)
Depreciation against USD	5.504*	5.481*
	(1.78)	(1.77)
Fiscal balance/GDP (%, current year)	-0.076	
	(-1.00)	
Fiscal balance/GDP (%, 12 months lag)	0.079	
	(1.39)	
Change in Fiscal balance/GDP		-0.077
		(-1.35)
Observations	52	52
Adj R-squared	0.89	0.90

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively.** The expected percentage inflation rate is derived from the business survey as described in the text. For other variables see notes to Table 6.6.

6.5.6 Marginal Probability Effects

One challenge with limited dependent variable models is that the parameter estimates do not measure marginal effects of changes in the independent variables in the same way as they do in standard linear regression models with continuous variables. Since the parameter estimates and their significance provide unclear effects on the intermediate categories, calculation of the marginal effects in these models is important to clarify how the intermediate variables affect the choice order. The marginal probability effects for the results in Tables 6.6 and 6.9 are provided in Table D6.3 in appendix D.

In general, the results show that inflation shocks, the output gap and depreciation of the local currency significantly affect the probability of changing the

policy rate consistent with flexible IT; and as expected, the results are broadly similar for the probit and logit models and also consistent with the coefficient estimates. In particular, an increase in inflation or forecast (expected) inflation deviation both increases the probability of raising the MPR and decreases the probability of cutting the MPR. Similarly, an increase in the output gap raises the probability of increasing the MPR or reduces the probability of decreasing the MPR. Depreciation of the local currency does not influence the probability of changing the policy rate especially when expected inflation is considered as noted earlier.

Finally, the results show that the historically high interest rates raise the probability of reducing the monetary policy rate and decrease the probability of increasing the rates. The estimated probabilities at means are 0.06 (decrease), 0.83 (no change) and 0.11 (increase) in the case of the ordered logit model using current inflation and these remain similar for the ordered probit model and also when expected inflation is considered.

6.5.7 Further Robustness Checks: GMM Estimates

To check robustness of the estimates in which we used OLS, we re-estimate the model based on the generalized method of moments (GMM) technique (Clarida *et al.* 1998). As argued by Clarida *et al.* (1998) and other studies, estimating the model involving expected explanatory variables creates potential endogeneity challenges because the error term will be correlated with the endogenous regressors. To take account of this potential endogeneity problem in the lead variables, we use the GMM technique to check robustness of our estimates.[85] The results which are provided on Table D6.4 in appendix D show that these are broadly similar to those of the OLS.

[85] The instrument set includes three lagged values of the inflation and output gaps, and the exchange rate depreciation variables similar to Clarida *et al*. (1998). In our case however, this approach may be the best give the short sample we use here.

6.6 Conclusion

Ghana stands out as an inflation-targeting country where inflation has been persistently some way above the target. The question posed here was whether that could be attributed to the conduct of monetary policy. To our knowledge this is the first study to estimate monetary policy reaction functions for Ghana under the formal IT regime of the post-2007 period.

We find that the reaction function in Ghana is remarkably similar to that estimated for countries where monetary policy is regarded as successful. Since 2010 real interest rates have been consistently positive, and the estimated long-run reaction of interest rates to inflation shocks is well above the theoretically recommended threshold of one. Moreover, the details of the inflation response are also consistent with theory. More notice is taken of non-food price inflation, which is more persistent than food price inflation, and therefore a better indicator of future inflation. More notice is also taken of expected inflation as revealed by the Bank's regular survey of business than of historical inflation. The speed of adjustment is similar to that in the advanced countries.

Moreover, irrespective of the specification (whether using current inflation or forecast inflation), the output gap plays some significant role in determining the probability of changing the policy rate which implies some concern for output growth independent of its impact on inflation. This finding is consistent with Bawumia (2010) who justifies this behaviour as reflecting the context (a major financial and economic crisis and significant domestic energy challenges) in which these policies were pursued. Interestingly, this is not the case for the exchange rate, which plays a particularly significant role only under the specification using current inflation. Thus, the implication is that in so far as BoG responds to the exchange rate, it does so because of its implications for future inflation, not because it is concerned with maintaining any particular value especially after 2007.

