Monetary-fiscal interactions during large-scale asset purchase programs*

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Abstract

This paper examines the effects of asset purchase programs (APPs) that were implemented in a number of countries during the COVID-19 pandemic in concert with large fiscal stimulus plans. We identify APP policy shocks for 14 advanced and emerging market economies using high-frequency identification techniques. We next estimate panel local projections, finding that APPs tend to stimulate output, but decrease prices. By using a Kitagawa-Blinder-Oaxaca decomposition, we demonstrate that these responses significantly depend on the magnitude of the simultaneously applied fiscal stimulus. One remarkable feature of higher government purchases during that period was that they crowded in private consumption and had a large effect on inflation. We show that these empirical findings, some of which are inconsistent with a standard New Keynesian framework, can be rationalized in a simple general equilibrium model with segmented asset markets and fiscal dominance.

Keywords: asset purchases, monetary-fiscal interactions, fiscal dominance, high-frequency identification, local projections, general equilibrium models

JEL Classifications: E44, E52, F41

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1 Introduction

Following the outbreak of the COVID-19 pandemic, many central banks around the world embarked on large-scale asset purchase programs (APPs). Remarkably, for the first time this policy was implemented not only in advanced economies, which had already been using APPs earlier to provide stimulus at the effective lower bound, but also by many emerging market economies, where monetary policy was still largely unconstrained. Perhaps even more importantly, the macroeconomic context was exceptional as purchases of bonds coincided with their massive issuance by the governments, which were trying to mitigate the effects of lockdowns on businesses and household income. The unprecedented scale, coordination, and fast deployment of these measures raised questions on how the swelling public debt will eventually be repaid and on the role of monetary policy in the process.

It is then not surprising that a growing number of studies acknowledge the possibility that much of the COVID-19 period debt will eventually be inflated away rather than repaid by an adjustment in taxes or public spending, also drawing analogies to exceptional episodes in the past like the world wars (see, e.g., Hall and Sargent, 2022; Cochrane, 2022; Leeper, 2021). In other words, the regime of fiscal dominance, extensively analyzed by the fiscal theory of the price level literature,[1] might have become a reality. These circumstances could be particularly relevant for emerging markets and developing economies, in some of which, including those that implemented APPs, the government framework can be considered relatively weak (Adrian et al., 2021). We also know from the recent theoretical literature that fiscal dominance can significantly change, or even reverse, the transmission of many standard shocks and policies (Smets and Wouters, 2024). It is therefore reasonable to expect that asset purchases implemented during a period of a particularly large and emergency fiscal stimulus may have had different macroeconomic effects than similar programs applied earlier by advanced economies.

Against this backdrop, in this study we first provide new empirical evidence on the effects of APPs applied during the COVID-19 pandemic and explore how these effects interact with fiscal policy. We use a sample of 14 small open economies, encompassing both advanced and emerging markets, for which we estimate monetary policy shocks using high-frequency identification methods that build on Swanson (2021). More specifically, for each country we extract three types of shocks, reflecting conventional interest rate setting, forward guidance, and asset purchases. These shocks are next cleaned of central bank information effects following

[1] Classical references include Sargent and Wallace (1981), Leeper (1991), Sims (1994), Woodford (1994), and Cochrane (2001). See also the literature review section below.

Jarociński and Karadi (2020). The sample runs from 2011 to 2023, and hence encompasses the period of monetary stimuli implemented in response to the COVID-19 pandemic.

In order to assess how APPs affect financial and macroeconomic variables, we estimate a number of panel local projections á la Jordà (2005). We find that APPs tend to boost output, household spending, and stock prices. However, there is limited evidence of currency appreciation, and consumer prices decline. If we compare these results with those obtained without removing information effects, we find that APPs were indeed partially interpreted as revealing bad news about economic fundamentals.

Since the launch of APPs during COVID-19 recession were accompanied by substantial fiscal expansion, we next conduct a Kitagawa-Blinder-Oaxaca decomposition of the local projection estimates as recently proposed by Cloyne et al. (2020), utilizing data on government spending. This allows us to separate the average monetary policy impact across the sample from its country-specific component, capturing the degree of domestic fiscal accommodation. Notably, our analysis reveals significant cross-country variation in government spending, which drives heterogeneous responses in GDP, consumption, and prices to APP shocks. Importantly, in countries where APPs coincided with a larger fiscal stimulus, the response of private consumption was significantly stronger, thus suggesting a crowding-in effect leading to a higher expansion in output. This part of the analysis also indicates that the response of inflation could be less negative, or even positive in countries where the fiscal stimulus was particularly big.

We note that some of the documented macroeconomic responses, including a fall in prices following a monetary easing, crowding-in of private consumption by government purchases, and a high sensitivity of inflation to their changes, are inconsistent with monetary policy transmission implied by the standard New Keynesian setup. We hence proceed by proposing a simple theoretical framework that could rationalize these findings. The key ingredients of the model are segmented bond markets and fiscal dominance. More specifically, we consider a simplified version of the setup proposed by Andres et al. (2004) and further developed by Chen et al. (2012). These papers incorporate limits to arbitrage between short and long-term bonds into a general equilibrium setup with nominal rigidities, so that changes in the relative supply of these assets, that can arise from large-scale purchases by a central bank, have real effects on economic activity and prices. Within this framework, we allow for the possibility that fiscal policy is active in the spirit of Leeper (1991).

In this model, APPs expand the economic activity and inflation if fiscal policy is assumed to be passive, i.e., taxes (or other fiscal instruments) eventually adjust to ensure long-run stabilization of public debt. However, when the economy operates under fiscal dominance, the response of inflation is negative, consistent with our empirical results. This is because APPs lower debt servicing cost and hence improve the fiscal position. Absent any adjustment in fiscal instruments, bringing public debt back to its long-run equilibrium level requires low inflation that is unaccommodated by monetary policy (which hence assumes a passive stance) – a mechanism consistent with the fiscal theory of the price level.

The model operating under fiscal dominance is also consistent with the part of our results that use the Kitagawa-Blinder-Oaxaca decomposition of APP effects with respect to government consumption. As this regime implies that taxes do not respond to an increase in public debt generated by increased government purchases, it is brought back to its long-run level through higher inflation, which decreases its real level and the real cost of servicing it. As a result, private consumption is crowded in while the response of inflation, given its key role in stabilizing debt, is much stronger than under the standard monetary active / fiscal passive regime.

Related literature The empirical part of our project builds on the vast literature that uses monetary policy shocks based on high-frequency identification to analyze their impact on financial markets (e.g., Kuttner, 2001; Cochrane and Piazzesi, 2002; Gürkaynak et al., 2005; Gilchrist et al., 2015; Altavilla et al., 2019; Andrade and Ferroni, 2021; Swanson, 2021; Lewis, 2023) and macroeconomic variables (e.g., Gertler and Karadi, 2015; Bauer and Swanson, 2023). To address the concern that central bank announcements may convey news about economic conditions, Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021) additionally isolate potential information effects. Some of these studies distinguishes between conventional and unconventional monetary policy shocks, the latter also including APPs. Fabo et al. (2021) provides a meta-analysis of this literature. The common feature of these papers is that they all focus on large advanced economies, such as the US or the euro area, and it is not clear to what extent the obtained results carry over to other countries, and especially to developing economies with much shallower bond markets and less established monetary and fiscal policy credibility.

