Monetary Policy Under Fiscal Stress: A Forward-Looking Analysis of Fiscal Dominance*

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Abstract

Subdued economic activity and low tax revenues, especially during crises, drive borrowing and increase public debt. Central banks may face pressure to deviate from policy targets during these periods to ease the debt burden. Under fiscal dominance, debt sustainability relies on low interest rates and high inflation rather than consolidation. This paper empirically tests the presence of fiscal dominance using forward-looking Taylor rules and data from 52 countries over three decades. The results detect fiscal dominance, with stronger effects in "de jure" inflation-targeting emerging economies with low central bank independence, especially those without debt rules and with high debt-to-GDP ratios. Emerging economies with high foreign currency-denominated debt are further affected by exchange rate debt valuation effects, and fiscal dominance leads their central banks to follow exchange rate stabilization policies. Since 2022–23, interest rate responses to fiscal imbalances have strengthened, posing challenges for future policy.

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1 Introduction

Economic downturns, such as the 1997 Asian financial crisis and the 2007–09 Global Financial Crisis, magnified fiscal and monetary policies complementary roles. Governments stepped up to take responsibility for the losses through stimulus packages and countercyclical fiscal policies, and central banks acted as lenders of last resort. Subsequently, the losses absorbed by the government and central banks were funded through taxation (e.g., inflation tax), borrowing, and sales of government assets to avoid large fiscal deficits and default (Bordo and Meissner, 2016). The COVID-19 pandemic only exacerbated these issues, causing further strains on economic, social, and public health. Governments provided stimulus packages such as tax and contribution deferrals, rates reduction, and healthcare and income subsidies; and central banks also intervened in the form of liquidity support, direct long-term lending, and credit creation (Kose et al., 2021).

Fiscal imbalances have since reached new heights. Government stimuli in the context of subdued economic activities and constrained tax revenues led to the need for additional borrowing, resulting in increased public debt. Meanwhile, inflation rates spiked globally leaving central banks with no choice but to increase interest rates. With the higher debt and increased interest rates, governments have seen their debt servicing bills increase in the aftermath, raising concerns about fiscal sustainability. Consequently, monetary authorities may face pressure to deviate from their main goals in ways designed to ease the debt burden and accommodate the fiscal stance, a situation that characterizes fiscal dominance.[1]

In this paper, we empirically investigate this question through the lens of forward-looking monetary policy rules. Namely, we estimate monetary policy rules that explicitly incorporate fiscal variables on a broad global sample of 52 countries over three decades, covering both advanced and emerging economies, as well as economies with different fiscal and monetary policy frameworks. Our main analysis looks at the key country and policy characteristics that are associated with the emergence of fiscal dominance. We consider two complementary hypotheses of how fiscal dominance may impact interest rate setting depending on the composition of debt. First, concerns about the sustainability of *domestic* debt would put pressure on central banks to lower interest rates to reduce the debt servicing burden. Lower interest rates would also lead to higher GDP growth and inflation, both of which erode the real value of debt. Second, in economies relying more strongly on *external* debt, fiscal sustainability would be further affected by exchange rate debt valuation effects. In that situation, central banks would face pressures to maintain the value of their currency through higher interest rates. Our main contribution is to establish under which conditions, especially regarding policy frameworks,

[1]There are two main views about fiscal dominance in the literature, both emerging from a situation where government debt and fiscal imbalances become unsustainably high, but differing with respect to how central banks react. In the first, high debt levels are financed through seigniorage and money creation, ultimately leading the central bank to lose control over inflation (Sargent and Wallace, 1981). In the second, monetary policy is used to reduce the value of debt by influencing the factors determining its dynamics, i.e., interest rates, inflation, and growth (Reinhart and Sbrancia, 2015). This paper focuses on the second view.

fiscal dominance tends to emerge more strongly.

Our framework is motivated by the literature on the so-called Taylor rule, which depicts how central banks set interest rates to achieve price stability and sustained economic growth (Taylor, 1993). The forward-looking Taylor rule suggests that when expected inflation is above the target and/or when expected output is higher than the potential output, central banks set interest rates above the natural rate to decelerate economic activity and reduce inflationary pressures (Clarida et al., 2000). However, in a context of fiscal imbalances the monetary authorities may be put under pressure for ensuring not only price stability but also fiscal solvency. The premise of fiscal dominance effects is that government accounts are not balanced. Hence, to test the fiscal dominance hypotheses, the Taylor rule must account for fiscal indicators. Particularly, in this paper we test for the inclusion of forecasts of fiscal balance into a forward-looking Taylor rule. Augmenting this framework, the impact of fiscal balances on interest rates is jointly assessed with estimates of how central banks respond to inflation and GDP growth expectations, as well as exchange rate depreciation and the U.S. natural rate of interest in an attempt to control for potential effects of imported inflation and trends in global interest rates that can impact the costs of borrowing.

The forward-looking feature is an important methodological contribution of this paper relative to previous studies.[2] Following the literature on real-time estimation of policy rules, central banks are more appropriately described by forward-looking Taylor rules in recognition that the impact of changes in interest rates on economic activity takes time (Orphanides, 2001). Hence, interest rates are better characterized as being determined by forecasts rather than actual data. We employ survey forecast data collected from market participants at a monthly frequency to account for such forward-looking behavior and overcome the limitation imposed by the usual quarterly availability of national accounts data.[3] Additionally, we incorporate both interest rate smoothing and autocorrelated policy shocks, with the latter addressing the challenge that emerges with a higher persistence of interest rates at the monthly frequency. Finally, we cover a broader sample of 52 countries which provides variability concerning policy frameworks and country-specific factors that may condition the impact of fiscal position. We take advantage of such heterogeneity to improve our understanding of when and under what conditions fiscal dominance and resulting macroeconomic instabilities are likely to emerge.

Our empirical findings reveal that central banks adjust interest rates in response to fiscal imbalances, but the response is nuanced, with income levels and institutional factors playing a significant role in shaping the monetary-fiscal interaction. Emerging economies, particularly those with limited central bank independence, high debt-to-GDP ratios, and no established

[2]For example, Ahmed et al. (2021) use contemporaneous actual values of GDP growth, inflation rates, and debt-to-GDP ratios.

[3]Although central banks usually set interest rates at a lower frequency, the monthly data provide a clearer identification of endogenous data-driven policy shocks that are embedded in market expectations in anticipation of monetary policy decisions (see, e.g., ADB, 2024). Notwithstanding, we also provide a robustness check with quarterly averaged data and find similar results.

debt rules are especially vulnerable to lowering interest rates to mitigate domestic fiscal pressures. Intriguingly, from an institutional perspective, we find that fiscal dominance is more pronounced in "de jure" inflation-targeting than non-inflation-targeting emerging economies. However, we also show that fiscal dominance is more prevalent among inflation targeters with low central bank independence. Moreover, responses to inflation expectations are found to be lower for economies with low central bank independence. Hence, our results suggest that central bank independence is a key determinant of "de facto" inflation-targeting, which, at least in theory, should not be affected by fiscal dominance. Indeed, central bank independence can be considered a cornerstone of the inflation-targeting framework (Bernanke and Mishkin, 1997). Finally, we also find evidence of fiscal dominance driven by external debt concerns. Particularly, central banks in emerging economies with substantial foreign currency-denominated debt face pressures to stabilize exchange rates, resulting in higher interest rates.

This study has important implications for policymaking since fiscal dominance leads to a sub-optimal setting of monetary policy, especially during periods of heightened debt vulnerability. The results underscore the complex relationship between fiscal and monetary policies, showing an important role for the design of fiscal rules. From a policy perspective, we find that fiscal rules targeting debt constraints—rather than budget balance rules—are more effective in curbing fiscal dominance. The reasoning is that fiscal rules focusing on debt accumulation may give fiscal authorities more flexibility to achieve fiscal sustainability without transferring that responsibility to central banks. Meanwhile, budget balance rules may trigger stronger fiscal austerity programs that adversely impact the economy and put pressure on the central bank to intervene. Finally, our study also highlights that fiscal dominance is likely to pose even more challenges for future policy. In an extension to our main estimates, we find that interest rate responses to fiscal balances have strengthened since 2022. Hence, monetary authorities are likely to face increased pressures to deviate from their main stability goals, which could undermine the anchoring of inflation expectations and re-ignite inflationary pressures in the coming years.

The remainder of this paper is organized as follows: Section 2 provides the conceptual background and a brief review of the relevant literature. Section 3 outlines the methodology and data used in the study. Section 4 discusses the results. Section 5 provides robustness checks and extensions to our baseline estimates. Section 6 concludes.

2 Background and Related Literature

2.1 Conceptual background

To understand the sources of fiscal pressure on monetary policy it is important to consider how the latter can impact fiscal sustainability. Focusing initially on purely domestic debt, the basic government budget constraint accounting identity implies that the debt-to-GDP ratio follows

the dynamics of

$$b_{t+1} = (1 + r_t - \pi_t - g_t)\, b_t + d_t, \tag{1}$$

where b_t is the government nominal debt-to-GDP ratio in period t, d_t is the primary fiscal deficit-to-GDP ratio, r_t is the nominal interest rate, π_t is the inflation rate, and g_t is the real GDP growth rate.[4] Hence, the debt-to-GDP ratio increases with primary fiscal deficits and with higher interest rates as the cost of debt increases, while higher inflation and growth rates decrease the debt-to-GDP ratio by eroding the real value of debt. Importantly, governments face an upper bound to their debt ratio, as markets interpret a high and growing debt ratio as a signal of looming fiscal insolvency, which could ultimately lead to a fiscal debt crisis and default (see, e.g., Escolano, 2010; Ghosh et al., 2013).

Equation 1 makes clear the "temptations" to solve fiscal imbalances with monetary policy. First, fiscal imbalances may put pressure on monetary authorities to lower interest rates to reduce the debt servicing burden. Second, a lower interest rate would also improve economic activity, raising the growth rate of real GDP and potentially leading to inflation, both of which erode the debt value. Finally, consideration of who holds the government debt can also play a role in monetary policy decisions. For example, domestic banks and households could be exposed to the debt valuation impacts of interest rates. In addition, debt monetization by the central bank (CB) can undermine the price stability goal. These broader financial stability concerns may put further pressure on the monetary authorities to use interest rate policy to attenuate fiscal imbalances.

Reliance on external debt leads to similar concerns about fiscal dominance, though the direction of additional pressure on interest rate policy goes the other way. Extending equation 1 with foreign currency-denominated debt (FX debt), b_t^*, leads to

$$b_{t+1}^{'} + b_{t+1}^* E_{t+1} = (1 + r_t - \pi_t - g_t)\, b_t^{'} + (1 + r_t^* - \pi_t - g_t)\, b_t^* E_t + d_t, \tag{2}$$

where $b_t^{'}$ now denotes the domestic government debt-to-GDP ratio, E_t is the exchange rate (LCU/FCU), and r_t^* is the foreign interest rate. Although the impacts of inflation and growth rates remain the same, interest rates now have two distinct effects on the dynamics of the debt ratio. First, the domestic debt servicing cost still increases with the domestic interest rate. Second, the interest rate differential relative to foreign interest rates can impact the valuation of FX debt through its impact on exchange rates. Particularly, recall that the uncovered interest parity condition implies that a higher interest rate differential will lead to an appreciation of the local currency (i.e., a decrease in E_{t+1}). As the exchange rate decreases, so does the value of FX debt (in local currency). Hence, external debt, which is especially relevant for small open economies, adds another layer of potential fiscal pressure on monetary policy. Depending on the level of external debt, monetary authorities may face pressure to maintain a high policy rate

[4] For exposition purposes, we are abstracting from several details of debt dynamics, such as different debt maturities and varying interest rates, which are also affected by different levels of risk premium.

above foreign interest rates to manage fiscal imbalances through exchange rate valuation.

The analysis above leads to two hypotheses about fiscal dominance's impacts on monetary policy. First, under the domestic debt concern, an expected deterioration in fiscal balance may lead to a lowering of policy rates. Second, under a higher dependence on external debt, an expected deterioration in fiscal balance may lead to increasing policy rates. Of course, the null hypothesis is that monetary authorities are independent of fiscal authorities and would not be influenced by the expected dynamics of fiscal balances.[5] In this paper, we test these hypotheses using the Taylor rule framework as described in the next section.