We also find some evidence of asymmetric behaviour on the part of the central bank during the easing cycle, a behaviour that possibly reflects a general tendency to reduce historically high interest rates in the country.

Our findings naturally raise the question of why inflation has not been closer to the Bank's target despite the apparently sound monetary policy reactions. A thorough investigation of this issue is beyond the scope of this paper, but there is some indication that Ghana still has a fiscal dominance problem that may be affecting inflation expectations.

We also find some evidence of asymmetric behaviour on the part of the central bank during the easing cycle, a behaviour that possibly reflects a general tendency to reduce historically high interest rates in the country.

Appendix D

Table D6.1: Regression Results of Difference between Actual and Expected Inflation over the Quarters

Actual less expected inflation‡	*Model 1*	*Model 2*
Quarter 1	-0.453	-0.439
	(-0.81)	(-0.79)
Quarter 2	-0.219	-0.181
	(-0.38)	(-0.31)
Quarter 3	-0.054	-0.036
	(-0.10)	(-0.07)
Subsidy removal dummy (2003)	6.834***	6.424***
	(9.53)	(7.90)
Trend		-0.011
		(-1.06)
Constant	1.580***	2.056***
	(3.82)	(3.38)
R-squared	0.58	0.59
Adjusted R-squared	0.56	0.56
Observations	73	73

Notes: *t*-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. Dependent variable is actual at end of year less expected inflation
‡. Dependent variable is the absolute difference between the actual end-year inflation and expected inflation) across the quarters of the survey

Table D6.2: Table D6.2: Estimates using Actual Inflation with Asymmetry

Model	*Ordered logit*	*Ordered probit*
Dependent variable: Δ in policy rate	***1: decrease, 2: no change, 3: increase)***	
Inflation exp less target	0.430**	0.253**
	(2.20)	(2.28)
Output gap	21.32**	11.79**
	(2.11)	(2.21)
Depreciation against USD	11.58*	6.78**
	(1.86)	(1.96)
Lagged policy rate (%)	-0.289*	-0.171**
	(-1.95)	(-1.96)
Dummy (lagged policy rate increase)	1.003	0.614
	(1.06)	(1.22)
Dummy (lagged policy rate decrease)	-2.004**	-1.170**
	(-2.04)	(-2.09)
cut1		
Constant	-5.698***	-3.328***
	(-2.59)	(-2.63)
cut2		
Constant	-0.778	-0.485
	(-0.37)	(-0.40)
Adj R-square		
Pseudo R-square	0.35	0.36
Pseudolikelihood	-32.16	-31.82
Observations	52	52

Notes: Robust t-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

1. Deviation of expected inflation from target rate
2. Measured as deviation of log composite index of economic activity from potential derived from HP filter
3. Monthly change in local currency units/$ (+depreciation/-appreciation)