We also contribute to the growing literature on identifying monetary policy shocks for multiple countries using a consistent econometric framework. Brandao-Marques et al. (2021) construct monetary policy shocks for 39 emerging markets and developing economies using Taylor rule residuals and investigate how the transmission of monetary policy rates to output and prices varies across country characteristics such as financial development, monetary policy frameworks, and financial dollarization. Deb et al. (2023) adopt a similar approach to construct monetary policy shocks for 33 countries and find significant heterogeneity in the transmission of monetary policy across countries, contingent upon cyclical conditions and structural characteristics. Checo et al. (2024) identify monetary policy shocks for 18 emerging market economies using Bloomberg analysts' forecasts of policy rate decisions and analyze their impact on a range of financial and macroeconomic outcomes, as well as firm-level variables. Finally, Choi et al. (2024) construct a panel dataset collecting estimates of monetary policy shocks for a sample of 176 countries and analyze how the effects of monetary policy vary with various industry characteristics. Relative to these studies, we contribute to the analysis of monetary transmission by distinguishing between three different types of monetary policy shocks and by focusing on the effects of APPs rather than conventional monetary policy shocks.

From a methodological perspective, we relate to papers that apply the Kitagawa-Blinder-Oaxaca (KBO) decomposition (Kitagawa, 1955; Blinder, 1973; Oaxaca, 1973) — a tool commonly used in applied microeconomics — to the macroeconomic context. In particular, Cloyne et al. (2020) use the KBO decomposition to show that the fiscal multiplier identified in the data depends on the behavior of monetary policy. Using a similar framework, Kolasa and Wesołowski (2024) study the domestic-foreign monetary policy interactions. In contrast to these studies, we apply the KBO decomposition to examine how the effects of APPs may be conditioned by fiscal reactions, which can be particularly relevant during exceptional circumstances such as those associated with the COVID-19 pandemic.

The theoretical part of our project builds on the bond market segmentation framework developed by Andres et al. (2004), Chen et al. (2012), and Kiley (2014). We extend this framework to incorporate an active fiscal / passive monetary policy mix as considered by Leeper (1991) and to investigate the interactions between APP shocks and the fiscal policy stance.

Our paper is also related to the growing body of literature that investigates the impact of the interactions between monetary and fiscal policies on inflation dynamics, especially in the context of programs implemented during the COVID-19 pandemic and attracting particular interest due to the following surge in inflation. Bianchi et al. (2020) study the implications of a coordinated fiscal and monetary strategy aiming at creating a controlled rise of inflation and an increase in fiscal space in response to the COVID-19 shock. Barro and Bianchi (2023) applies the idea of fiscal dominance to a panel of 37 OECD countries for 2020-2023 and find that the recent fiscal expansion has been a key driver of inflation. Caramp and

Silva (2023) uses a decomposition of the equilibrium in a simple model with sticky prices to show how the economy's responses to monetary policy crucially depend on the fiscal backing. Witheridge (2024) develops a small open economy New Keynesian model with monetary-fiscal interactions to show that a fiscal-led policy mix can explain the increase in inflation documented in emerging markets after monetary policy tightening. Despite these recent empirical and theoretical advances, there is still a major gap in the literature concerning the degree to which the fiscal stance determines the effectiveness of unconventional monetary policy measures such as APPs, and how these interdependencies differ from the case of standard interest rate-based monetary policy.

Outline The rest of this paper is structured as follows. Section 2 presents the monetary shock identification procedure and its outcomes. Section 3 provides empirical evidence on the impact of APPs on macroeconomic and financial variables and how this impact depends on the simultaneously provided fiscal stimulus. Section 4 develops a stylized theoretical model with bond market segmentation that allows us to consider alternative monetary-fiscal regimes. Section 5 presents the model simulations. Section 6 concludes.

2 Shock identification

In this section, we describe the procedure used to identify conventional and unconventional monetary surprises for a number of small open economies that implemented large-scale asset purchase programs during the COVID-19 pandemic. In total, we consider 14 countries, encompassing both advanced and emerging market economies.[2] As our goal is to focus on exceptional circumstances that led to a large and concerted monetary-fiscal stimulus during the COVID-19 recession, our sample excludes countries that were actively using asset purchases prior to the pandemic, such as the US, euro area, Japan, Sweden, and the UK. The data sample for most economies covers the period from 2011m1 to 2023m12[3].

To construct the monetary policy shocks, we rely on a high-frequency identification scheme proposed by Swanson (2021) and applied to the US, which builds upon earlier work by Gürkaynak et al. (2005). A similar method was employed by Altavilla et al. (2019) to

[2]The countries are: Brazil, Canada, Chile, Colombia, Hungary, Indonesia, Israel, Korea, Mexico, Norway, Poland, Romania, South Africa, and Thailand.

[3]The exceptions here are Brazil, Colombia, Mexico, and Romania, for which, due to limited data availability, the samples cover the periods of, respectively, 2014m2-2023m12, 2012m8-2023m12, 2011m1-2023m1, and 2011m8-2023m12.

identify conventional monetary policy surprises, as well as forward guidance and QE shocks in the euro area.

In the first step of our procedure, we construct a monetary event database for each country in the sample. This database includes not only the meeting dates of monetary policy decision-making bodies (downloaded from Bloomberg) but also the announcement dates of asset purchase programs collected by Fratto et al. (2021) and Rebucci et al. (2020), which are listed in Table 3. Next, we gather high-frequency data on interest rates with varying maturities to calculate the changes in these rates around the monetary policy events. Due to limited data availability, we consider slightly different sets of interest rates for each country. We utilize both spot and forward interest rates. The detailed list of interest rates used, along with their Bloomberg tickers, is presented in Table 2. Since the financial markets in many of the economies included in our sample are not as liquid as in the US, we do not rely on the intraday changes in the interest rates but utilize two-day windows around monetary events (from the end of the day before to the end of the day after). A natural concern is that changes in interest rates of small open economies in such wider time windows may not solely reflect the effects of domestic monetary events, but can also result from trends in global financial markets. To control for this effect, we run a simple linear regression for each interest rate, where we explain the changes in that rate using changes in interest rates of the corresponding maturities in two leading global economies: the US and the euro area[4]. The residuals from these regressions are then utilized in the subsequent analysis.

As a next step, for each country, we construct a $T \times n$ matrix X, where the rows correspond to monetary policy events and the columns represent the residuals from the regressions described above. Following Swanson (2021), we first scale each column of X to have a mean of zero and a variance of one. We then employ factor analysis to describe the variability among the collected standardized changes in interest rates using a smaller number of unobserved factors. Thus, we express X as:

$$X = F\Lambda + \varepsilon \tag{1}$$

where F is a $T \times k$ matrix of unobserved factors (with $k \leq n$), Λ is a $k \times n$ matrix of loadings of interest rate responses on the k factors, and ε is a $T \times n$ matrix of white noise residuals that is uncorrelated over time and across interest rates.

We estimate the unobserved factors F and retain three principal components (i.e. $k = 3$) that have the greatest systematic impact on interest rates around the considered monetary

[4]To increase the number of observations, we do not restrict ourselves to monetary policy event dates when running these regressions. Instead, we use the entire time series of daily data.

events[5]. We then rotate these components to provide a structural interpretation as conventional monetary policy, forward guidance, and asset purchase program factors. For this purpose, we construct an alternative factor model represented by the matrices $F^* \equiv FU$ and $\Lambda^* \equiv U'\Lambda$, where U is a 3×3 orthogonal rotation matrix that satisfies the following three restrictions: (i) changes in APP have no effect on the short-term (one-month) interest rate, (ii) changes in forward guidance have no effect on the short-term (one-month) interest rate, and (iii) the APP factor has the smallest variance during the period before the implementation of APP in 2020 and after the end of 2021. More technical details regarding the identification strategy and the construction of the rotation matrix can be found in Swanson (2021) and Altavilla et al. (2019), which we follow closely.

The three restrictions, along with the orthogonality assumption, uniquely identify U and F^* to a sign normalization for each column. In the final step, we normalize the sign of the first rotated factor to have a positive effect on the one-month rate, the sign of the second one such that it has a positive impact on the two-year rate[6], and the third one to have a positive impact on the ten-year interest rate.