2.2 Related literature

This paper relates to four major strands in the literature. First, the theoretical implications of fiscal dominance and the interplay between monetary and fiscal policies have been the subject of extensive literature. A seminal model in this literature was developed by Sargent and Wallace (1981), who argued that when real public debt is high and inflation targets are impractical, seigniorage revenues must fall in the short-run which must, in turn, be compensated by higher seigniorage in the long-run, ultimately leading to high inflation.[6] Along similar lines, the fiscal theory of the price level, developed for example in the frameworks of Woodford (1998, 2001), implies that government debt with fiscal policy dominance can become explosive. Cochrane (2023) provides a modern review of the fiscal theory of price level. Another strand of the theoretical literature focuses on equilibrium determinacy and stability properties under fiscal dominance (Leeper, 1991, is a seminal paper in this literature). For example, Kumhof et al. (2010) evaluate the implications of fiscal dominance in a structural framework with simple monetary policy rules. While they find that unique equilibria are still feasible in economies that suffer from fiscal dominance, they conclude that such equilibria are associated with extremely volatile inflation. These theoretical frameworks motivate our empirical analysis in this paper.

The second strand of literature our paper relates to is about the empirical evidence of fiscal dominance. Evidence suggests that fiscal dominance leads to high inflation, increases in risk premia, and is associated with other economic ills such as dollarization (Yörükoğlu and Kilinç, 2012). The initial level of debt, the proportion of FX debt, and the level of risk aversion in financial markets also pay an important role on the emergence of fiscal dominance. Focusing on the case of Brazil between 2002 and 2003, Blanchard (2004) shows that under such circumstances inflation targeting can have perverse effects, as increases in the real interest in response to higher inflation leads to a real depreciation, which then magnifies inflationary pres-

[5] As alluded to in the text, even when fiscal accounts are balanced, monetary authorities may still have financial stability concerns depending on the exposures of the domestic banking system and households to government debt. Although these concerns would not be directly captured by *current* fiscal balances, they are likely to emerge in contexts where excessive past debt accumulation has increased the risk of debt unsustainability, which are likely captured in *expected* fiscal balances.

[6] In the context of equation 1, this type of fiscal dominance emerges with the inclusion of a monetary aggregate as an additional form of financing fiscal imbalances by monetizing debt, also known as seigniorage.

sures. Similarly, Ahmed et al. (2021) makes the case that emerging economies suffering from high levels of external debt to GDP ratio face fiscal dominance challenges since real exchange rate depreciation increases cost of servicing debt. In practice, these objectives are achieved through a "hybrid" IT regime that exhausts or draws upon international reserves and sovereign wealth funds. Hence, larger debt-to-GDP ratios in foreign debt leads to more fiscal dominance, causing higher interest rates and higher risk-premia in emerging economies. Perhaps in an attempt to attenuate these issue, in recent years many emerging economies have switched towards domestic financing and reduced currency mismatches. Nevertheless, counter currents such as population aging pose a threat to fiscal discipline through potential increases in pension schemes and redistribution in the medium to long-term (Montoro et al., 2012). Moreover, fiscal surprises such as unexpected increases in the debt-to-GDP ratio have been found to impact long-term government bond yields, which indicates that fiscal imbalances can have nonlinear effects government borrowing costs (Cotton, 2024). While there is evidence of fiscal dominance in some economies, there is still scope for research on the conditions that lead countries to fall in such a regime. Our work builds on this literature by estimating forward-looking Taylor rules augmented to allow testable sensitivity to forecasted fiscal (im)balances.

A third strand of related literature delves into the effectiveness of fiscal rules. Well-designed rules-based frameworks, such as debt ceilings, offer a credible framework to curb excessive borrowing and ease procyclicality; however, their efficacy depends on strong enforcement mechanisms and institutional support (Wyplosz, 2012). Moreover, Davoodi et al. (2022) provide empirical evidence that fiscal rules, when complemented by independent fiscal councils, have been effective in maintaining fiscal discipline even during crises. In recent years, countries with established fiscal rules have gradually incorporated additional provisions in their escape clauses. These provisions offer significant flexibility, which allow governments to respond effectively to adverse shocks. Despite this flexibility, the long-term sustainability of debt remains a critical concern, emphasizing the need for stringent debt rules and strong institutional frameworks.[7] Lastly, the work of Combes et al. (2018) is particularly relevant to our research as it investigates the effectiveness of fiscal rules within the context of the interdependence between fiscal and monetary policies. Their findings indicate that the integration of inflation-targeting regimes and fiscal rules leads to acceptable levels of price stability and fiscal discipline. Therefore, to delve deeper into the role of fiscal rules in this interdependent relationship, we identify which specific rules, whether implemented or not, are indicative of fiscal dominance.

Finally, the methodological framework we employ is related to the literature on monetary policy response rules. The seminal work of Taylor (1993) introduced what became known as Taylor rules, arguing that a CB can be described by an interest-rate-setting rule that reacts to deviations of inflation from its target and output from potential output. Apart from the normative debate on the advantages of rules over discretion in monetary policy making, the paper

[7]The most common framework involves a debt rule, often combined with either expenditure rule or budget balance rule.

motivated significant empirical research on the specification of monetary policy rules for the assessment and description of CB actions. One important contribution in this area is the work of Clarida et al. (2000), who proposed that a more appropriate description of monetary policy should account for forward-looking behavior of CBs. Namely, when setting the interest rate CBs recognize that its impacts on real economic activity takes time. Hence, CBs will be looking and giving a greater weight to forecasts of inflation and economic activity rather than only the most recent available hard data, which in turn are published with a lag. Similarly, Orphanides (2003) argued that the actual information available at the time of policy formulation is not in line with the classical Taylor rule's assumptions. There are many ex-post policy data revisions, especially in output gap estimates, which have high degrees of inaccuracy in real time. Thus, Orphanides (2003) established that estimation of Taylor rules based on real-time information available to the policymaker deviates from the classical Taylor rule's assumptions. In this paper we attempt to address these issues in our empirical strategy by using survey forecasts. Given that these forecasts were reported in real-time, our data is consistent with the idea that policy responses should be evaluated concerning the information set available to policymakers at the time their decisions were made. Moreover, the forward-looking nature of this data is more consistent with the forward-looking behavior of CBs than estimates based on actual hard data.[8]

3 Methodology and Data

In this section, we outline our monetary policy reaction function and discuss the data and estimation method.

3.1 Taylor rule

In the Taylor rule framework the CB of country i is assumed to set its desired nominal interest rate target, $\tilde{r}_{i,t}$, according to

$$\tilde{r}_{i,t} = r^*_{i,t} + \tilde{\beta}_i(\pi^e_{i,t} - \pi^*_{i,t}) + \tilde{\gamma}_i(y^e_{i,t} - y^*_{i,t}) + \tilde{\delta}_i(X_{i,t}), \tag{3}$$

where $r^*_{i,t}$ stands for the nominal neutral rate of interest, which is the level at which monetary policy is neither contractionary nor expansionary, $\pi^e_{i,t}$ is expected future inflation, $\pi^*_{i,t}$ is the CB's inflation target, $y^e_{i,t}$ is expected future output, and $y^*_{i,t}$ is the economy's potential output. Both response coefficients are expected to be positive, $\tilde{\beta}_i > 0$ and $\tilde{\gamma}_i > 0$, so that the CB will desire to raise the nominal interest above the neutral rate when expected inflation is above target and/or when expected output is above potential, and vice versa. The last term in equation (3),

[8] Other extensions of this framework include non-linear specifications (see, e.g., Castro, 2011), and the inclusion of other variables such as exchange rates (Taylor, 2001), growth rates (Coibion and Gorodnichenko, 2011), debt-to-GDP ratios (Ahmed et al., 2021), or even money aggregates (see, e.g., Belongia and Ireland, 2017; Qureshi, 2021, 2023).

$X_{i,t}$, is used to extend the standard Taylor rule with other variables that the CB may consider when setting interest rates. For example, Taylor (2001) extends the policy rule with the real exchange rate; Coibion and Gorodnichenko (2011) includes output growth. In the context of the present paper, a vector of (non-standard) exogenous variables, $X_{i,t}$, includes the real effective exchange rate depreciation, $e_{i,t}$, to account for the potential effects of imported inflation; and estimates of the U.S. neutral rate of interest, $r^*_{US,t}$, serving as the benchmark for all countries, to capture the time variations in global neutral rates. The responses to these exogenous variables, $X_{i,t}$, are anticipated to be positive, $\tilde{\delta}_i > 0$.

In addition, the main hypothesis concerning fiscal dominance is tested with the inclusion of expectations of fiscal balance, $f^e_{i,t}$, in the vector of exogenous variables, $X_{i,t}$, in equation 3. In the context of the discussion in section 2.1, letting $\tilde{\phi}$ ($\in \tilde{\delta}$) represent the coefficient on $f^e_{i,t}$, the hypothesis tested in this paper can be summarized as:

$H_0 : \tilde{\phi} = 0$ **(Null hypothesis)** Monetary policy is not influenced by expected fiscal balance.

H_1**:** $\tilde{\phi} > 0$ **(Alternative hypothesis 1)** Fiscal dominance driven by domestic debt concerns. An expected deterioration in fiscal balance is associated with lower policy rates.

H_2**:** $\tilde{\phi} < 0$ **(Alternative hypothesis 2)** Fiscal dominance driven by FX debt. An expected deterioration in fiscal balance is associated with higher policy rates.

The setting of the actual interest rate towards the CB's desired target is smoothed over time. Other than being an empirical fact, interest rate smoothing is motivated in order to avoid excess volatility due to real-time measurement errors and uncertainties about the economy's structural parameters (Sack and Wieland, 2000). Hence, the actual nominal interest rate target, $r_{i,t}$, is determined as

$$r_{i,t} = \sum_{k=1}^{K} \rho^r_{i,k} r_{i,t-k} + (1 - \rho^r_i(1))\tilde{r}_{i,t} + u_{i,t}, \tag{4}$$

where each period the actual interest rate is only partially adjusted towards the CB's desired target. Note this specification allows for up to K lags and $\rho^r_i(1) = \sum_{k=1}^{K} \rho^r_{i,k}$. The error term, $u_{i,t}$, can be interpreted as an exogenous interest rate shock, which is also allowed to be serially correlated according to

$$u_{i,t} = \sum_{j=1}^{J} \rho^u_{i,j} u_{i,t-j} + \varepsilon_{i,t}.$$

Substituting equation (3) into equation (4) leads to

$$r_{i,t} = \sum_{k=1}^{K} \rho^r_{i,k} r_{i,t-k} + (1 - \rho^r_i(1))[r^*_{i,t} + \tilde{\beta}_i(\pi^e_{i,t} - \pi^*_{i,t}) + \tilde{\gamma}_i(y^e_{i,t} - y^*_{i,t}) + \tilde{\delta}_i(X_{i,t})] + u_{i,t}. \tag{5}$$

Equation (5) is linear in variables and can be estimated empirically using the reduced form

given by[9]

$$r_{i,t} = \alpha_i + \sum_{k=1}^{K} \rho^r_{i,k} r_{i,t-k} + \beta_i(\pi^e_{i,t} - \pi^*_{i,t}) + \gamma_i(y^e_{i,t} - y^*_{i,t}) + \delta_i(X_{i,t}) + u_{i,t}, \tag{6}$$

where the long-run response coefficients can be recovered according to

$$\tilde{\beta}_i = \beta_i/(1-\rho^r_i(1)), \tilde{\gamma}_i = \gamma/(1-\rho^r_i(1)), \tilde{\delta}_i = \delta/(1-\rho^r_i(1)).$$

Equation (6) provides the basis for the empirical specification estimated in our paper, where we consider several variations. Under full panel specifications, the response and smoothing coefficients are assumed constant across countries (i.e., $\rho_i = \rho$, $\beta_i = \beta$, $\gamma_i = \gamma$, and $\delta_i = \delta$), while the intercepts can differ across countries in the form of fixed effects. In some specifications, the inflation target is assumed constant, and the expected output gap term is replaced by the expected growth rate, in which case the country fixed effects will also capture the cross-country variation in inflation targets and potential output growth. The stability of responses is also evaluated by estimating equation (6) using rolling window regressions. Finally, to investigate potential heterogeneity in monetary policy responses across different groups of countries, equation (6) is estimated with interacting dummy variables as described next.