Table D6.3: Marginal Probability Effects for the Ordered Regression

	Actual inflation			Expected inflation		
	Decrease	***No change***	***Increase***	***Decrease***	***No change***	***Increase***
Ordered logit						
Inflation exp less target	-0.024	-0.018	0.043	-0.041	-0.030	0.072
	-1.54	-0.95	(2.02)**	(1.75)*	-0.87	(2.17)**
Output gap	-1.169	-0.884	2.053	-0.899	-0.655	1.554
	(2.08)**	-0.81	(1.76)*	-1.56	-0.85	(1.89)*
Depreciation against USD	-0.661	-0.499	1.16	-0.363	-0.264	0.627
	-1.6	-0.86	(1.71)*	-0.92	-0.6	-0.87
Lagged policy rate (%)	0.016	0.012	-0.029	0.021	0.015	-0.036
	-1.49	-0.93	(1.85)*	(1.74)*	-0.85	(2.04)**
Lagged policy rate change	-0.078	-0.059	0.137	-0.047	-0.034	0.081
	-1.64	-0.86	(1.74)*	-1.17	-0.73	-1.23
Sample frequencies	0.237	0.579	0.184	0.237	0.579	0.184
Probability at the means	*0.06*	*0.83*	*0.11*	*0.05*	*0.87*	*0.09*
Ordered probit						
Inflation exp less target	-0.029	-0.019	0.049	-0.046	-0.031	0.077
	-1.62	-0.98	(2.15)**	(1.73)*	-0.85	(2.31)**
Output gap	-1.324	-0.872	2.196	-1.021	-0.686	1.707
	(1.94)*	-0.86	(1.94)*	-1.58	-0.83	(1.96)**
Depreciation against USD	-0.781	-0.515	1.295	-0.426	-0.286	0.711
	(1.75)*	-0.86	(1.80)*	-1.04	-0.65	-1.03
Lagged policy rate (%)	0.020	0.013	-0.033	0.023	0.016	-0.039
	-1.53	-0.94	(1.90)*	(1.71)*	-0.84	(2.16)**
Lagged policy rate change	-0.093	-0.061	0.154	-0.056	-0.038	0.094
	(1.77)*	-0.88	(1.93)*	-1.27	-0.77	-1.43
Sample frequencies	0.237	0.579	0.184	0.237	0.579	0.184
Probability at the means	*0.06*	*0.84*	*0.11*	*0.04*	*0.88*	*0.08*

Notes: Robust *t*-statistics in parentheses. *, ** and * Significant at the 10, 5 and 1 percent levels respectively**

Table D6.4: GMM Estimates of the Policy Reaction Function (2002 - 2017)

Dependent variable: Δ in policy rate	*Current inflation gap*	*Expected inflation gap*
Inflation exp less target	0.044	0.254
	[0.00]	[0.00]
Output gap	5.175	14.376
	[0.00]	[0.00]
Depreciation against USD	4.580	-1.388
	[0.94]	[0.65]
Lagged policy rate (%)	0.012	-0.069
	[0.00]	[0.00]
Lagged policy rate change	0.262	-0.407
	[0.30]	[0.05]
R-squared	0.04	0.19
Adjusted R-squared	-0.04	0.12
J-statistic	0.31	1.97
Prob(J-statistic)	0.96	0.74

Notes: *p-values* in square brackets. The instrument set includes three lagged values of the inflation and output gaps, and the exchange rate depreciation variables similar to Clarida *et al.* (1998).

Chapter 7
General Conclusion

7.1 Introduction

The main thrust of this thesis is to provide new insights into the conduct of macroeconomic policy in lower-income countries. In particular, two main areas were considered: the fiscal deficits – inflation nexus, the focus of chapters 2 to 4; and inflation targeting (IT) in lower-income countries, considered in chapters 5 and 6. We answer three main questions. Firstly, what is the role of institutions in the fiscal deficits-inflation nexus? Secondly, what is the effect of IT in lower-income countries (LICs) compared with those in higher-income countries (HICs) and emerging-market economies (EMEs)? Thirdly, how does the central bank of Ghana respond to inflation and other macroeconomic shocks under its IT framework? In what follows, we summarise our main findings and contribution (section 7.2), discuss the policy implications (Section 7.3), highlight the limitations of our study and suggest areas for future research (Section 7.4)

7.2 Summary of Main Findings and Contribution

Macroeconomic theory postulates a negative relationship between the fiscal balance and inflation, particularly when countries are constrained in their ability to borrow. Previous research has shown that the negative relationship holds in lower-income countries. In chapters 2 to 4, we show that the crucial factor is the quality of institutions. In chapter 2, we provided an empirical examination of the quality of institutions as a possible key factor affecting the deficit-inflation nexus. We apply recent econometric techniques that allow for cross-country heterogeneity and cross-section dependence. Chapter 3 provides further analyses of the macroeconometric

panel models applied in chapter 2 and shows that two alternative robust estimators, the median and robust regression estimators, potentially yield more agreement between the PMG and MG estimates.