Once we have estimated the conventional, forward guidance and APP factors, we obtain their surprise components by eliminating the information effects from the identified shocks. As argued by Jarociński and Karadi (2020) or Miranda-Agrippino and Ricco (2021), central bank decisions convey information about both monetary policy and the central bank's view on the economic outlook. These two components can have very different implications for the reaction of standard macroeconomic aggregates. In order to disentangle one from another, we follow the strategy proposed by Jarociński and Karadi (2020) and analyze the co-movement of shocks identified in the previous step and stock prices around policy announcements. If the shock co-moves negatively with the stock market, we treat it as a 'pure' monetary intervention. The positive co-movement is an indication for the presence of an accompanying information shock. In the further analysis, we use the shocks that have been cleaned of the informational content of monetary decisions.

Having estimated surprise components of monetary policy decisions, we verify the identification scheme by estimating their effects on four assets at a weekly frequency: the one-month interest rate, the 10-year interest rate, stock prices, and the exchange rate of the domestic currency against the US dollar (an increase indicates an appreciation of the local currency). For each of these variables, we run the sequence of the following panel regressions:

[5] Depending on the country, three factors explain between 77% and 97% of the variation in X.

[6] For Hungary, (long enough) daily data on two-year interest rates are not available, and so we normalize the forward guidance shock to have a positive impact on the three-year interest rate.

$$y_{j,t+h} - y_{j,t-1} = \alpha_{j,h} + \beta_h \varepsilon_{j,t} + \mathbf{x}_{j,t} \gamma_h + \nu_{j,t+h} \tag{2}$$

where $y_{j,t}$ is one out of four endogenous variables in country j in period t and $\varepsilon_{j,t}$ is a vector of the three monetary policy shocks that hit the economy j at time t. The first two shocks represent surprise components of conventional monetary policy and forward guidance, as obtained in the identification procedure described above. The third shock is defined as the surprise APP factor multiplied by the dummy variable $d_{j,t}$ that equals one in the periods following the first APP announcement in a given country and zero otherwise. The set of the control variables $\mathbf{x}_{j,t}$ includes: four lags of the dependent variable and monetary policy factors, as well as the APP factor multiplied by the $1 - d_{j,t}$ (contemporaneous and four lags).

Figure 1 presents the responses of the above-mentioned financial variables to each of the three types of accommodative monetary shocks. In line with our identification restrictions, forward guidance and APP shocks are found to have no impact on the short-term interest rate. This applies not only to the immediate response of the variable, but also to its reaction in the following weeks. Long-term interest rates decline in response to all three types of monetary disturbances. However, the reaction to conventional monetary policy shocks occurs somewhat more gradually. The accommodative conventional monetary shock also leads to depreciation of the domestic currency in line with the standard theory, and insignificant response of stock prices. At the same time equity valuations turn out to be more responsive to expansionary forward guidance and APP shocks, pointing to their importance for financial markets. Furthermore, these two shocks result in appreciation of the domestic currency – the latter result found also by Arena et al. (2021) in the context of APP programs.

3 Empirical evidence

This section presents the main empirical results of the paper. First, we estimate the impact of monetary policy shocks on the economies included in our sample. To this end, we run a set of panel local projections (Jordà, 2005) and present the impulse response functions (IRFs) based on them. Second, we focus on the monetary-fiscal interactions and use the so-called Kitagawa-Blinder-Oaxaca (KBO) decomposition (Kitagawa, 1955; Blinder, 1973; Oaxaca, 1973) to condition the transmission of APP shocks on government spending responses. More specifically, we do it by adopting a panel local projection implementation of this decomposition developed by Cloyne et al. (2020).

3.1 Panel local projections

While analyzing the effects of APP shocks, we consider six monthly time series, i.e. industrial production[7], retail sales, CPI, real effective exchange rate, long-term interest rate, and stock prices. More specifically, for each of these six variables we estimate the following panel local projections:

$$y_{j,t+h} - y_{j,t-1} = \alpha_{j,h} + \beta_h \varepsilon_{j,t} + \mathbf{x}_{j,t}\gamma_h + \nu_{j,t+h} \tag{3}$$

for horizons $h = 0, ..., 11$ months, where $\epsilon_{j,t}$ represents the APP shock defined as in regressions 2. The set of control variables $\mathbf{x}_{j,t}$ in our baseline specification includes: 6 lags of the dependent variable, the APP factor multiplied by the $1 - d_{j,t}$, 6 lags of the APP factor, contemporaneous and 6 lags of the US industrial production growth, and contemporaneous and 6 lags of the Google mobility index (which aims to capture the impact of COVID-19 restrictions), contemporaneous and 6 lags of growth of the VIX index. In the regressions for variables other than industrial production, we also include 6 lags of this variable. Finally, $\alpha_{j,h}$, β_h and γ_h are the estimated parameters, where $\alpha_{j,h}$ denote the country fixed effects, and $\nu_{j,t+h}$ are the regression residuals. The choice of the control variables was based on economic intuition and common practice, but we test also a number of alternative specifications differing in the number of lags and set of controls.[8] The data sources are listed in Table 4.

Figure 2 presents the responses of the endogenous variables to a one-standard deviation APP shock. As one could expect, the accommodative APP shock lowers the long-term interest rate by 2 bp on impact and 4 bp at the trough. It also stimulates the economic activity, leading to a long-lasting increase in industrial production and a temporary rise in retail sales (by 0.4% each). These results are robust across many specifications such as including less (see Figure 3) and more controls,[9], changing the number of their lags and the way shocks are identified – see Figure 4 for shocks unadjusted for information effects and Figure 5 for shocks unadjusted for either information effects or for the impact of foreign interest rates.

Furthermore, we find that after an APP accommodation, the exchange rate slightly depreciates (by 0.1%), stock prices increase (by 0.5% at the peak), while consumer prices mildly decrease. The responses of these three variables depend on whether we clean from the information effects, stressing the importance of this step while identifying APP shocks. In

[7] Since industrial production data for Mexico and South Africa are unavailable, we use instead the series for production in total industry, including construction, and production in total manufacturing, respectively.

[8] These results are not reported in the paper but available upon request.

[9] We tested adding variables such as the exchange rate, interest rate, oil prices as well as conventional and forward guidance monetary policy shocks.

particular, unadjusted APP shocks do not significantly increase stock prices on impact and lead to exchange rate appreciation, which is consistent with some of the findings reported in the literature as discussed in section 2. Interestingly, if we do not clean the shocks of information effects, prices no longer fall in response to an APP expansion, but even show some increase. Together with a somewhat smaller expansion of industrial production and retail sales in this specification compared to our baseline variant, the change in the sign of the inflation response suggests that APP announcements were partially interpreted as unfavorable information about economic supply-side fundamentals, revising agents' expectations towards lower economic activity and higher inflation pressure.

3.2 Kitagawa-Blinder-Oaxaca decompositions

The second part of our empirical investigation focuses on monetary-fiscal interactions, aiming to assess the extent to which fiscal policy may reinforce the impact of APPs. To this end, we use the KBO decomposition, which boils down to running a two-step regression. In the first step, we estimate a panel model, in which we regress the changes in government spending from period $t-1$ to $t+h$ on the APP shock $\epsilon_{j,t}$, allowing the coefficient to vary by country. More specifically, we estimate the sequence of the following local projections:

$$G_{j,t+h} - G_{j,t-1} = \alpha_{j,h} + \sum_{i=1}^{j} \varepsilon_{j,t} I(j=i)\Theta_j^h + (\mathbf{x}_{j,t} - \bar{\mathbf{x}}_j)\,\gamma_h + \nu_{j,t+h} \tag{4}$$

where Θ_j^h is our key variable of interest, capturing cross-country heterogeneity in the sensitivity of fiscal policy to APP shocks, and all control variables are expressed in differences from their means.