3.2 Subpanel and threshold regression specifications

In order to estimate heterogeneous monetary policy responses, the Taylor rule framework outlined above is further extended by introducing interacting dummy variables that group countries according to different characteristics. Several classifications will be considered, such as country income class, monetary policy regime, and debt levels. A full list is detailed below. Importantly, some of these characteristics do not have an *a priori* classification, in which case we estimate threshold values using threshold regressions.

Generally, and abstracting from the specific explanatory variables, specification (6) is extended as

$$r_{i,t} = \alpha_i + \sum_{k=1}^{K} \rho^r_{i,k} r_{i,t-k} + \theta_0 Z_{i,t} + \theta_1 D_{i,t} Z_{i,t} + u_{i,t}, \tag{7}$$

where $D_{i,t} = 1$, when the country observation falls in a different regime than the baseline $D_{i,t} = 0$, and $Z_{i,t}$ stands for a vector of explanatory variables in the Taylor rule specification, as detailed above. Hence, θ_0 captures the (short-run) responses for countries in the baseline regime and $\theta_0 + \theta_1$ the (short-run) responses for countries in the second regime. Note we only allow regime-dependent responses to the explanatory variables, while maintaining a common specification of interest rate smoothing for parsimony. Long-run responses can be calculated in a similar way as with the panel specification.

[9]This also assumes a constant nominal neutral rate of interest, $r^*_{i,t}$, which ends up in the country-specific intercept, α_i. This assumption will be later relaxed by using estimates of the US neutral interest rate as a proxy.

For the cases where the regime-defining variable is not categorical, e.g., debt-to-GDP ratios, $D_{i,t}$ is estimated using threshold regressions (see, e.g., Hansen, 2000). In a nutshell, the approach relies on a grid search over the potential threshold values of the regime-defining variable. Namely, equation (7) is estimated for a (trimmed) set of values λ of the threshold variable $x_{i,t}$ that define the dummy variable as

$$D_{i,t} = \begin{cases} 0 & \text{if } x_{i,t} < \lambda, \\ 1 & \text{if } x_{i,t} \geq \lambda, \end{cases}$$

and the ultimate threshold value is chosen to minimize the sum of squared residuals of the regression.

3.3 Data

Our analysis takes advantage of historical consensus forecasts to capture the forward-looking behavior of CBs, along with actual data to account for the current state of the economy. The sample covers 52 countries and ranges from December, 1989 to January, 2024, with unbalanced observations. We also employ methods such as interpolation and Winsorization prior to the application of statistical techniques. These methods and data definitions are described in the following subsections.

3.3.1 Policy rates

In the estimation of the augmented forward-looking Taylor rule, the response variable is the nominal interest rate—which could be in the form of target rate, repo, or refinancing rate, depending on the country. In cases when there are no explicit interest rates, the widely known policy rate benchmarks are taken.[10]

3.3.2 Consensus forecasts

While the nominal interest rates are contemporaneous, the major covariates are forward-looking expectations. Specifically, inflation and growth rates are 12-month ahead expectations. Consensus forecasts are used to capture those expectations. Consensus forecasts are predictions of select economic and financial indicators that are surveyed from independent professional forecasters which are then aggregated using simple averages. These consensus forecasts provide approximations for market expectations about the relevant variables. Besides, by construction, consensus forecasts provide real-time market assessments of the forecast variables, in contrast to, for example, model-based forecasts estimated from revised data. Hence, in the absence of

[10]For instance, from April, 2013 to August, 2016, Japan adopted monetary base targeting, but the announced overnight call rates over the period are taken as the policy rate.

a historical record of CB forecasts, consensus forecasts provide a useful approximation to the expectations that feed into the monetary policy decision-making process.

In this paper, we primarily use consensus forecasts from Consensus Economics (CE). Since October 1989, CE has surveyed monthly forecasts of up to 35 market participants per country in the G7 and Western Europe. Over time it expanded its coverage to 89 economies: 17 in Asia Pacific, 25 in the G7 and Western Europe (including the Euro Zone), 29 in Eastern Europe, and 18 in Latin America. The historical CE forecasts have different timing at the beginning of the series.[11] CE publishes forecasts of major macroeconomic indicators such as GDP growth, inflation, current account, and other variables such as fiscal balance, exports, and imports. The forecasts reported in CE are annual fixed-event forecasts, usually targeting the end of the current year and the next year. For monetary policy purposes, fixed-horizon forecasts are more appropriate. Hence, the CE forecasts are converted to 12-month ahead forecasts using a simple weighted average approximation (Winkelried, 2023). Details about this interpolation are provided in Appendix A.1.

3.3.3 Expected fiscal balance

A key variable to this paper's hypothesis about fiscal dominance is the expected fiscal balance. Conceptually, fiscal balance is the difference between government revenues and expenditures. A positive net value means a budget surplus while a negative net value is a budget deficit. Similarly to inflation and growth rates, fiscal balance expectations are proxied by consensus forecasts. However, there are many missing observations for monthly forecasts of fiscal indicators from the CE database. In order to obtain a broad sample, the CE data on fiscal balance forecasts are combined with similar data obtained from Focus Economics.[12] Half of the sample (i.e., 26 of 52 countries) have data on budget balance from Consensus Economics. Importantly, for 13 of these countries (from Eastern Europe and Latin America) fiscal balances are expressed in % of GDP while for the remaining countries (from Asia Pacific, and G7 and Western Europe) the forecasts are in levels. In order to normalize the data to a common definition, we take the ratio between the budget balance in levels published at each survey month and nominal GDP in the corresponding year. The missing budget balance figures from the CE database are then filled with data from Focus Economics, which are defined in % of GDP.[13]

[11] Timing and period: (i) G7 and Western Europe monthly October, 1989–January, 2024; (ii) Asia Pacific monthly January, 1990–January, 2024; (iii) Latin America bimonthly February, 1990–December, 2000, monthly starting 2001 but excluding January and March, and monthly January, 2002–January, 2024; and (iv) Eastern Europe bimonthly November, 1990–November, 2006, monthly starting 2007 but excluding February and April, and monthly January, 2009–January, 2024.

[12] The correlation of comparable fiscal balance forecasts from CE and Focus Economics is almost 1.0. The total number of observations obtained with the merging increased the sample by 40%.

[13] Governments account for different revenue and expenditure items in the calculation of their fiscal balance and have varying accounting periods—some are in fiscal years with different start and end months and others in calendar years. We utilized what has been reported in Consensus Economics and Focus Economics regardless. Of all the countries that report fiscal/budget balance, the UK and Brazil publish public sector borrowing instead.

3.3.4 Inflation targets and output gaps

Two refinements of equation (6) are the inclusion of expected inflation deviation from the target and the expected output gap. These modifications allow accounting for time-varying inflation targets and potential growth rates, as opposed to the assumption that these remained constant and captured by the country fixed effects. In order to obtain a broad and comparable sample, for the inflation targets of countries that do not implement an inflation-targeting (IT) framework, we assume an implied 2% target; and, for those years when a country had not yet adopted IT (e.g., Philippines prior to January, 2002), we extrapolate backward using the first announced target.

For the output gaps we construct forward-looking measures following the methodology of Galimberti and Moura (2016). In a nutshell, the methodology is based on the application of the Hodrick-Prescott filter on (simulated) real-time economic activity time series extended with forecasts. The output gaps are based on (revised) real GDP data, split into monthly vintages, and augmented with forecasts using the corresponding CE forecasts for GDP growth. To simulate what a policymaker would have been able to observe in real-time, the vintages are constructed assuming that GDP data is observed with a two-month lag after the end of each quarter. The final output gap measure we use each month corresponds to the average of the estimated output gaps from the previous quarter up to three quarters ahead (see, e.g., Clarida et al. (2000). Further details about this methodology are provided in Appendix A.2.

3.3.5 Other factors

Augmenting the forward-looking Taylor rule entails controlling for other factors such as real effective exchange rate (REER) depreciation to consider the impact of imported inflation and costs of external debt, and neutral interest rate to account for the potential time variation on equilibrium interest rates. REER depreciation is the log difference of REER between month m at the current year and the previous year. For countries without REER from the Bank for International Settlements, the log difference of real exchange rates vis-à-vis the US dollar is used since the correlation of the two variables in a comparable set of observations is $\approx$1.0. The U.S. neutral rates, which are estimated by Holston et al. (2023), serve as the benchmark neutral interest rate for all countries in the sample.

In addition to the variables used for the estimation of the augment Taylor rule, the subpanel analysis looks into conditioning factors of the estimated policy responses across countries. Table A.1 presents the selected country characteristics such as IT schemes and adoption dates, current exchange rate regimes, and income class. Of the 52 countries, 67% are (de jure) inflation targeters, 69% implement (de jure) floating exchange rate regime, and 33% are advanced economies. The majority of countries have some type of fiscal rules in place, except revenue rule which is only implemented in Australia and Viet Nam. Table A.2 lists the definition and sources of data.

3.3.6 Outliers treatment

Outliers may have a large influence on regression estimates. These can emerge in actual data due to extreme events such as wars and speculative currency attacks, as well as in consensus forecasts due to typing errors, miscalculations, and incomplete knowledge of the survey participants. Besides, periods of extremely high inflation rates may reflect circumstances that are not adequately captured by policy functions. Therefore, prior to the model estimation, we exclude the observations with at least 40% actual or expected inflation rates, or those with above 10 absolute percentage point change in policy rates; then, we Winsorize—replace (not drop) outliers with its nearest neighbors—the bottom and top 1% observations of expected output growth, output gap, and actual real exchange rates.

3.3.7 Sample statistics

The sample covers 52 countries and ranges from December, 1989 to January, 2024, yielding 15,053 total observations. Euro Zone countries are treated as a single unit, aggregating the data based on accession dates. Table 1 presents the descriptive statistics of the final sample used for estimation.

Table 1: Descriptive statistics

	Mean	Std. Dev.	Min.	Max.	No. of Obs.
Nominal interest rate (%)	5.6	5.3	-0.8	82.0	15,053
Expected inflation (%)	4.4	3.9	-1.8	39.4	15,053
Expected inflation deviation from target (%)	1.3	3.5	-16.7	37.1	15,053
Expected GDP growth (%)	3.2	1.9	-2.2	8.1	15,053
Expected GDP gap (%)	-0.4	1.1	-4.7	2.0	12,922
REER depreciation (%)	-0.1	7.8	-20.7	27.8	14,803
US neutral interest rate estimate (%)	1.7	1.0	0.6	3.9	15,053
Expected fiscal balance (% of GDP)	-2.5	3.1	-21.6	16.4	10,659

GDP = gross domestic product, REER = real effective exchange rate, US = United States.

3.4 Estimation methods

In estimating the augmented Taylor rule specified in equation (6), we employ panel (non-linear) least squares.[14] This method estimates the same slope parameters across all countries while allowing different country-specific intercepts (or fixed effects) to account for cross-country variations that cannot be explained by the covariates. Furthermore, to determine the optimal lag length in monthly frequency data, we use the Bayesian information criterion (BIC) for a set of 0 to 12 lags, which corresponds to up to four quarter lags as commonly suggested in

[14] Although least squares are potentially inconsistent due to endogeneity, Carvalho et al. (2021) show that the bias tends to be small.

the literature (Woodford, 2003; Coibion and Gorodnichenko, 2012). Since our data is at the monthly frequency, we expect a higher degree of interest rate persistence compared to that typically observed in quarterly data. This persistence is captured by interest rate smoothing (i.e., lagged interest rates) and AR shocks (i.e., lagged error terms), which means that interest rates and policy shocks could perpetuate for a long time.