Our results in these chapters, while confirming the previous finding that deficits are inflationary in lower-income countries, show *crucially* that the key factor affecting this relationship is the quality of institutions. Specifically, we show that the relationship holds in countries with weak institutions, but not in those with strong institutions, even if their per capita GDP is quite low. This may reflect a number of possibilities. First in the advanced economies, strong institutions may prompt a government to rely less on seigniorage as a financing source of deficits. Specifically, when citizens' political participation for instance is guaranteed in those economies, the political leadership may be more sensitive to the public's dislike for inflation, so that fiscal shocks that lead to a build-up of public debt tend to induce fiscal consolidations rather than a resort to seigniorage revenue. Moreover, governments in low-income countries are susceptible to low credibility in the context of institutions, which may tend to limit access to the international capital market. This, in turn, may imply that such countries find it less costly to finance deficits with seigniorage than with borrowing, strengthening the deficits-inflation nexus as a result.

In chapter 4, we develop a theoretical model to examine formally how institutions may affect the deficits-inflation nexus. The model is a simple monetary model of an endowment economy without uncertainty, consisting of a government and infinitely-lived households. Money is incorporated into the model following the money-in-utility approach, i.e., by assuming that households' utility is increasing in real money balances due to transaction services money brings (Sidrauski, 1967). Government finances deficits either by issuing bonds or by creating money. It is assumed that under weak institutions (where government officials are unconstrained), there are leakages in tax revenues, and this siphoning of the revenues by corrupt officials creates economic inefficiency and increases the reliance on seigniorage revenues which ultimately generates inflation. Therefore,

institutional constraints and reforms that align public debt more closely with tax and spending smoothing are necessary to sustainably contain inflation in the long run.

Chapters 5 and 6 provide new insights on IT in low-income countries. Previous empirical studies, conducted almost exclusively on the experience of HICs and EMEs, show that IT has been effective in lowering inflation in EMEs, but scarcely at all in high-income countries where inflation was typically already low. In the twenty-first century a sufficient number of low-income countries have adopted IT to enable us to assess its effectiveness separately from emerging markets. This exercise revealed that IT has been much less effective in reducing inflation in LICs than EMEs. Thus, the effect of IT is non-monotonic across country-groups at different per capita income levels. A possible explanation for the non-monotonic effects of IT is the difference in the quality of institutions. This finding can be explained by the model of policy reform of Acemoglu *et al.* (2008). This model predicts that good macroeconomic outcomes can be achieved even without reform in countries with good institutions, and in countries with very poor institutions reform does not work; only in countries with intermediate institutions does policy reform (in this case IT) improve macroeconomic outcomes significantly.

Moreover, our empirical analysis revealed that, in a pooled sample of EMEs and LICs, IT is somewhat more effective at reducing inflation when institutions are stronger. We then considered pegging the exchange rate as an alternative nominal anchor to IT, and showed that IT only makes a difference to inflation under floating rates. Without IT, inflation rates are significantly higher under floating than under a peg.

Finally, using a combination of standard linear and limited dependent variable models, we investigate the behaviour of the central bank of Ghana under its IT framework. Ghana has been one of the least successful low-income IT countries, with inflation persistently considerably above target. Our analysis shows that the reaction function in Ghana is remarkably similar to that estimated for countries where monetary policy is regarded as successful. The estimated long-run reaction of interest rates to inflation shocks is well above the theoretically

recommended threshold of one. Moreover, the details of the inflation response are also consistent with theory, with more notice taken of non-food price inflation, which is more persistent than food price inflation, and therefore a better indicator of future inflation; more notice also taken of expected inflation as revealed by the Bank's regular survey of business than of historical inflation; and the speed of adjustment is similar to that in the advanced countries. The findings naturally raise the question of why inflation has not been closer to the Bank's target despite the apparently sound monetary policy reactions. We find some evidence that Ghana still has a fiscal dominance problem that may be affecting inflation expectations.