In the second step, we use the estimates of Θ_j^h to decompose the response of endogenous variables into two components: the direct (average) effect of APP shock and the indirect effect that explores how the effects of APP shocks are modulated by the fiscal reaction in a particular country. More precisely, we estimate:

$$y_{j,t+h} - y_{j,t-1} = \alpha_{j,h} + \beta_h \varepsilon_{j,t} + \varepsilon_{j,t}\left(\Theta_j^h - \bar{\Theta}^h\right)\theta_\varepsilon^h + \varepsilon_{j,t}\left(\mathbf{x}_{j,t} - \bar{\mathbf{x}}_j\right)\theta_x^h + \left(\mathbf{x}_{j,t} - \bar{\mathbf{x}}_j\right)\gamma_h + \nu_{j,t+h} \tag{5}$$

where $\beta_h \varepsilon_{j,t}$ measures the direct impact of APP shock and $\varepsilon_{j,t} \left(\Theta_j^h - \bar{\Theta}^h \right) \theta_\varepsilon^h$ captures the indirect effect. Here, $\bar{\Theta}^h$ represents the average of Θ_j^h across all countries, while θ_ε^h denotes the estimated parameter. Following Cloyne et al. (2020), our regression includes the control variables expressed as deviations from their means, as well as the interaction between the demeaned controls and the APP shock.

Due to the limited availability of fiscal variables at a monthly frequency, we conduct the KBO decomposition using quarterly data and consider three endogenous variables: GDP, private consumption, and consumer prices. Furthermore, since regression 5 includes interaction terms, we need to limit the number of controls compared to the local projections 3 in order to preserve degrees of freedom. As a result, our set of controls includes: APP shock as well as APP factor multiplied by the $1 - d_{j,t}$ and their first lags, one lag of domestic GDP, as well as contemporaneous and first lags of US GDP and Google mobility index. As can be seen by comparing our baseline results (Figure 2) with those that use this reduced set of controls (Figure 3), they are very similar.

Figure 6 presents the response of three key variables to APP shock depending on the degree of fiscal accommodation obtained from the KBO decomposition. More precisely, in the upper left panel showing the response of government spending, each line represents $\bar{\Theta}^h + \kappa \sigma_{\Theta_j^h}$, where $\sigma_{\Theta_j^h}$ denotes the cross-country standard deviation of Θ_j^h, and κ takes one of the following values: -1, -0.5, 0, 0.5, and 1. On the panels presenting the remaining variables, each line corresponds to $\beta_h + \theta_\varepsilon^h \kappa \sigma_{\Theta_j^h}$, with κ taking the same values as in the case of government spending.

As shown in Figure 6, the response of government spending to an APP shock is highly heterogeneous across the analyzed countries: the average reaction of government spending in our sample is slightly negative, but in some countries the decrease is much more prominent, while in others it is positive. Interestingly, we find the crowding-in effects of fiscal spending for private consumption since more expansionary fiscal policy is associated with higher consumption and, as a result, also higher GDP. What is also remarkable, output and consumption vary significantly depending on the government spending level (Figure 7). They may even decline after an expansionary APP shock if the government decides to significantly cut its spending in response to this shock.

Similarly to our baseline results from local projections, the average response of consumer prices to an accommodative APP shock is negative and the drop in prices becomes more pronounced when fiscal policy is more restrictive. Even though their response is not as heterogeneous conditional on fiscal policy as in the case of real variables, we find that it may also change a sign. In particular, prices increase slightly if accommodative APP is accompanied by a sufficiently large increase in government spending.

4 Theoretical model

In this section, we develop a simple model that combines segmented bond markets with fiscal dominance, otherwise collapsing to the textbook New Keynesian framework.

4.1 Households

Our model economy is populated by two types of households, differing in their financial market participation. The first type, whom we call passive investors, indicated with superscript P, and whose mass is $0 \leq \omega \leq 1$, can trade only long-term bonds. The other households, dubbed as active, indicated with superscript A and of mass $1-\omega$, have access to both short and long-term bonds, but holding the latter is subject to transaction costs.

Following Woodford (2001), we model long-term bonds as perpetuities that pay an exponentially decaying coupon $1, \delta, \delta^2, \ldots$ starting in the period following issuance, where $\delta \in (0,1]$ is a parameter that controls the average bond duration. Both types of agents earn labor income and receive profits from monopolistically competitive firms, which they spend to purchase a homogeneous consumption good and to pay lump-sum taxes. Their nominal budget constraints can hence be written as

$$P_t c_t^P + T_t^P + P_{L,t} L_t^P \leq W_t n_t^P + D_t^P + (1 + \delta P_{L,t}) L_{t-1}^P \tag{6}$$

$$P_t c_t^A + T_t^A + P_{L,t} L_t^A (1 + \zeta_t^A) + B_t^A \leq W_t n_t^A + D_t^A + \Gamma_t^A + (1 + \delta P_{L,t}) L_{t-1}^A + R_{t-1} B_{t-1}^A \tag{7}$$

where, for $j = \{P, A\}$, B_t^j and L_t^j denote, respectively, agent j's holdings of short and long-term bonds, c_t^j is real consumption, n_t^j is labor effort, T_t^j stands for taxes paid to the government, and D_t^j are nominal dividends. The nominal wage rate is denoted by W_t, the price of newly issued long-term bonds is $P_{L,t}$,[10] the short-term interest rate is R_t, and the

[10] See Chen et al. (2012) on how to derive the equations above without needing to keep track of long-term bonds issued in the past.

price level is P_t. We assume that transaction costs are an increasing function of aggregate holdings of long-term bonds by active agents, i.e., $\zeta_t^A = \zeta(B_{L,t}^A/P_t)$, $\zeta' > 0$. These costs are rebated back in a lump-sum fashion and denoted as Γ_t^A.

Households maximize a standard utility functional

$$U_0^j = \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta_j)^t \left[\log(c_t^j) - \frac{(n_t^j)^{1+\varphi}}{1+\varphi} \right] \tag{8}$$

where $0 \leq \beta_j < 1$ is the discount factor, and $\varphi > 0$ denote the (inverse) intertemporal and Frish elasticity, respectively.

4.2 Production

The production sector in our model is very standard in the New Keynesian literature. At the middle stage of production homogeneous goods are produced by perfectly competitive aggregators that use a continuum of intermediate inputs indexed by i

$$y_t = \left(\int_0^1 y_t(i)^{\frac{1}{\mu}} di \right)^{\mu} \tag{9}$$

where $\mu > 1$ controls the degree of substitution between individual input varieties.

Intermediate inputs are either produced by monopolistically competitive firms that operate a linear production function in labor

$$y_t(i) = n_t(i) - \phi \tag{10}$$

where $\phi \geq 0$ is a fixed cost of production that ensures zero profits in the steady state.

All intermediate goods firms set their prices are subject to the Calvo-style price rigidity. More specifically, every period producers face a constant probability $1 - \theta$ of price reoptimization. The problem of firms at the time of price reset is to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \theta^t \frac{\lambda_t}{P_t} \left[P_0 \left(i \right) y_t(i) - W_t n_t(i) \right] \tag{11}$$

where $\lambda_t = (\beta_P / c_t^P)^{\omega} (\beta_A / c_t^A)^{1-\omega}$ is the stochastic discount factor reflecting that firms are owned by households proportionally to their shares in population. This maximization problem is subject to the demand schedules solving aggregators' optimization problem described above.

4.3 Monetary authority

Monetary authority follows a Taylor-like rule

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi} \right)^{\gamma_\pi} \left(\frac{y_t}{y} \right)^{\gamma_y} \tag{12}$$

where variables without time subscripts indicate their steady state values while γ_π and γ_y control the policy rate feedback to the cyclical deviations of inflation and output.