To uncover the heterogeneity of monetary policy responses across country groups, we apply subpanel least squares in the estimation of equation (7) that introduces covariates interacted with country characteristics in the form of binary variables (e.g., either emerging or advanced economy).[15] For country characteristics that are continuous (e.g., government debt as % of GDP), we utilize threshold regressions to identify the optimal threshold value that will define two mutually exclusive country groups and subsequently estimate the coefficients in both regimes. To avoid too unbalanced sample splits, the threshold variables are trimmed to the interval between the 20^{th} and 80^{th} percentiles of the variable.

Lastly, to determine the extent by which the Taylor rule estimates remain stable over time, we use panel least squares with a rolling window of 10 years (or 120 monthly observations per country, though unbalanced). This method modifies our baseline model (6) by allowing the estimated coefficients to vary over time, providing insights into temporal changes in interest rate responses.

4 Results

4.1 Taylor rule panel estimates

Table 2 presents the panel estimates of equation (6), focusing on the implied long-run responses of policy rates to different specifications of explanatory variables. The estimates in column (1) represent the most traditional specification which includes only inflation expectations, GDP growth expectations, and interest rate smoothing. These results reveal a high degree of persistence in policy rates, which is partly due to the use of monthly frequency data. Both inflation and GDP growth expectations exhibit significant relationships with policy rates. However, the coefficient of inflation is below unity, indicating a violation of the Taylor principle which posits that policy rates should be changed in more than one-to-one proportion with inflation rates.

The introduction of autocorrelated policy shocks into the model helps reduce the degree of interest rate smoothing (column 2). This suggests that part of the persistence observed in policy rates can be attributed to persistence in monetary policy shocks, even though interest rate smoothing remains high and significant. The inclusion of autocorrelated policy shocks leads to a higher response to inflation and a lower response to GDP growth. The response to inflation is

[15] In a previous version of this paper we have also estimated Taylor rules at the individual country level, and observed substantial variations in monetary responses across individual countries, although the estimates were also noisier. We leave that approach for future research.

Table 2: Panel estimation results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inflation	0.739***	1.001***	1.245***		1.091***	0.899***	0.934***	0.889***
	(0.125)	(0.141)	(0.206)		(0.152)	(0.110)	(0.184)	(0.163)
Inflation deviation from target				1.111***				
				(0.227)				
GDP growth	0.510***	0.266**	0.312**	0.286**	0.453***	0.168*	0.149	0.134
	(0.135)	(0.111)	(0.126)	(0.131)	(0.129)	(0.092)	(0.111)	(0.111)
Output gap			0.105	0.099				
			(0.067)	(0.070)				
REER depreciation					0.091***			0.032*
					(0.032)			(0.019)
US neutral						1.084***		0.769***
						(0.140)		(0.185)
Fiscal balance							0.188***	0.160***
							(0.052)	(0.049)
Interest rate smoothing	0.963***	0.853***	0.865***	0.868***	0.909***	0.835***	0.845***	0.841***
	(0.006)	(0.029)	(0.024)	(0.025)	(0.013)	(0.034)	(0.034)	(0.033)
AR policy shocks		0.773***	0.749***	0.761***	0.658***	0.756***	0.723***	0.705***
		(0.041)	(0.029)	(0.030)	(0.033)	(0.050)	(0.055)	(0.058)
Lag order	10	5	6	6	5	5	6	6
AR order	0	12	12	12	12	12	12	12
No. of observations	14,810	13,635	11,986	11,986	13,333	13,635	9,582	9,523
No. of countries	52	52	52	52	52	52	52	52
R-squared	0.990	0.990	0.990	0.990	0.991	0.990	0.992	0.992
BIC	1.542	1.134	1.031	1.038	1.049	1.128	0.890	0.886
AIC	1.509	1.095	0.986	0.993	1.008	1.088	0.835	0.830
DW	1.273	1.939	1.918	1.914	1.915	1.941	1.830	1.833

AR = autoregressive, AIC = Akaike information criterion, BIC = Bayesian information criterion, DW = Durbin-Watson statistic, GDP = gross domestic product, REER = real effective exchange rate, US = United States.

Notes: ***, **, and * denote estimates statistically significant at the 1%, 5%, and 10% levels, respectively. Robust standard errors (period clustered) are in parentheses. Coefficient estimates are the implied long-run responses, except for interest rate smoothing and AR policy shocks which are the sum of corresponding lagged estimates. Lag orders are selected by minimizing BIC over a grid from 0 to 12 lags.

not statistically greater than unity, hence, it still does not satisfy the Taylor principle. Overall, statistical evidence favors the inclusion of autocorrelated policy shocks, e.g., the information criteria are lower and the Durbin-Watson statistic for serial correlation in the residuals is closer to 2, which indicates little evidence of residual autocorrelation.[16] Therefore, the autocorrelated shocks are maintained in the remaining specifications.

Output gaps may help in the identification of response coefficients; however, there is a penalty on the data sample (columns 3 to 4). The inclusion of output gaps jointly with GDP growth leads to an increase in the response to inflation, although the response to output gaps is not statistically significant. On another note, adding inflation targets (column 4) does not alter much the conclusions derived with the raw inflation expectations variables. Our estimations retain the expectations of inflation and GDP growth.

Aside from estimating the responses to inflation and output consistently with the traditional Taylor rule, this paper is equally concerned with the responses of policy rates to the non-standard explanatory variables (columns 5 to 8) such as exchange rate depreciation, U.S. neutral rates, and especially the expectations of fiscal balance. Exchange rate depreciation has

[16]It is important to note that the Durbin-Watson statistic is not developed for panel data and it is known to be biased for models including lags of the dependent variable. Here, the statistic is used mainly for comparison across the estimated models.

a positive effect on policy rates, consistent with open-economy concerns that currency depreciation can lead to higher prices of imported goods and consequently put upward pressure on domestic inflation. However, the magnitude of exchange rate effects on policy rates is only moderate as a 10% depreciation (recall from Table 1 that the standard deviation of this variable is 7.8%) can be associated with an average increase in policy rates of 32 (column 8) to 90 (column 5) basis points. The U.S. neutral interest rate is also found to have a positive relationship with policy rates (column 6), corroborating the hypothesis that long-run trends in global interest rates are an important conditioning factor for monetary policy. These estimates indicate a near one-to-one proportional relationship between policy rates and estimates of the U.S. neutral rate, which is in line with the baseline Taylor rule predictions (see equation 3). Importantly, accounting for the time variation in neutral rates reduces the estimated responses to inflation and GDP growth.

Fiscal balance, which is the main variable of interest in this paper, has a positive effect on policy rates (column 7). This relationship is also robust to the inclusion of exchange rates and neutral rates (column 8). An expected deterioration in fiscal balances of 1 percentage point translates, on average, to a decrease in policy rates of 16 basis points (column 8). The positive coefficient is consistent with the hypothesis of fiscal dominance driven by domestic debt concerns (H_1). Namely, an expected deterioration in fiscal balance is associated with lower interest rates. Thus, fiscal sustainability concerns appear to play a major role in monetary policy decisions.[17]

4.2 Heterogeneity analysis

Panel estimates may hide substantial heterogeneity of monetary policy responses across countries. In order to evaluate the potential impacts of hidden heterogeneity, this section examines subpanel estimates of the complete Taylor rule specification estimated above (column 8 in Table 2). Several conditioning variables are considered, their definitions and sources are described in Table A.2.

Figure 1 presents the subgrouped estimates of long-run responses to fiscal balance, with each bin containing two categories which represent a separate regression as described in equation (5).[18] In general, the estimates remain positive across all subpanels, consistent with H_1, except for countries with high FX debt, where the response is negative but the standard error is high—hence, at least in the average full sample, there is no evidence for the hypothesis of

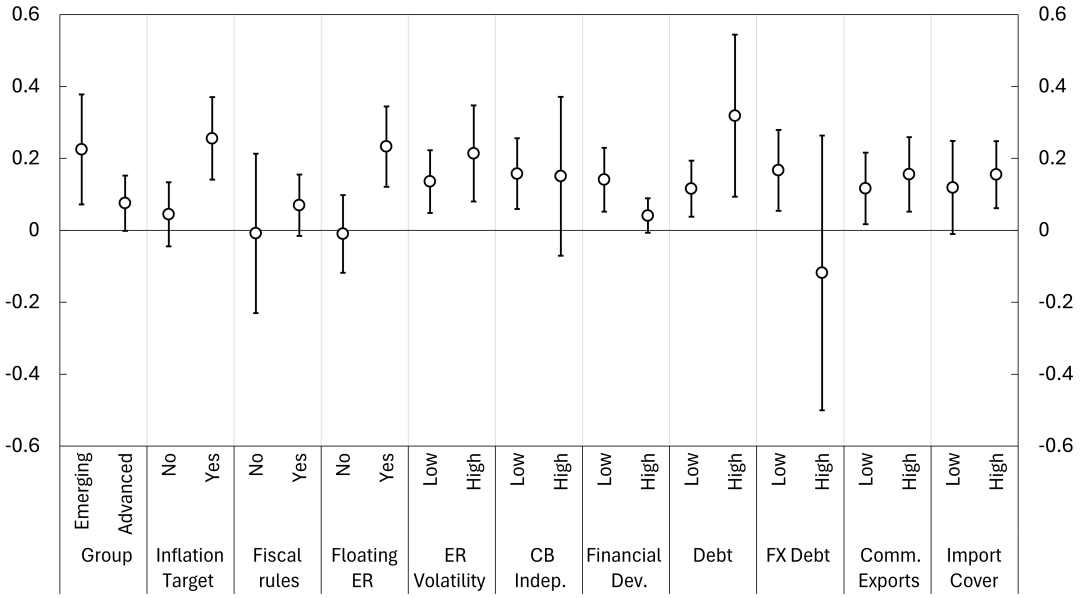
[17] Intriguingly, after including fiscal balance in the Taylor rule, expected GDP growth loses statistical significance, which may raise concerns about endogeneity. There are two potential drivers of this result: first, as the fiscal balance is defined as the ratio to GDP, there can be some correlation between the two variables; second, government expenditures and taxes are also important determinants of aggregate demand, which feeds into the determination of GDP growth. While in the next section we test the robustness of our results to these issues, we decided to keep GDP growth in our baseline specification as the coefficient estimate remains relatively high.

[18] Figure A.1 presents the number of observations and countries per subgroup. From exchange rate volatility (XR_VOL) to import cover (RES_IMP), the threshold values are specified. Furthermore, Figure A.2 illustrates the minimization of the sum of squared residuals from the threshold estimation.

fiscal dominance driven by FX debt (H_2). Nevertheless, there is significant variation across some classifications.

Fiscal dominance tends to be stronger among emerging economies, *de jure* inflation targeters, and countries with a *de jure* floating exchange rate regime, though it is important to note that these two policy frameworks tend to be highly correlated, i.e., countries adopting IT tend to also adopt floating exchange rates as part of the monetary policy framework. The finding of fiscal dominance for inflation targeters may sound counterintuitive. However, we also note that fiscal dominance is only statistically significant among countries where the CB is less independent. CB independence is a cornerstone of IT. Hence, one potential explanation is that *de jure* IT regimes may hide *de facto* non-IT.