7.3 Policy Implications

The findings of this thesis have a number of implications especially for macroeconomic management in lower-income countries. First, we have confirmed that deficits are inflationary in the long-run especially in LICs. However, the crucial factor is the quality of institutions. The relationship holds in countries with weak institutions, but not in those with strong institutions, even if their per capita GDP is quite low. The implication is that institutional improvements can enhance macroeconomic outcomes in poor countries. Specifically, institutional improvement can be a key ingredient in the quest for sustainably reducing inflation especially in LICs.

Secondly, strong institutions, accompanied by appropriate policy choices (for instance floating) can enhance the effectiveness and credibility of major policy reforms such as inflation targeting. Thus, our results lend support to the view that building credibility through fixed exchange rate polices can be difficult as this undermines monetary autonomy and leads to poorer macroeconomic outcomes. Overall, institutional enhancement along with building and maintaining credibility can significantly enhance macroeconomic performance in LICs.

We find additionally that the central bank of Ghana responds to inflation shocks and shocks to the real economy, the latter independently of its implication on inflation. Ghana's reaction function is remarkably similar to that estimated for countries where monetary policy is regarded as successful. The estimated long-run reaction of interest rates to inflation shocks is well above the theoretically recommended threshold of one, with more notice taken of expected inflation revealed by the Bank's regular survey of business than of historical inflation and the more persistent components of inflation. This raises the question as to why inflation has not been closer to the Bank's target despite the apparently sound monetary policy reactions. We find some evidence that Ghana still has a fiscal dominance problem that may be affecting inflation expectations which means that alongside the sound conduct of monetary policies by the Bank of Ghana, far-reaching fiscal reforms may be warranted in order to anchor inflation expectations.

7.4 Research Limitations and Recommendations for Future Research

There are a number of limitations in our research. In particular, our theoretical model of deficits-inflation nexus outlined one possible source of the link and does not claim to comprehensively represent all possible channels. It may be useful for future research to explore other possible channels in the nexus. Secondly, in the empirical analysis, as a possible future work, it may be useful to further explore cases in which the mechanism from deficits to inflation under weak institutions runs via money growth (that is possibly presenting supplementary regressions in which money growth is the dependent variable, the fiscal deficit a control and there are interaction between deficits and measures of institutional quality.

Since this thesis has been concerned primarily with lower-income countries, a key challenge has been the data coverage for most LICs, notably the exclusion of many LICs for lack of data. This is especially true for the analysis of the fiscal deficits – inflation nexus using the heterogeneous panel models where we applied a

simple restriction of at least twenty consecutive years of data. Moreover, a number of LICs only recently adopted the IT framework and given that only a short time has elapsed since the adoption, a few of these countries were omitted in the analysis. In the future, as more data accumulates, it may be important to re-examine the effect of IT in LICs. Similarly, the use of simple pooled fixed effects estimators in Chapter 5 as opposed to the more sophisticated methods allowing for heterogeneity used in Chapters 2 and 3 was justified on grounds of data constraints since the latter requires both large cross-section and long-time series. As future work, it may be imperative to potentially explore heterogeneity in the effects of IT across countries using other methodologies (for instance the MG and PMG) as more countries adopt IT and more data accumulates. Moreover, although the Bank of Ghana's MPC decisions have been clearly shown as consistent with theoretical expectations, there is nevertheless a semblance of fiscal dominance in Ghana in spite of the adoption of inflation targeting as demonstrated in chapter 6. This possibly has some influence on inflation expectations which have remained high. We leave a formal investigation of this hypothesis to future work.

Despite these weaknesses in the study, the research has many strengths including arguably the use of the broadest and most recent data in the analysis along with some recent advanced econometric techniques.

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