The central bank can also take an exogenous position in long-term bonds L_t^C, fully financing it by issuing reserves $-B_t^C$ that pay the same interest rate as short-term bonds. Its one-period holding profit is then

$$\Phi_t = (1 + \delta P_{L,t}) L_{t-1}^C + R_{t-1} B_{t-1}^C \tag{13}$$

4.4 Fiscal authority

The fiscal authority purchases an exogenously determined amount of goods g_t and adjusts taxes according to the following rule

$$T_t = \phi(F_t^G - P_t f^G) \tag{14}$$

where $\phi \geq 0$. To prevent taxes from adjusting to changes in public debt that are purely driven by revaluation effects, the rule responds to debt evaluated at steady-state bond prices

$F_t^G = B_t^G + P_L L_t^G$ (f^G being its real steady-state value), which is close to the face value concept used in official government statistics.

We assume that both types of households pay the same taxes in per capita terms, i.e., $T_t = T_t^P = T_t^A$. We also assume that the fiscal authority keeps the maturity structure of its debt constant, i.e., $P_{L,t} L_t^G / B_t^G = \alpha$ for all t.

Given these policies, public debt evolves according to

$$P_{L,t} L_t^G + B_t^G = (1 + \delta P_{L,t}) L_{t-1}^G + R_{t-1} B_{t-1}^G + P_t g_t - T_t - \Phi_t \tag{15}$$

4.5 Market clearing

The model is closed with a standard set of market clearing conditions. Goods market clearing implies

$$y_t = \omega c_t^P + (1 - \omega) c_t^A + g_t \tag{16}$$

The aggregate resource constraint is

$$y_t \Delta_t = \omega n_t^P + (1 - \omega) n_t^A - \phi \tag{17}$$

where $\Delta_t = \int_0^1 \left(\frac{P_t(i)}{P_t} \right)^{\frac{\mu}{1-\mu}} di$ is the measure of price dispersion resulting from staggered pricing by intermediate goods producers.

Finally, the bond market clearing implies

$$B_t^G - B_t^C = (1 - \omega) B_t^A \tag{18}$$

$$L_t^G - L_t^C = \omega L_t^P + (1 - \omega) L_t^A \tag{19}$$

4.6 Calibration

As the simulations that we present in the next section are meant to be illustrative, we do not calibrate our model to any particular country but choose the parameters to values typically used in the literature or to match long-run proportions observed in the group of countries that we use in the empirical part of the paper.

We assume that long-term bonds correspond to the 10-year maturity, implying $\delta = 0.981$, and set their steady-state share in total public debt to 75% so that the obtained average debt duration is slightly below 8 years. The steady-state ratio of debt to annual GDP is set to 40% and the share of government spending is 20%. The assumed value $\beta_A = 0.995$ targets the annual real interest rate of 2%, which together with $\beta_P = 0.99375$ implies the term premium of 0.5%. To keep our analysis simple, we abstract away from trend inflation and hence set $\pi = 1$.

The parameters controlling the degree of market segmentation are set to $\omega = 0.2$ and $\zeta' = 0.02$, and are chosen to yield conservative responses of long-term yields and output to asset purchases. The Frisch elasticity of labor supply and steady-state production markups are calibrated at standard values: $\varphi = 1$, $\mu = 1.1$. The Calvo probability $\theta = 0.9$ is consistent with a realistically flat Phillips curve during the analyzed period.

Finally, the parameters describing the dynamic reactions of monetary and fiscal authorities (γ_π, γ_y and ϕ) depend on the monetary-fiscal policy mix and are explained in the next section.

5 Model implications

5.1 Transmission of asset purchases

We first use the model described above to simulate the effects of APPs by the central bank. The results are presented in Figure 8, in which we contrast two versions of the monetary-fiscal policy mix. The first one, depicted with solid lines, is when fiscal policy does not endogenously adjust its instruments in response to changes in public debt ($\phi = 0$) and the monetary authority follows an interest rate peg ($\gamma_\pi = \gamma_y = 0$). This regime hence corresponds to the active fiscal / passive monetary policy mix in the sense of Leeper (1991), and we will refer to it as fiscal dominance. The second regime, represented by dashed lines in the figure, is the standard passive fiscal / active monetary policy mix typically assumed in New Keynesian models. In this case, the fiscal authority adjusts taxes in response to deviations of public debt from its steady-state level. This is achieved by assuming $\phi = 0.01$, which implies that the adjustment is realistically delayed far into the future. As regards the monetary policy, it follows a standard Taylor rule with feedback coefficients $\gamma_\pi = 1.5$ and $\gamma_y = 0$.

Broadly in line with how APPs were implemented in practice, we assume that, once the purchases are announced, they are phased in over a period of one year to peak at about 10 percent of pre-stimulus annual GDP. Then the program is slowly withdrawn so that the central bank balance sheet is back to its pre-APP level after five years since the stimulus. This path is presented in the upper-left panel of Figure 8 as the market value of long-term bonds held by the central bank relative to total outstanding bonds issued by the fiscal authority. By lowering transaction costs associated with holding long-term bonds, asset purchases drive their yields down. It is worth noting that the path of long-term rates is very similar under the two considered variants of the monetary-fiscal policy mix. However, the responses of economic activity, and even more so of inflation differ.

In both monetary-fiscal regimes, lower yields stimulate spending by passive investors, which translates into higher aggregate output. However, lower long-term rates also imply a lower cost of servicing the public debt, so that it starts declining, and the way it is restored to its steady-state value is very different under the two considered variants of the policy mix. When fiscal policy is passive, as in a textbook New Keynesian setup, public debt is brought back to its initial level by a reduction in taxes, which gives an additional boost to consumption. In contrast, an active fiscal regime implies no reaction of any fiscal instrument, so the response of consumption is weaker. Instead, public debt is brought back to its long-run equilibrium by persistently lower inflation, which, absent an offsetting response from monetary policy, implies higher real interest payments to agents holding short-term bonds and a higher real value of coupons paid to long-term bond holders.

Overall, the proposed simple theoretical framework can rationalize why inflation may fall in response to APPs, as suggested by our empirical results presented earlier in the paper. According to our model, this is a possible outcome during the periods of fiscal dominance. This regime is likely to prevail in exceptional circumstances like the COVID-19 pandemic, which is exactly when so many central banks introduced large-scale asset purchase programs.

5.2 Effects of government spending

Another somewhat surprising result presented in Section 3 is a strong crowding-in of private consumption by an increase in public spending and high inflation sensitivity to this policy instrument. Note that a standard New Keynesian setup implies that private spending is crowded out unless the policy rate is stuck at the effective lower bound for sufficiently long, which was not necessarily the case for many countries in our sample, and especially not for most emerging market economies. Moreover, the textbook New Keynesian model implies low responsiveness of inflation to an increase in public consumption as this policy increases both actual and potential output, and hence does not generate large movements in the relevant measure of economic slack (the output gap).

Our next experiment with the model is then aimed at checking if it can account for these puzzling responses. To this end, Figure 9 plots the dynamic responses to a persistent increase in public consumption, again comparing the two alternative monetary-fiscal regimes. More specifically, we assume that the public consumption shock is driven by an AR(1) process with autocorrelation 0.75, and its initial reaction is normalized to 1 percent.

Starting with the fiscal passive / monetary active regime, we can see standard responses, including an expansion in output but crowding out of private consumption as higher public spending means that taxes must be eventually increased. The implied fiscal multiplier is hence positive, but less than unity. For reasons discussed above, inflation moves very little.[11]

These outcomes can be contrasted with those arising under fiscal dominance. As taxes do not respond to an increase in public debt, it is brought back to its long-run level through higher inflation, which decreases its real level and the real cost of servicing it (given no response of the policy rate). As a result, private consumption is crowded in while inflation, because of its role in achieving debt sustainability, responds vigorously.