Figure 1: Long-run responses to fiscal balance expectations



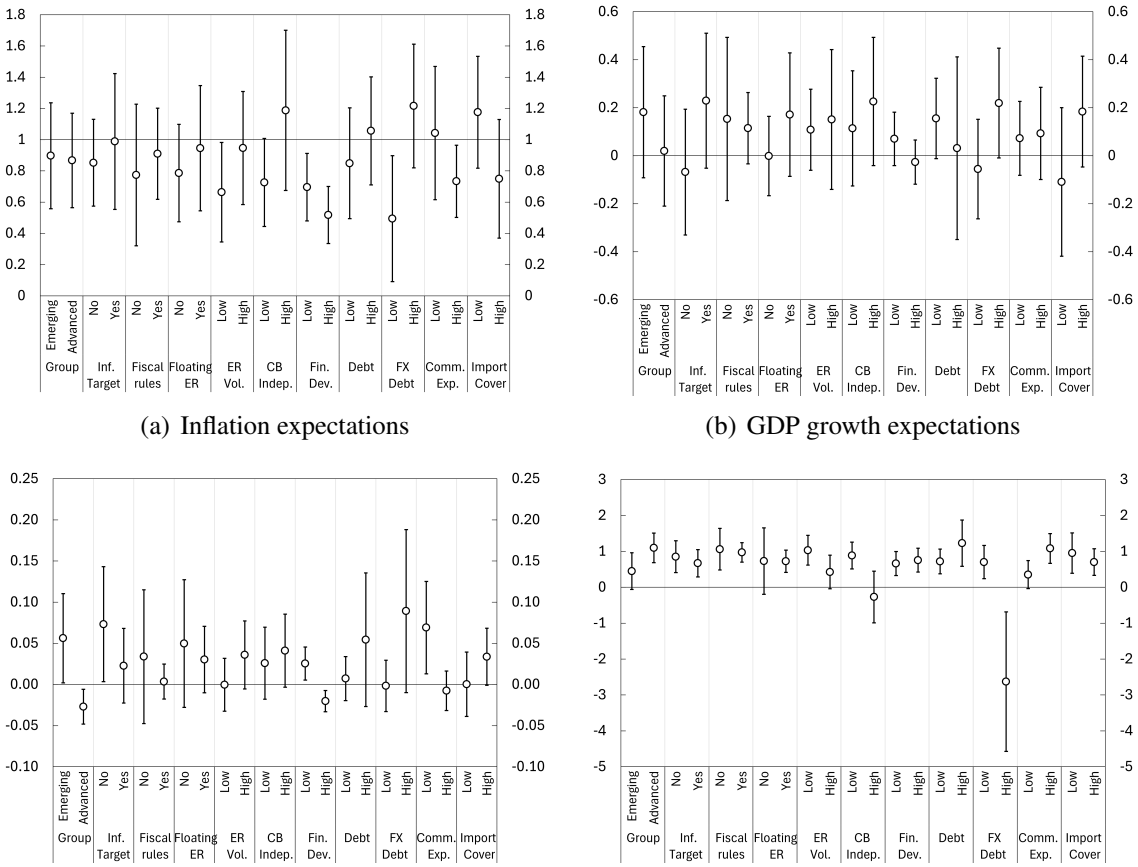
Notes: The confidence level of the error bars is 95%.

Countries with a higher debt-to-GDP ratio also exhibit a stronger response to fiscal balance expectations, consistent with the presumption that fiscal dominance is more likely to emerge with debt sustainability concerns, although the estimated effects are not statistically significantly different. Other factors seem less relevant to monetary policy responses to fiscal balances. A great deal of heterogeneity in this relationship appears to be associated with emerging economies and *de jure* inflation targeters. The next subsection explores this further.

Although our primary focus is to identify the common characteristics of countries exhibiting fiscal dominance, we broaden our analysis to classify countries based on their monetary policy responses to the covariates of the extended Taylor rule other than fiscal balance (see Figure 2). Consistent with theory, responses to inflation expectations (panel a) tend to be stronger in countries with a more independent CB, but weaker in countries with lower exposure to FX debt. The latter finding may constitute further indirect evidence in favor of hypothesis H_1. Namely, countries with higher dependency on domestic debt may face stronger fiscal

dominance pressures and not raise policy rates as much as required to maintain price stability.[19] All subgrouped estimates of responses to GDP growth (panel b) remain insignificant at the 5% level.

Figure 2: Long-run responses using threshold regression, by country and policy characteristics



(a) Inflation expectations

(b) GDP growth expectations

(c) Exchange rates

(d) US neutral rates

Notes: The confidence level of the error bars is 95%.

As expected, there is more variation in estimated responses to exchange rates (panel c), reflecting the different degrees that imported inflation matters across countries. First, emerging and advanced economies have opposite responses to currency depreciations; while emerging economies respond with higher interest rates, i.e., counterweighting the depreciation by reducing interest parity gaps, advanced economies respond with lower interest rates, which could be reasoned as a concern that depreciations may lead to aggregate demand pressures as exports gain competitiveness. This explanation seems consistent with the estimate that only low-commodity exporters respond positively to currency depreciations. Financial development also appears to play a role as it correlates with the estimated impacts by income groups.

Lastly, policy rates tend to be more positively correlated with U.S. neutral rates (panel d) in advanced economies than in emerging economies. This may be interpreted as a reflection

[19]Commodity exporters and countries with high import coverage also tend to have a weaker response to inflation, but the statistical significance of these differences is only marginal as the wide and overlapping standard error bars indicate.

of higher financial integration among advanced economies. This relationship also weakens for more independent CBs, suggesting that this may be a factor in the determination of long-run interest rates. Namely, stronger independence may give the CB more flexibility to set interest rates according to the domestic factors balancing the saving-investment relationship that underlies long-run interest rates. Intriguingly, policy rates tend to be negatively correlated with U.S. neutral rates in countries with a higher dependence on external debt. One would expect that for such countries it would be even more important to follow international interest rates to fight against capital flight when, say, those rates increase. One tentative explanation is that this estimated relationship captures portfolio re-allocation flows, e.g., from bonds to equity, as the higher international interest rates are likely to weaken foreign equity markets. We leave further analysis of this channel for future research.

4.3 Fiscal dominance in emerging economies

To inspect the responses to fiscal balances in emerging economies, the model is re-estimated over that subsample and further introducing interactions between the country classifications. Figure 3 presents the corresponding estimates. Across all estimates it is mostly the case that non-(*de jure*)-IT emerging economies have insignificant responses to fiscal balances.

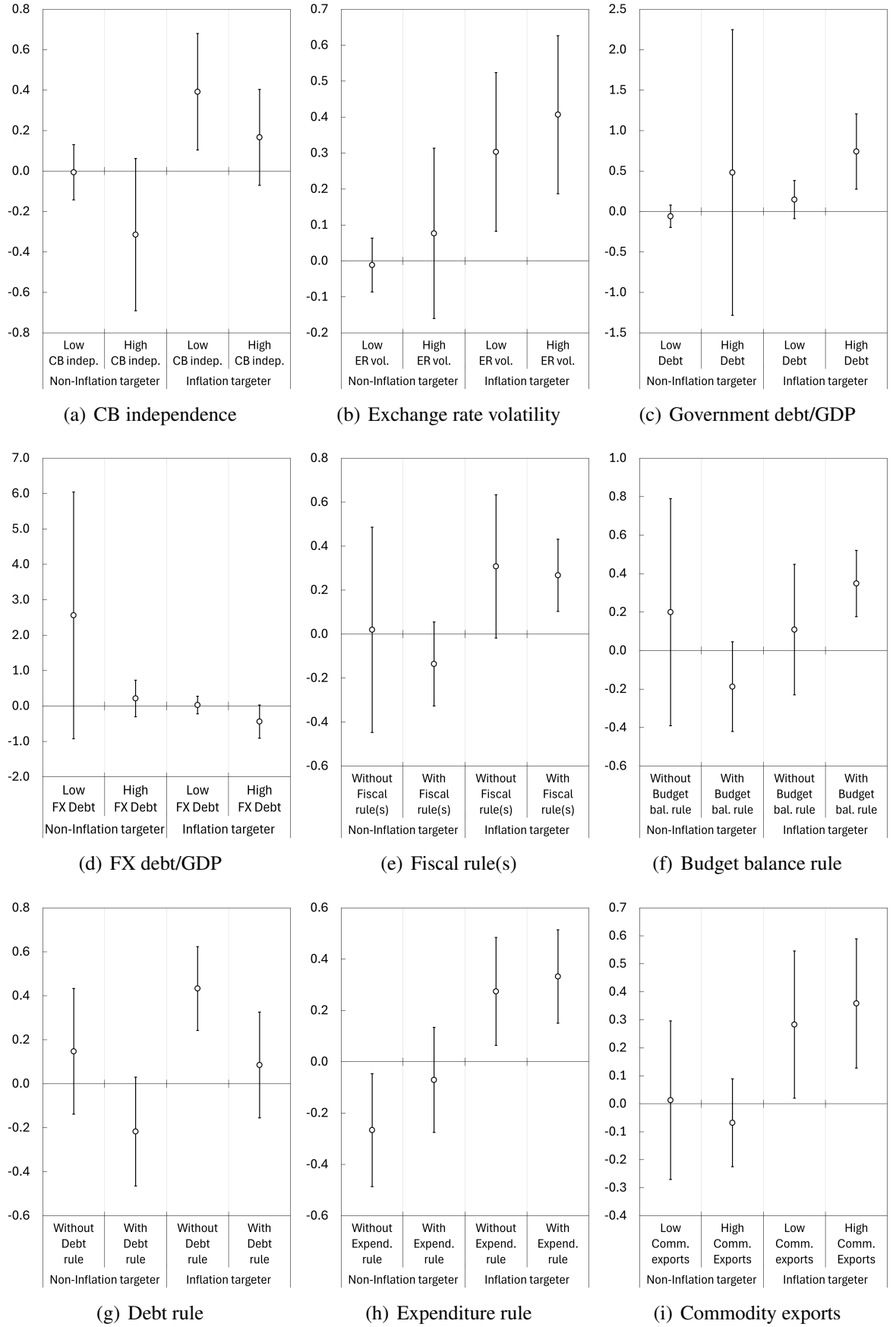
Emerging economies often face significant fiscal pressures due to high levels of government debt. In many cases, fiscal authorities rely heavily on CBs to monetize debt or lower borrowing costs when deficits cannot be financed sustainably. In the context of fiscal dominance, *de jure* IT emerging economies with limited CB independence (or *de facto* non-IT) may be compelled to lower interest rates, prioritizing fiscal objectives over stabilizing inflationary pressures (panel a). Interestingly, there is no statistically significant difference in the responses to fiscal balance between emerging economies with high and low exchange rate volatility (panel b) or intensity of commodity exports (panel i).[20] Hence, these results suggest that CB independence is a key determinant in the *de facto* characterization of an IT framework, which should, in theory, not be affected by fiscal dominance.

Emerging economies with higher debt tend to respond more strongly to fiscal balances, especially those under a *de jure* IT framework (panel c).[21] As discussed above, this is consistent with the view that the interaction between monetary and fiscal policy strengthens with concerns over debt sustainability as the debt-to-GDP ratio grows. However, debt composition is also an important determinant of the impact of fiscal balances on monetary policy. Namely, IT emerging economies with a high share of FX debt tend to respond to a deterioration in fiscal balances with higher policy rates (panel d). This finding is consistent with the hypothesis

[20]The findings that exchange rate volatility and commodity exports are not important determinants of fiscal dominance are in contrast with the findings of Ahmed et al. (2021), who associated *de facto* IT with levels of exchange rate volatility. By considering CB independence, our results complement their findings in providing a clearer *de facto* classification of IT.

[21]However, it must be noted there are fewer cases of high debt non-IT in the sample, which creates difficulties for inference as the large error bands in panel c of Figure 3 indicate.

Figure 3: Long-run responses to fiscal balance expectations in emerging economies, by country characteristic interacted with IT



(a) CB independence (b) Exchange rate volatility (c) Government debt/GDP

(d) FX debt/GDP (e) Fiscal rule(s) (f) Budget balance rule

(g) Debt rule (h) Expenditure rule (i) Commodity exports

Notes: The confidence level of the error bars is 95%.

of fiscal dominance driven by external debt concerns (H_2). It highlights a different channel through which fiscal and monetary policies can interact: exchange rate debt valuation effects. Particularly, a country holding a large share of debt denominated in foreign currencies will see its fiscal space shrink if its currency depreciates and the repayment burden of FX debt increases. Hence, fiscal dominance can manifest in putting pressure on monetary policy to keep interest rates high even as fiscal balances deteriorate, as the high interest rates would support the value of the national currency.