Overall, the model is consistent with the reactions of private consumption and inflation that we documented in the empirical part of the paper if the analyzed period could be characterized by fiscal dominance.

6 Conclusions

Large-scale asset purchases have become a commonly used tool in central banks' arsenals in recent years, no longer being limited to several advanced economies struggling with the effective lower bound on the policy rates. This has become recently apparent as APPs were used by the monetary authorities worldwide to mitigate the economic repercussions of the COVID-19 pandemic. These policies have raised concerns about fiscal dominance as they

[11] As can be seen in Figure 9, inflation even falls. This is because we assume that the monetary policy rule responds to deviations of output from the steady state, and so it tightens sufficiently to generate a negative output gap. If we assumed that the policy rule features the deviation of output from its flexible price level, the model would generate a positive but still very small response of inflation.

were accompanied by massive fiscal packages. In this study, we presented a new set of estimates of the effects of APPs using a sample of 14 economies, zooming in on the COVID-19 recession and its aftermath. To this end, we identify APPs shocks using high-frequency methods and use panel local projections as well as Kitagawa-Blinder-Oaxaca decompositions to assess how they affected financial and macroeconomic variables in the analyzed economies.

Our findings indicate that APPs had several effects that are difficult to reconcile with a standard monetary transmission mechanism but can be rationalized in a simple theoretical framework that allows for fiscal policy to be active. These include a fall in inflation in response to an expansion in central bank assets as well as crowding-in of private consumption by government spending, as well as its high influence on inflation. Overall, our combined empirical and theoretical analysis can be treated as indirect evidence that the monetary-fiscal policy mix observed during the COVID-19 recession could be characterized as fiscal dominance.

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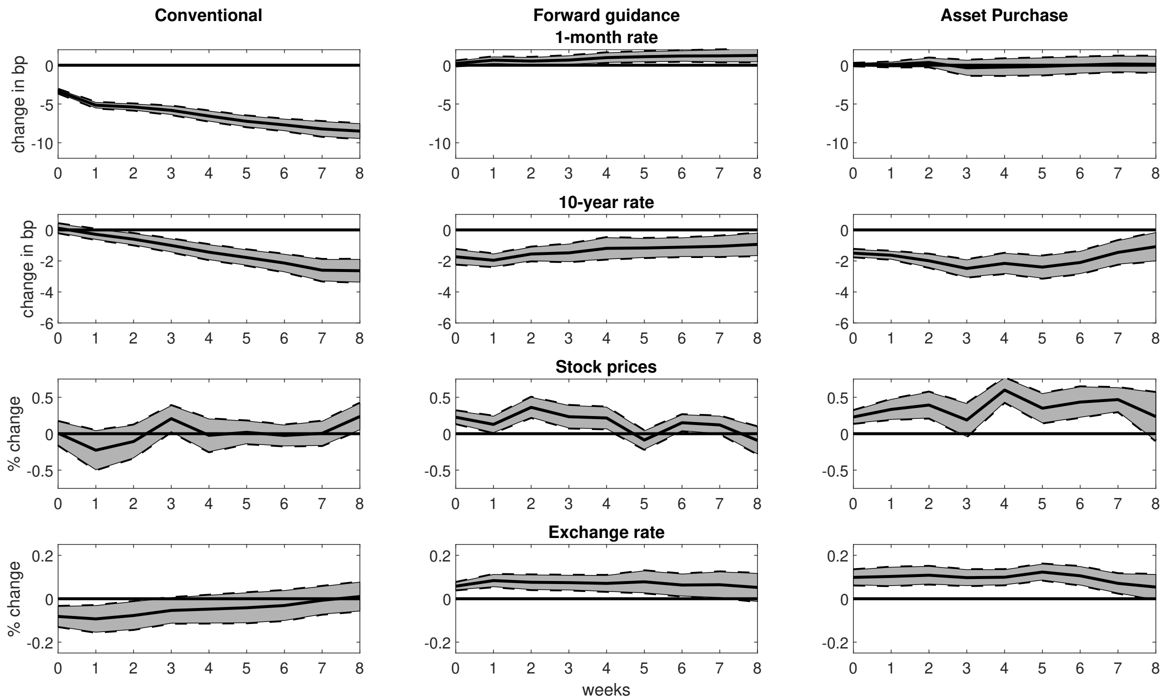
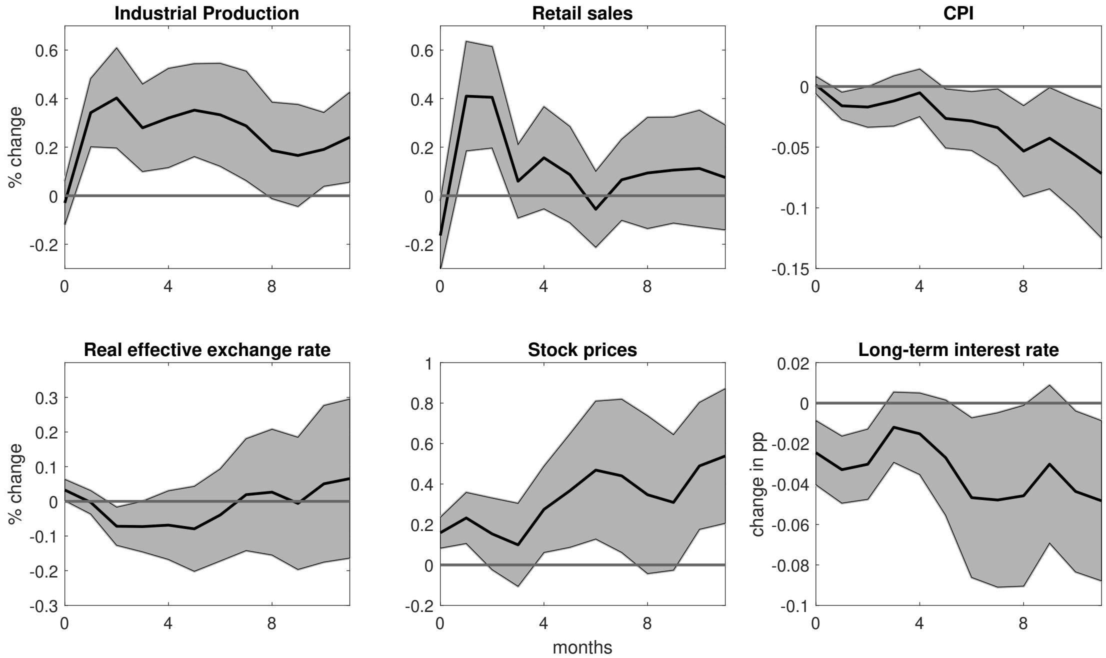
Figures

Figure 1: Shock identification: impact on financial variables



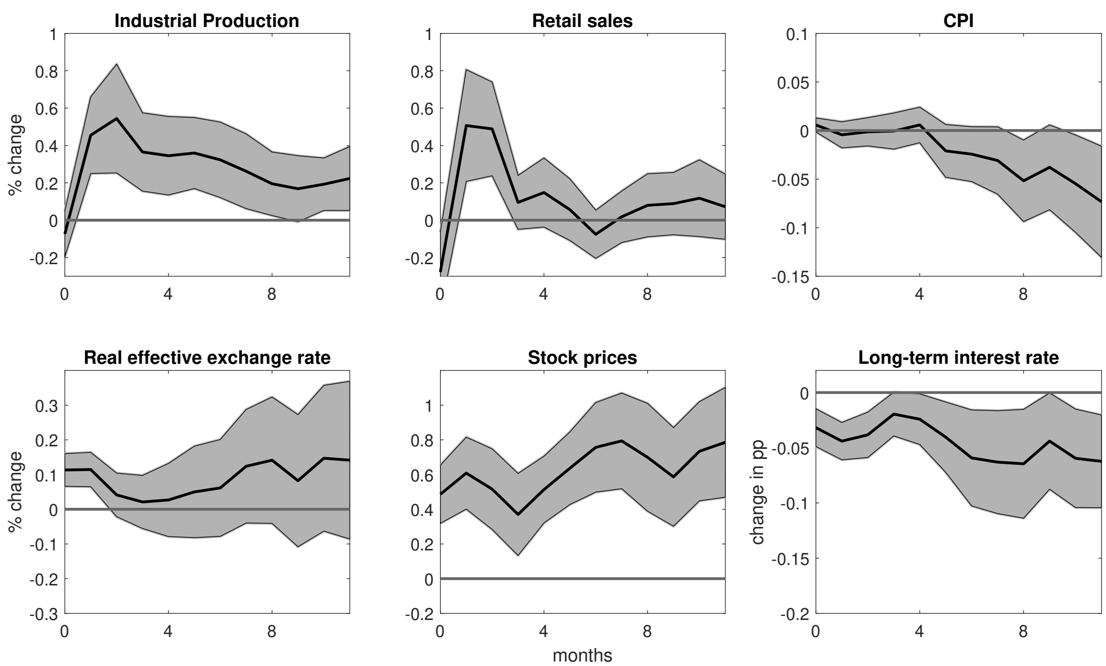
Note: The figure presents the mean responses to three types of identified monetary shocks and the 68% confidence bands.

Figure 2: Impulse response to an APP shock



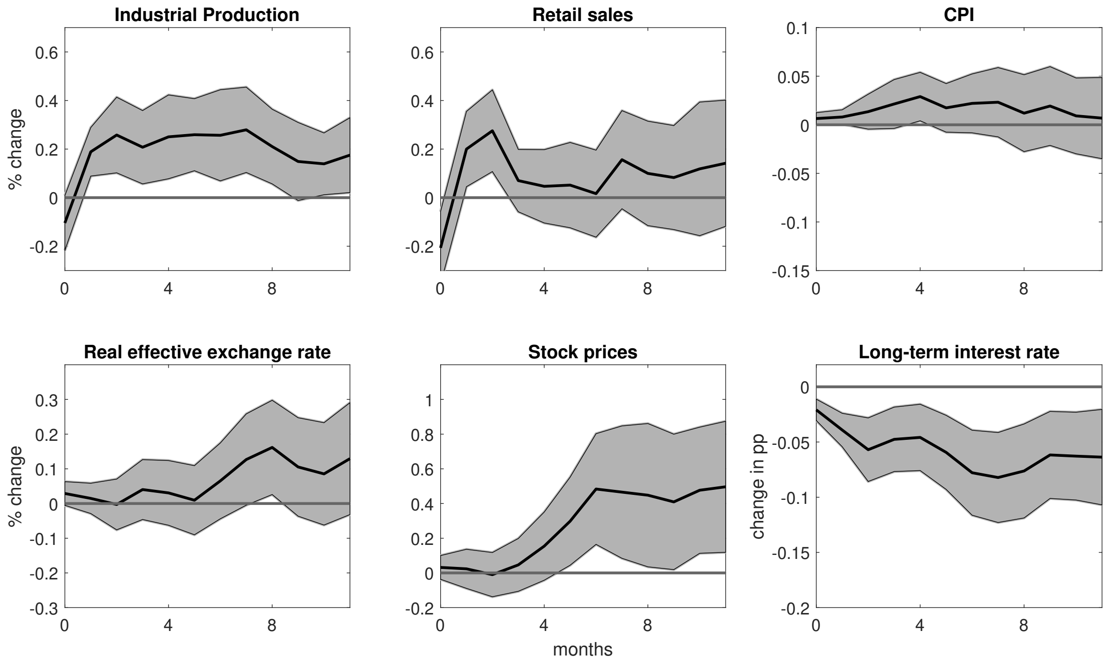
Note: The figure presents the mean responses to APP shocks and the 68% confidence bands.

Figure 3: Impulse response to an APP shock: KBO set of controls



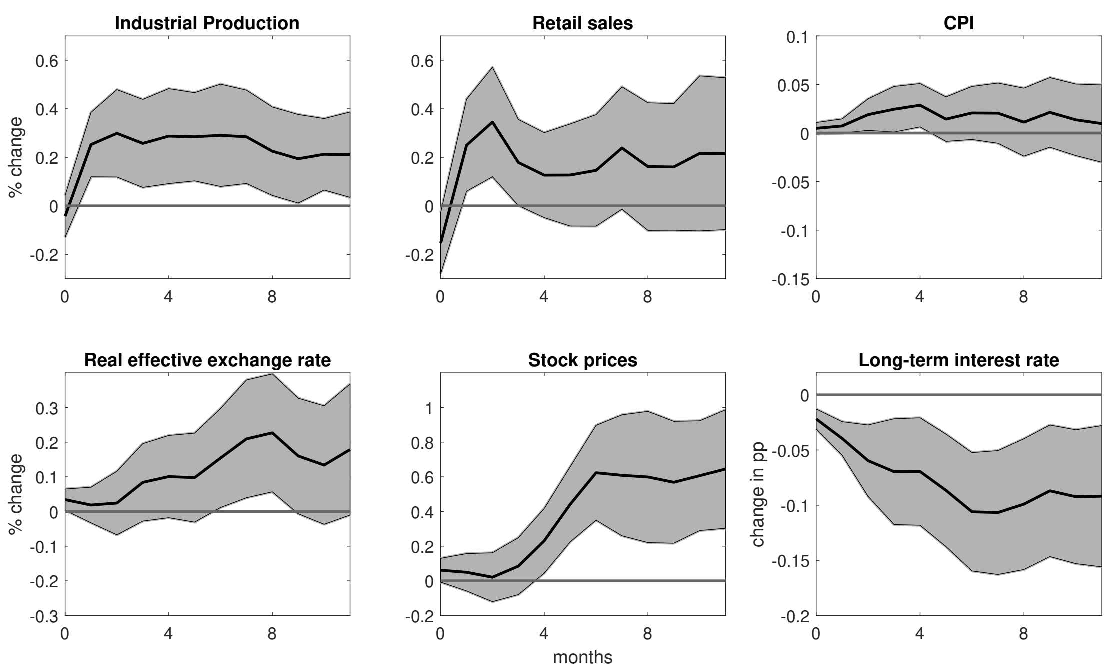
Note: The figure presents the mean responses to APP shocks and the 68% confidence bands.

Figure 4: Impulse response to an APP shock: shocks uncleaned from information effects



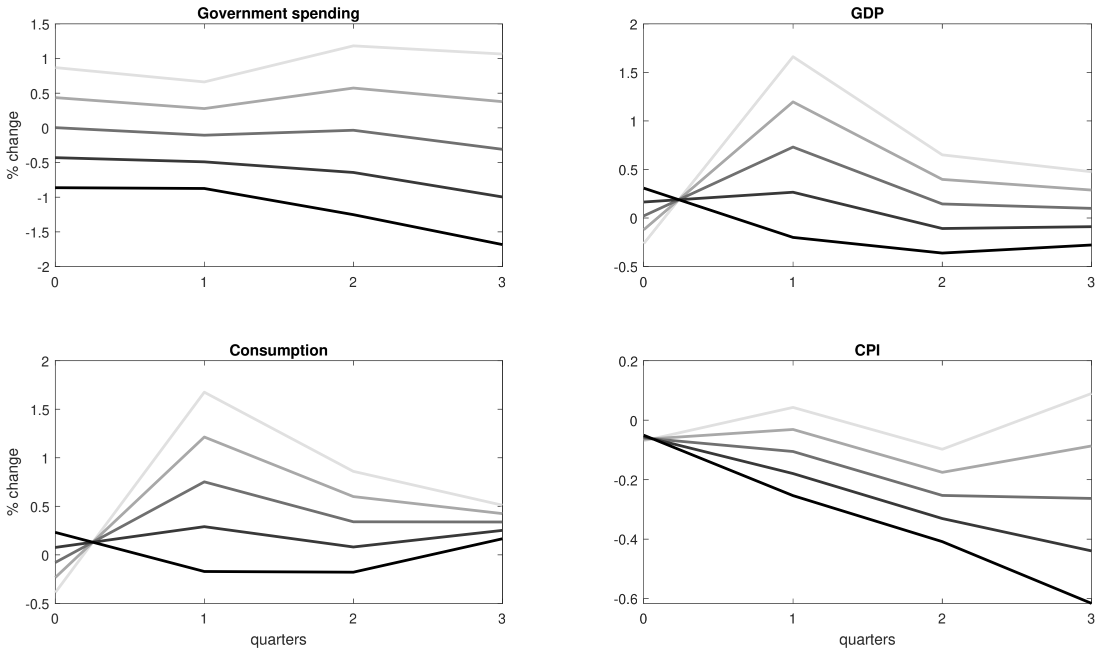
Note: The figure presents the mean responses to APP shocks and the 68% confidence bands.