Fiscal dominance seems to prevail in *de jure* IT emerging economies, whether or not fiscal rules are in place (panel e). However, analyzing different types of fiscal rules reveals variations in fiscal dominance. Countries with budget balance rules (panel f) and those without debt rules (panel g) show relatively stronger positive responses to fiscal balance, while expenditure rules do not differentiate fiscal dominance among IT emerging economies (panel h). These results provide interesting insights about the impacts of fiscal rules on the conduct of monetary policy. Recall that, under H_1, fiscal dominance happens when a negative fiscal balance, driven by an increasing fiscal deficit, forces the CB to reduce policy rates. In countries with a budget balance rule, rising deficits can trigger fiscal tightening measures (e.g., spending cuts), which can have a contractionary effect on the economy. To sustain economic growth, CBs may respond by lowering interest rates to encourage borrowing and investment–this is also particularly the case for IT, which according to the Taylor rule would seek to stabilize economic activity. Hence, the implementation of fiscal budget balance rules, which would in principle lead to an improvement in fiscal accounts, can have a perverse effect on monetary policy by increasing fiscal dominance. In contrast, debt rules lead to lower fiscal dominance. In countries without a debt rule, fiscal deficits are more easily financed through borrowing, which would eventually increase fiscal dominance pressures on CBs. Hence, our results indicate that to avoid fiscal dominance the design of fiscal rules should focus on constraining debt accumulation instead of budget balance rules as the former may give more flexibility to fiscal authorities to achieve debt sustainability without "forcing the hand" of monetary authorities to cushion the impacts of fiscal austerity.

5 Robustness and Extensions

5.1 Robustness checks

To ensure the reliability and validity of our results, we perform a series of robustness checks. The estimates in column 1 of Table 3 is the baseline specification (from column 8 of Table 2), which serves as the benchmark of comparison for robustness checks.[22]

A concern in estimating the extended forward-looking Taylor rule is the potential correla-

[22]In addition, Table A.3 presents the panel estimates using a fixed sample that corresponds to the smaller common sample possible across the specifications. The results are broadly aligned with the estimates in Table 2. Hence, sample composition is not a major issue in this analysis.

Table 3: Panel estimation results, by model and estimator

	(1) Baseline	(2) Changes	(3) Changes	(4) Changes	(5) Quarterly	(6) No AR	(7) Censored	(8) PMG
Inflation	0.889***	0.915***	0.922***	0.922***	1.047***	0.702***	0.806***	1.485***
	(0.163)	(0.161)	(0.165)	(0.163)	(0.126)	(0.105)	(0.112)	(0.076)
GDP growth	0.134	0.140		0.196	0.008	0.209**	0.107	-0.054
	(0.111)	(0.112)		(0.129)	(0.135)	(0.097)	(0.099)	(0.057)
Δ(GDP growth)			-0.021	-0.089				
			(0.120)	(0.128)				
REER depreciation	0.032*	0.033*	0.030	0.032*	0.044**	0.043**	0.045**	-0.030***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.021)	(0.018)	(0.019)	(0.010)
US neutral	0.769***	0.786***	0.936***	0.778***	1.061***	1.053***	1.402***	0.733***
	(0.185)	(0.191)	(0.190)	(0.192)	(0.165)	(0.131)	(0.159)	(0.113)
Fiscal balance	0.159***	0.162***		0.147***	0.166**	0.064*	0.210***	0.140***
	(0.049)	(0.047)		(0.052)	(0.067)	(0.038)	(0.041)	(0.033)
Δ(Fiscal balance)		-0.017	0.097	0.001				
		(0.070)	(0.078)	(0.070)				
Interest rate smoothing	0.841***	0.844***	0.847***	0.844***	0.721***	0.932***	0.933***	
	(0.033)	(0.033)	(0.033)	(0.032)	(0.040)	(0.010)	(0.010)	
AR policy shocks	0.705***	0.701***	0.696***	0.701***	0.522***			
	(0.058)	(0.060)	(0.063)	(0.060)	(0.064)			
Lag order	6	6	6	6	3	12	10	4
AR order	12	12	12	12	4	0	0	0
No. of observations	9,523	9,487	9,479	9,479	3,432	10,523	10,538	10,178
No. of countries	52	52	52	52	52	52	52	52
(Pseudo) R-squared	0.992	0.992	0.992	0.992	0.975	0.991	0.854	
BIC	0.886	0.884	0.886	0.884	2.413	1.225	1.308	
AIC	0.830	0.826	0.830	0.826	2.299	1.177	1.261	
DW	1.833	1.821	1.822	1.827	1.726	1.276	1.163	

AR = autoregressive, AIC = Akaike information criterion, BIC = Bayesian information criterion, DW = Durbin-Watson statistic, GDP = gross domestic product, PMG = pooled mean group, REER = real effective exchange rate, US = United States.

Notes: ***, **, and * denote estimates statistically significant at the 1%, 5%, and 10% levels, respectively. Robust standard errors (period clustered) are in parentheses. Coefficient estimates are the implied long-run responses, except for interest rate smoothing and AR policy shocks which are the sum of corresponding lagged estimates. Lag orders are selected by minimizing BIC over a grid from 0 to 12 lags.

tion between fiscal balance expectations (as a share of GDP) and GDP growth expectations. To address this, we incorporated changes in expected fiscal balance and/or changes in expected GDP growth into the model. The results show that the magnitude and significance of the explanatory variables remain largely unchanged, while the change variables are not statistically significant (columns 2 to 4). This suggests that the estimated effects of fiscal balances on policy rates are not driven by correlation with expected GDP growth.

The use of monthly data may constitute another concern. Monetary policy decisions tend to occur at a lower frequency, while most estimates in the previous literature adopt quarterly data. Using quarterly averages also helps to attenuate the issue of missing monthly data. Column 5 presents the results obtained with quarterly averages. The magnitude and significance of responses to exogenous variables are generally consistent with the baseline, except for responses to inflation expectations and the U.S. neutral rates which are closer to unity. The former still does not satisfy the Taylor principle, as the estimate is not statistically significantly above unity, and the latter follows the standard relationship of actual policy rates and global neutral rates.

Another potential concern with the Taylor rule estimates presented so far is with respect

to the effect that the effective lower bound on interest rates may have on the response estimates. Several countries, especially advanced, have approached what can be considered effective lower bounds on interest rates over recent decades. Under these circumstances, monetary policy faces an asymmetric constraint as it cannot use policy rates for expansionary purposes, and that asymmetry can bias response estimates (Kim and Mizen, 2010). One alternative is to estimate censored regressions (column 7). Specifically, observations where the policy rate is below 25 basis points are tagged as censored and the panel Taylor rules are re-estimated. Unfortunately, for technical reasons the censored regression framework does not allow inclusion of autocorrelated policy shocks. Hence, these are estimated including only interest rate smoothing. The estimates are more properly comparable to panel estimates without autocorrelated policy shocks (column 6). They are broadly consistent with the baseline uncensored estimates (excluding AR policy shocks) although the coefficients of fiscal balance, U.S. neutral rate, and interest rate smoothing are higher. The increase in responses is consistent with intuition, as the censored regression estimates represent *desired* policy responses as opposed to the actual responses that were constrained by the effective lower bound.[23]

Lastly, to address the limitation of panel estimation in accounting for dynamic heterogeneous panels, we employed pooled mean group regression. The response to expected inflation is higher than baseline estimates, and the response to exchange rate depreciation inverts. This suggests heterogeneity in monetary policy responses is an important factor to consider, as our previous section results also illustrated. Finally, the response to fiscal balance remains close to the baseline estimates.

In summary, the robustness checks support our baseline specification—particularly with respect to the estimated policy rate response to fiscal balance expectation, which is found to be relatively stable and statistically significant across all robustness checks.

5.2 Time-varying responses

All estimates presented so far have been based on a sample covering up to about three decades of monetary (and fiscal) policymaking, depending on the country.[24] Monetary policy responses may have changed substantially over such a period with the turnover of CB officials, changing preferences, and even structural changes to the economy and policymaking frameworks. To evaluate the time-sensitiveness of inferences about monetary policy responses, the panel specification of the Taylor rule is re-estimated using rolling regressions.[25] Particularly, the model is re-estimated over 10-year rolling windows of data with the first window starting from January, 2000 to December, 2009, and extending for 23 years until the end of the sample in 2023.[26]

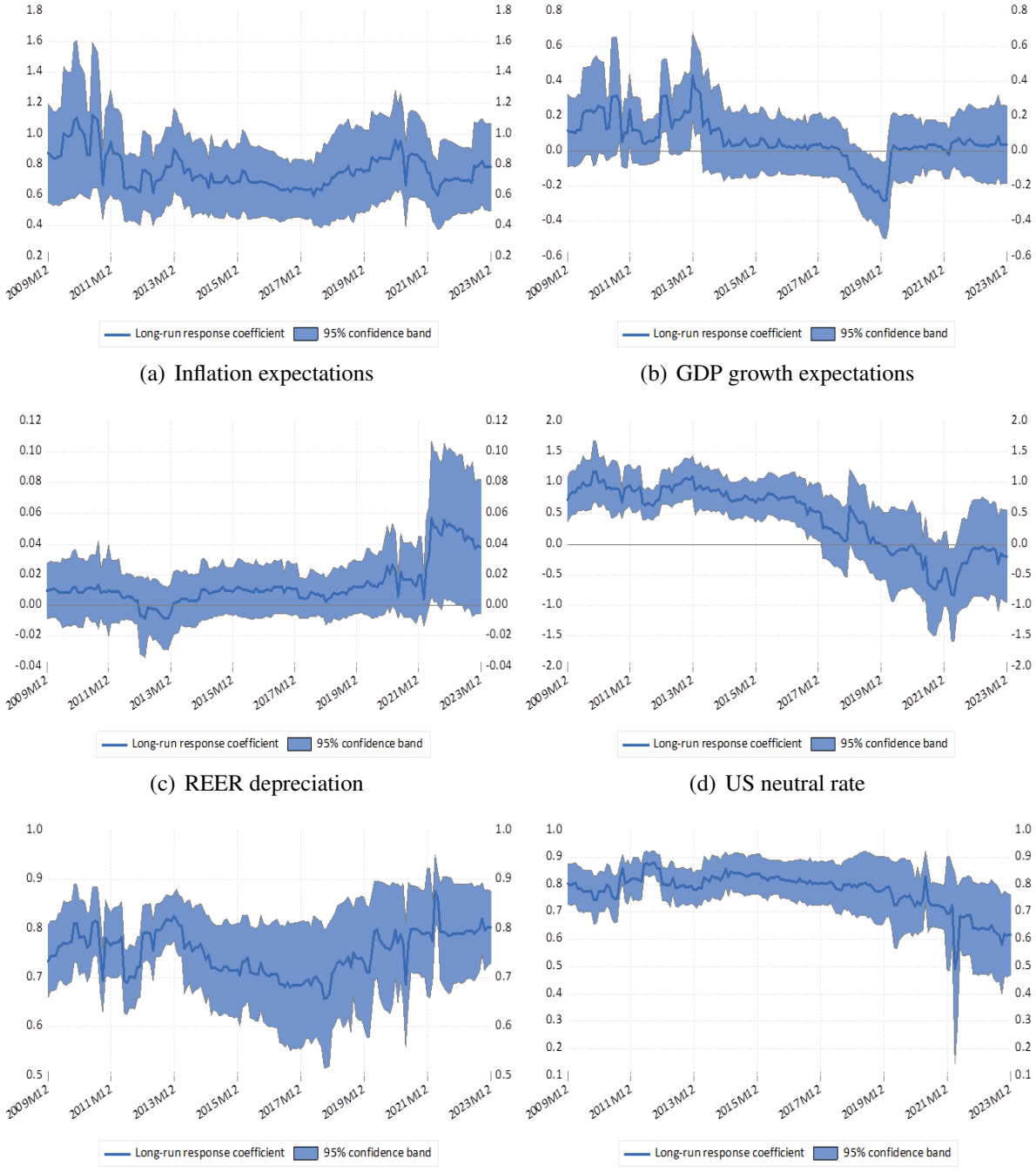
[23] Panel estimates with censored regression for the same specifications of Table 2 are presented in Table A.4 and further support this finding.

[24] Table A.5 lists the earliest date and maximum time period covered by country.

[25] Due to the granularity of data, the analysis in this section is restricted to the overall panel estimates.

[26] The lag orders are allowed to vary over time and the selection is re-ran for every window using the BIC.

Figure 4: Long-run responses using rolling regression



(a) Inflation expectations

(b) GDP growth expectations

(c) REER depreciation

(d) US neutral rate

(e) Interest rate persistence

(f) Policy shocks persistence

Figure 4 presents the evolution of the long-run interest rate response coefficients for the baseline panel specification (corresponding to column 8 in Table 2). Panel responses to expected inflation (panel a) remained relatively stable over the recent two decades, varying between 0.60 and 1.12, and statistically significant over the entire period. Responses to expected GDP growth (panel b) also fluctuated, with statistically significant positive responses between 2012–13, a period over which monetary authorities were mostly concerned with low economic growth and high unemployment, but negative responses in the period prior to the COVID-19

pandemic. Responses to exchange rate depreciation (panel c) were mostly statistically insignificant but increased abruptly in 2022 at the onset of the global interest rate hiking cycle to fight inflation. The period coincides with an appreciation of the U.S. dollar and the corresponding depreciation of emerging economies' currencies. Responses to the U.S. neutral interest rate trended down since 2018 (panel d), which may reflect increased global fragmentation in financial markets. Finally, interest rate smoothing (panel e) and policy shocks persistence (panel f) moved in opposite directions since the late 2010s, reflecting a shift to decreasing persistence in policy shocks and slightly stronger interest rate smoothing. Overall, standard errors are higher than in the full sample panel estimates reflecting the smaller number of observations used in the rolling windows.

Figure 5: Long-run responses to fiscal balance expectations using rolling regression

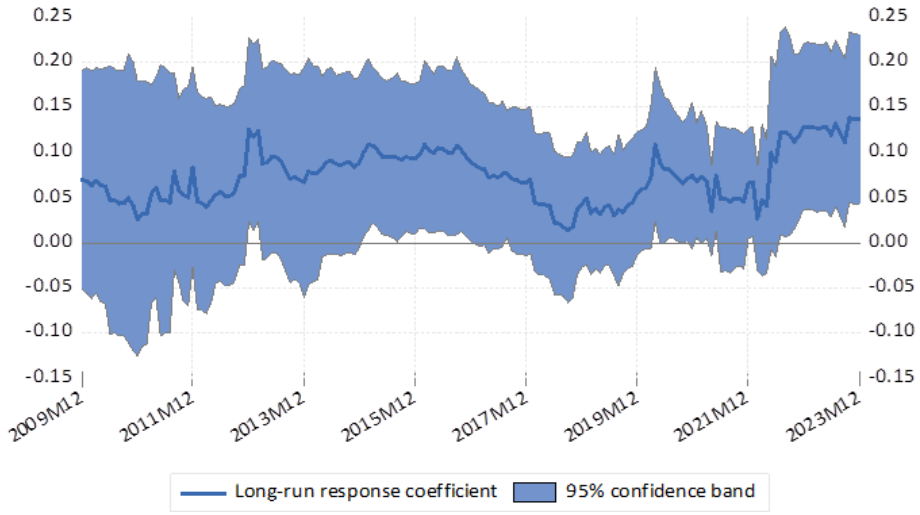


Figure 5 depicts the evolution of responses to fiscal balance expectations. Although the average response remained below the full sample estimates, there were noticeable fluctuations over the period. For example, the responses to fiscal balances were mostly positive and statistically significant between 2015 and 2016. Perhaps more intriguing, responses to fiscal balances have increased and reached their peak over the 2022–23 period, which highlights the topicality of fiscal dominance effects on monetary policy over the recent and coming years.

6 Conclusions

This paper investigates whether forward-looking monetary authorities are influenced by their country's fiscal position in setting interest rates. Particularly, we test for the presence of fiscal dominance, a situation where the central bank is put under pressure to deviate from its main goals of price stability and sustained economic growth and sets interest rates to accommodate fiscal imbalances. The approach relies on an augmented Taylor rule framework whereby central banks can respond to inflation and output growth expectations, as well as accounting for

exchange rates and trends in (global) neutral interest rates. The hypothesis of fiscal dominance is evaluated by further augmenting the policy rule with fiscal balance expectations. Estimating panel regressions with fixed effects over a sample of 52 economies, we find that central banks tend to respond positively to fiscal balance expectations, which suggests fiscal dominance effects on monetary policy.

Going beyond the aggregate panel analysis, we find that fiscal dominance effects appear stronger among inflation-targeting emerging economies with low central bank independence. Importantly, the design of fiscal rules emerges as a key determinant of fiscal dominance. Responses to expected fiscal (im)balances are found to be more pronounced in emerging economies with a budget balance rule. In contrast, debt rules are found to reduce fiscal dominance pressures in emerging economies. Hence, while disciplining governments to maintain fiscal sustainability, budget balance rules may lead to increased pressure for more accommodative monetary policy stances as these rules may trigger stronger fiscal austerity programs. Fiscal rules focusing on debt accumulation seem to avoid these perverse effects as fiscal authorities have more flexibility to achieve debt sustainability without crippling the economy.

We also find stronger interactions between monetary and fiscal policy for economies with a higher debt-to-GDP ratio. Interestingly, emerging economies with a high share of foreign exchange-denominated debt respond differently to fiscal imbalances. Namely, exchange rate debt valuation effects can create pressure on monetary policy to keep interest rates high even as fiscal balances deteriorate, so that interest rate differentials support the value of the national currency and prevent a deterioration in debt sustainability.

Finally, we find that interest rate responses to fiscal balances have increased in magnitude over the 2022–23 period. Therefore, these findings have important implications for contemporaneous monetary policy as many governments face increasing challenges of debt sustainability in the aftermath of the COVID-19 pandemic. As the analysis in this paper indicates, such challenges are likely to continue putting pressure on central banks and may lead to increased deviations from their main goals.

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A Appendix

A.1 Forecasts interpolation

Consensus Economics reports annual fixed-event forecasts (FEFs), wherein the forecast 'event' is set at a fixed date, usually ending in December. At each survey month m, forecasters provide a FEF for the current year that has a forecasting horizon of $(13-m)$ months, and a FEF for the succeeding year that has a forecasting horizon of $(25-m)$ months. Hence, the forecasting horizon shortens as the survey period approaches the end of the year.

For monetary policy purposes, the interest is instead on fixed-horizon forecasts, also known as rolling-event forecasts (REFs). A simple approach to convert FEFs into REFs is to weight-average the current- and next-year FEFs (Winkelried, 2023). Specifically,

$$\tilde{Y}_t^{t+12} = \left(\frac{13-m}{12}\right) Y_t^{cy} + \left(\frac{m-1}{12}\right) Y_t^{ny} \tag{8}$$

where Y_t^{cy} and Y_t^{ny} are the current-year and next-year FEF at survey month t, respectively, while $\tilde{Y}_t^{t+12}$ is the approximation of a 12-month ahead corresponding REF. In our application, this interpolation method is used to transform the FEFs for inflation, GDP growth, and fiscal balance to REF.

A.2 Output gaps

In order to obtain forward-looking output gap estimates we adopt the methodology of Galimberti and Moura (2016). The methodology involves three stages.

First, the data needs to be arranged in the form of monthly vintages. Our economic activity variable is real GDP. Given that real-time datasets are not available for the sample of countries we cover, we simulate what is known as *quasi-real* estimates (see Orphanides and Norden (2002)). Namely, we create monthly vintages of revised real GDP data where the latest data point of each vintage is determined to approximate what a policymaker would have been able to observe in real time. GDP data is generally published with a lag. While this lag can vary across countries, we make a simplifying assumption that the latest GDP data point in each vintage is observed with a two-month lag after the end of each quarter for every country in our sample.

Second, after creating the monthly vintages of real GDP data, we extend each vintage's sample using the CE forecasts of the vintage month. Because the CE forecasts are fixed-event forecasts for the current and next year, the number of GDP forecasts we can calculate will change with the vintage month. For example, in January vintages we can calculate up to eight quarters-ahead forecasts, while by December the number of possible forecasts is reduced to four.[27] To avoid creating a seasonal asymmetry in the number of forecasts used throughout the vintages we restrict the number of forecasts to four quarters across all vintages.

Finally, we filter the resulting vintages of extended GDP data to obtain four quarters-ahead output gap estimates. The final output gap measure we use each month corresponds to the average of the estimated output gaps from the previous quarter up to three quarters ahead. Averaging the forward-looking output gaps helps to smooth out seasonal variations generated by the forecasting method while discarding the last forecasted output gap (four quarters ahead)

[27] Note that in the January vintages the latest available real GDP figure will be from Q3 of the previous year due to the assumed two-month lag in the observation of that variable. Hence, to construct the January forecasts we use the December forecasted value of Q4 GDP to define the forecast base year.

helps to attenuate end-of-sample uncertainty in those estimates.[28] The use of average output gaps is also common in the literature (see, e.g., Clarida et al. (2000)). As for the filtering method, we adopt a Hodrick-Prescott filter with the smoothing parameter set to the standard value for quarterly frequency data (λ=1,600).

A.3 Supplementary data and results

Table A.1: Country classification

Country	IT	Adoption date	Exchange rate	Advanced
Albania	Yes	Jan-09	Floating	No
Armenia	Yes	Jan-06	Floating	No
Australia	Yes	Apr-93	Free floating	Yes
Azerbaijan	No		Stabilized arrangement	No
Belarus	No		Floating	No
Bolivia	No		Stabilized arrangement	No
Brazil	Yes	Jun-99	Floating	No
Bulgaria	No		Currency board	No
Canada	Yes	Feb-91	Free floating	Yes
Chile	Yes	Sep-99	Free floating	No
Colombia	Yes	Sep-99	Floating	No
Czech Republic	Yes	Dec-97	Free floating	Yes
Denmark	No		Conventional peg	Yes
Ecuador	No		No separate legal tender	No
Egypt	No		Stabilized arrangement	No
Euro Zone	Yes	Jan-99	n.a.	Yes
Georgia	Yes	Dec-09	Floating	No
Hungary	Yes	Jun-01	Floating	No
Hong Kong, China	No		Currency board	No
India	Yes	May-16	Floating	No
Indonesia	Yes	Jul-05	Floating	No
Israel	Yes	Jun-97	Floating	Yes
Japan	Yes	Jan-13	Free floating	Yes
Kazakhstan	Yes	Aug-15	Floating	No
Macedonia	No		Stabilized arrangement	No
Malaysia	No		Floating	No
Mexico	Yes	Jan-01	Free floating	No
New Zealand	Yes	Jan-90	Floating	Yes
Nigeria	No		Stabilized arrangement	No
Norway	Yes	Mar-01	Free floating	Yes
Paraguay	Yes	May-11	Floating	No

[28] Specifically, there are three sources of artefactual seasonal variation in the monthly vintages of output gap estimates. First, the two-month data publication lag can lead to stronger revisions in the third month of each quarter, when a new quarterly GDP data point becomes available. Second, the shrinking forecast window of current-year forecasts increases measurement errors in the conciliation with (revised) quarterly GDP data towards the last months of each year (and January due to the two-month lag). Third, the use of revised data can exacerbate these effects given that the CE forecasts were made in real time when forecasters only had access to unrevised data for the most recent quarters.

Table A.1: Country classification

Country	IT	Adoption date	Exchange rate	Advanced
Peru	Yes	Jan-02	Floating	No
Philippines	Yes	Jan-02	Crawl-like arrangement	No
Poland	Yes	Dec-98	Free floating	No
Republic of Korea	Yes	Jan-01	Floating	Yes
Romania	Yes	Aug-05	Crawl-like arrangement	No
Russia	Yes	Jan-15	Free floating	No
Saudi Arabia	No		Conventional peg	No
Serbia	Yes	Sep-06	Stabilized arrangement	No
Singapore	No		Stabilized arrangement	Yes
South Africa	Yes	Feb-00	Floating	No
Sri Lanka	Yes	Jan-15	Floating	No
Sweden	Yes	Jan-93	Free floating	Yes
Switzerland	No		Crawl-like arrangement	Yes
Taipei,China	No		n.a.	Yes
Thailand	Yes	May-00	Floating	No
Türkiye	Yes	Dec-06	Floating	No
Ukraine	Yes	Aug-15	Floating	No
United Kingdom	Yes	Dec-92	Free floating	Yes
United States	No		Free floating	Yes
Uruguay	Yes	Sep-07	Floating	No
Viet Nam	No		Crawl-like arrangement	No

IT = inflation targeter.

Source: Authors' compilation.

Table A.2: Definition and sources of data

Data	Sources
Consensus forecasts:	
Fiscal balance (% of GDP), inflation (%), GDP growth (%)	Consensus Economics
• Monthly, Fixed-event consensus forecasts	
Fiscal balance (% of GDP)	Focus Economics
• Monthly, Fixed-event consensus forecasts	
Actual data:	
Commodity exports (FOB in USD)	UN Comtrade
• Yearly, Total value of commodities with HS codes 1–10, 27–29, 44, 47–48, 72–76, 78–81	
CPI (index)	World Bank, CEIC, Eurostat, Reserve Bank of Australia, Reserve Bank of New Zealand
• Monthly (Quarterly in Australia and New Zealand), Changes in the cost to the average consumer of acquiring a basket of goods and services	
Government debt (% of GDP)	IMF, CEIC
• Yearly, Total stock of debt liabilities issued by the government	
FX debt (% of GDP)	World Bank
• Quarterly, Borrowing denominated in a currency other than that of the debtor's country	
Inflation rate (%)	CEIC
• Monthly, Percentage change in CPI year-on-year	
Exchange rate	CEIC, Eurostat
• Monthly, The value of local currency against 1 US dollar	
Interest rate (%)	BIS, CEIC, Bank of Japan
• Monthly, Interest rate that is used by central bank to implement or signal its monetary policy stance	
GDP gap (%)	Authors' calculations
• Monthly, Difference between a country's expected GDP and its potential GDP	
REER	BIS
• Monthly, Geometric trade-weighted averages of bilateral exchange rates that are adjusted using relative CPI	
Import cover	World Bank
• Yearly, Total reserves expressed in terms of the number of months of imports of goods and services that a country could pay for	
US neutral rate (%, estimates)	Holston, Laubach, & Williams (2023)
• Monthly, Real short-term interest rate expected to prevail when an economy is at full strength and inflation is stable	
Classification:	
Advanced economies	IMF

Table A.2: Definition and sources of data

Data	**Sources**
Inflation targeters	Fratzscher, Grosse-Steffen, & Rieth (2020), IMF
Exchange rate regimes	IMF
Fiscal rules	IMF
• Yearly, Long-lasting constraint on fiscal policy through numerical limits on budget balance, expenditure, revenue, and debt	
Index:	
CB independence index	Romelli (2024)
• Yearly, Combination of six dimensions such as governor and central bank board, monetary policy and conflict resolution, objectives, limitations on lending to the government, financial independence, and reporting and disclosure, expressed as an index that ranges from 0 being the lowest to 1	

Source: Authors' compilation.

Table A.3: Panel estimates with fixed sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inflation	0.965***	0.993***		0.977***	0.905***	0.933***	0.890***
	(0.191)	(0.224)		(0.193)	(0.166)	(0.184)	(0.163)
Inflation deviation from target			0.794***				
			(0.237)				
GDP growth	0.227*	0.214	0.157	0.260*	0.174	0.145	0.135
	(0.123)	(0.136)	(0.130)	(0.132)	(0.113)	(0.111)	(0.111)
Output gap		0.047	0.033				
		(0.056)	(0.059)				
REER depreciation				0.034			0.032*
				(0.022)			(0.019)
US neutral					0.832***		0.775***
					(0.186)		(0.185)
Fiscal balance						0.190***	0.160***
						(0.052)	(0.049)
Interest rate smoothing	0.854***	0.839***	0.823***	0.859***	0.845***	0.844***	0.841***
	(0.033)	(0.047)	(0.057)	(0.031)	(0.033)	(0.033)	(0.032)
AR policy shocks	0.720***	0.753***	0.790***	0.711***	0.706***	0.724***	0.705***
	(0.058)	(0.072)	(0.066)	(0.059)	(0.060)	(0.055)	(0.058)
Lag order	6	10	9	6	6	6	6
AR order	12	10	10	12	12	12	12
No. of observations	9,543	8,909	8,914	9,543	9,543	9,543	9,543
No. of countries	52	52	52	52	52	52	52
R-squared	0.992	0.992	0.992	0.992	0.992	0.992	0.992
BIC	0.891	0.861	0.870	0.890	0.887	0.889	0.885
AIC	0.837	0.801	0.811	0.835	0.833	0.835	0.829
DW	1.825	1.812	1.806	1.826	1.828	1.830	1.833

AR = autoregressive, AIC = Akaike information criterion, BIC = Bayesian information criterion, DW = Durbin-Watson statistic, GDP = gross domestic product, REER = real effective exchange rate, US = United States.

Notes: ***, **, and * denote estimates statistically significant at the 1%, 5%, and 10% levels, respectively. Robust standard errors (period clustered) are in parentheses. Coefficient estimates are the implied long-run responses, except for interest rate smoothing and AR policy shocks which are the sum of corresponding lagged estimates. Lag orders are selected by minimizing BIC over a grid from 0 to 12 lags.

Table A.4: Panel estimates using censored regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inflation	0.860***	1.246***		0.989***	0.750***	0.871***	0.807***
	(0.153)	(0.186)		(0.152)	(0.115)	(0.132)	(0.112)
Inflation deviation from target			1.056***				
			(0.182)				
GDP growth	0.693***	0.492***	0.564***	0.864***	0.187	0.295***	0.108
	(0.171)	(0.156)	(0.173)	(0.180)	(0.121)	(0.107)	(0.099)
Output gap		0.889***	0.996***				
		(0.245)	(0.269)				
REER depreciation				0.144***			0.045**
				(0.037)			(0.019)
US neutral					1.928***		1.407***
					(0.217)		(0.160)
Fiscal balance						0.289***	0.210***
						(0.051)	(0.041)
Interest rate smoothing	0.969***	0.970***	0.974***	0.967***	0.958***	0.943***	0.933***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)
Lag order	12	10	4	9	11	10	10
AR order	0	0	0	0	0	0	0
No. of observations	14,755	12,817	12,888	14,654	14,783	10,593	10,558
No. of countries	52	52	52	52	52	52	52
BIC	1.600	1.318	1.323	1.550	1.589	1.326	1.306
AIC	1.565	1.280	1.289	1.517	1.554	1.281	1.260

AR = autoregressive, AIC = Akaike information criterion, BIC = Bayesian information criterion, GDP = gross domestic product, REER = real effective exchange rate, US = United States.

Notes: ***, **, and * denote estimates statistically significant at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. Coefficient estimates are the implied long-run responses, except for interest rate smoothing which is the sum of corresponding lagged estimates. Lag orders are selected by minimizing BIC over a grid from 0 to 12 lags.

Table A.5: Time periods covered in the sample, by country

Country	Start date	Time span	Country	Start date	Time span
Albania	May-07	200	Mexico	Dec-98	301
Armenia	May-07	200	New Zealand	Jan-90	408
Australia	Jan-90	408	Nigeria	Dec-06	205
Azerbaijan	Jan-05	228	Norway	Nov-89	410
Belarus	May-98	308	Paraguay	Jul-10	162
Bolivia	Jan-13	132	Peru	Sep-03	244
Brazil	Feb-90	407	Philippines	Dec-94	349
Bulgaria	Jan-95	348	Poland	Jan-93	372
Canada	Oct-89	411	Republic of Korea	May-99	296
Chile	Jun-95	343	Romania	Jan-03	252
Colombia	Apr-95	345	Russia	Jan-95	348
Czech Republic	Jan-96	336	Saudi Arabia	Jan-00	288
Denmark	Nov-89	410	Serbia	May-07	200
Ecuador	Aug-95	341	Singapore	Jul-05	222
Egypt	Dec-94	349	South Africa	Jun-93	367
Euro Zone	Dec-02	253	Sri Lanka	Jan-97	324
Georgia	Jan-08	192	Sweden	Nov-89	410
Hong Kong, China	Jun-92	379	Switzerland	Nov-89	410
Hungary	Nov-90	398	Taipei,China	Jan-90	408
India	Dec-94	349	Thailand	May-00	284
Indonesia	Jul-05	222	Türkiye	Mar-02	262
Israel	Dec-94	349	Ukraine	Jan-95	348
Japan	Oct-89	411	United Kingdom	Jan-04	240
Kazakhstan	May-98	308	United States	Oct-89	411
Macedonia	Jul-07	198	Uruguay	Sep-07	196
Malaysia	Nov-95	338	Viet Nam	Aug-03	245

Figure A.1: Number of observations and countries, by sub-sample

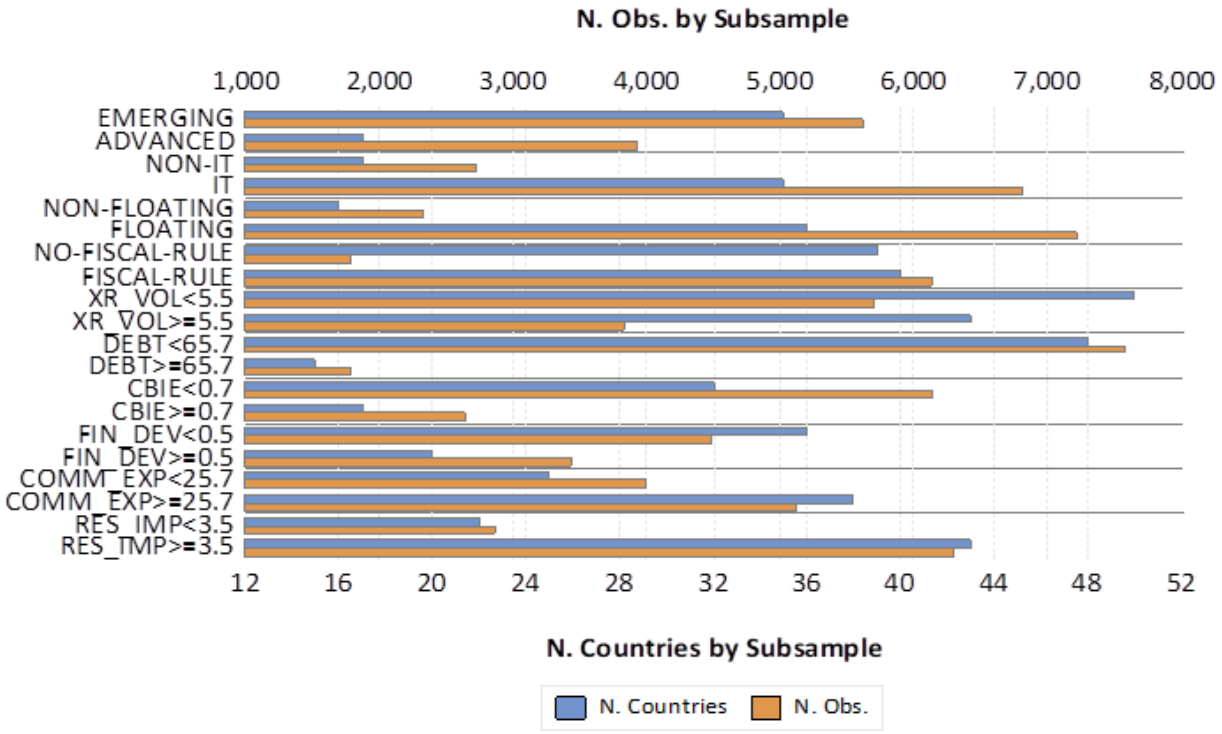


Figure A.2: Minimization of sum of squared residuals from threshold estimation