Figure 5: Impulse response to an APP shock: shocks uncleaned from information effects and foreign interest rates



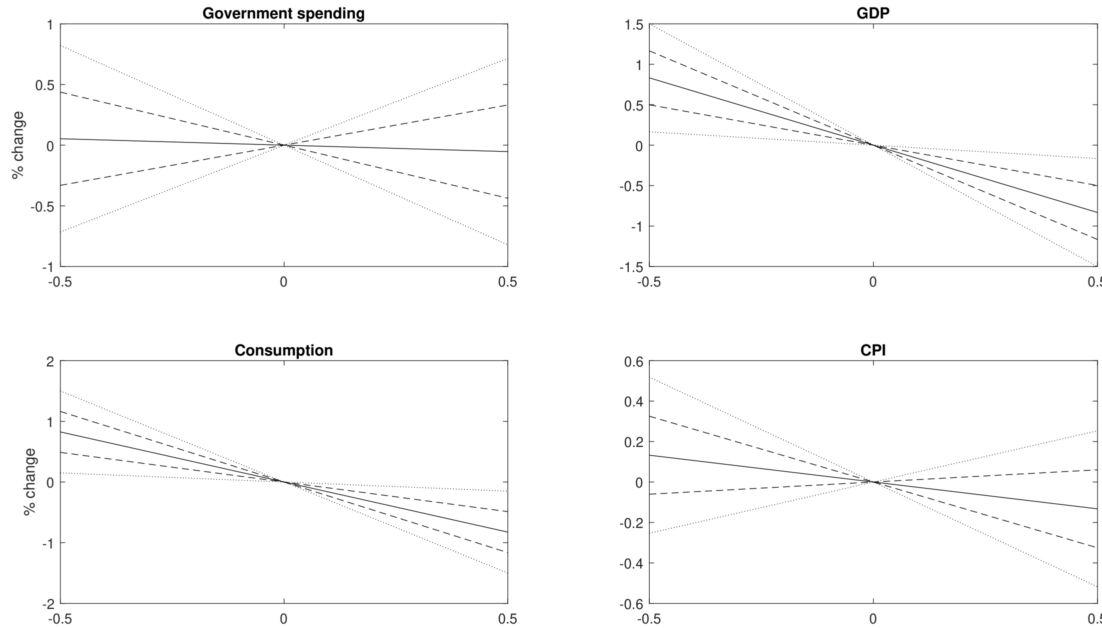
Note: The figure presents the mean responses to APP shocks and the 68% confidence bands.

Figure 6: Impulse responses to an APP shock depending on the degree of fiscal accommodation



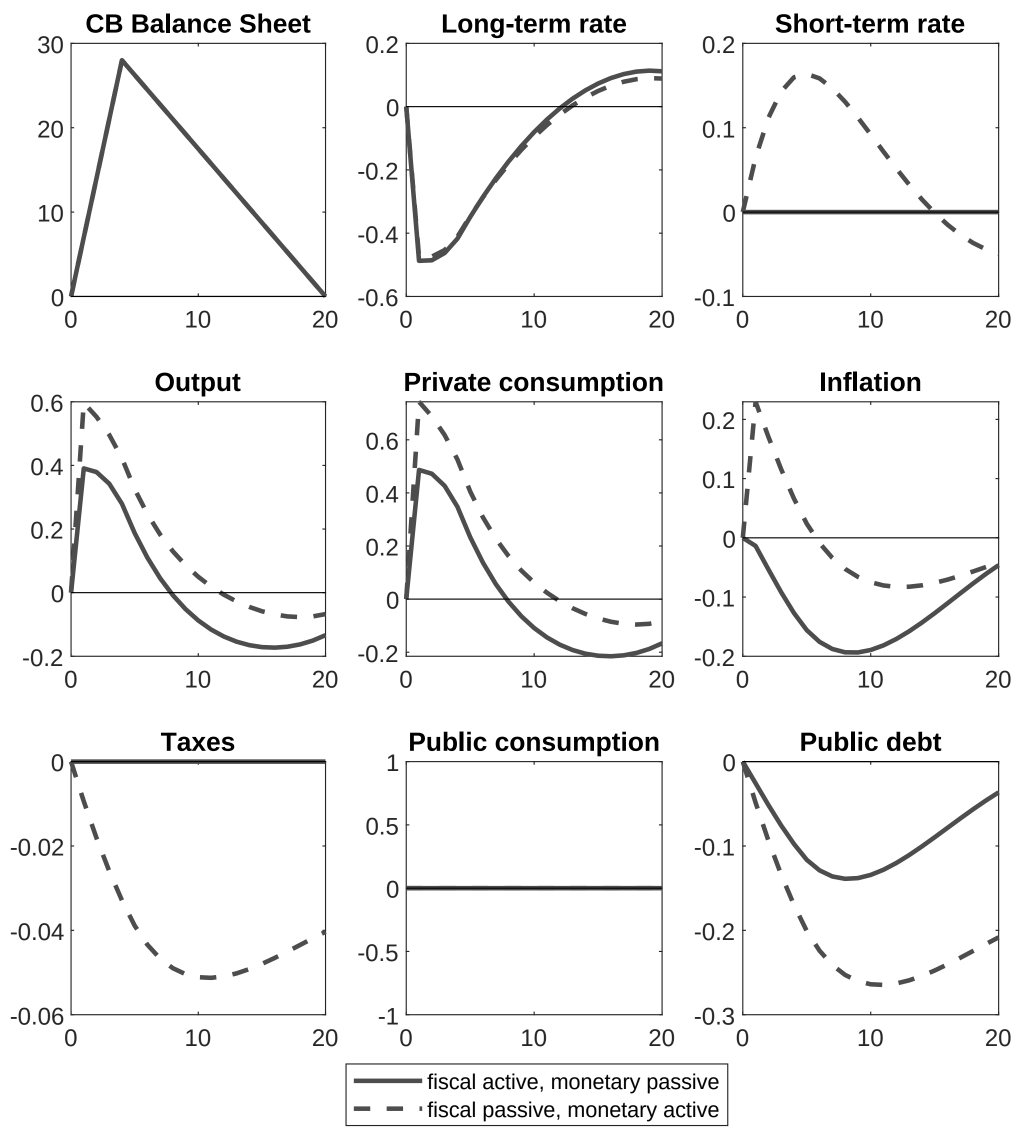
Note: The figure presents the responses to APP shocks for different values of government spending. Darker lines correspond to more restrictive fiscal policy (presented in the upper left panel).

Figure 7: Impact of government spending on responses to APP shocks at one-quarter horizon.



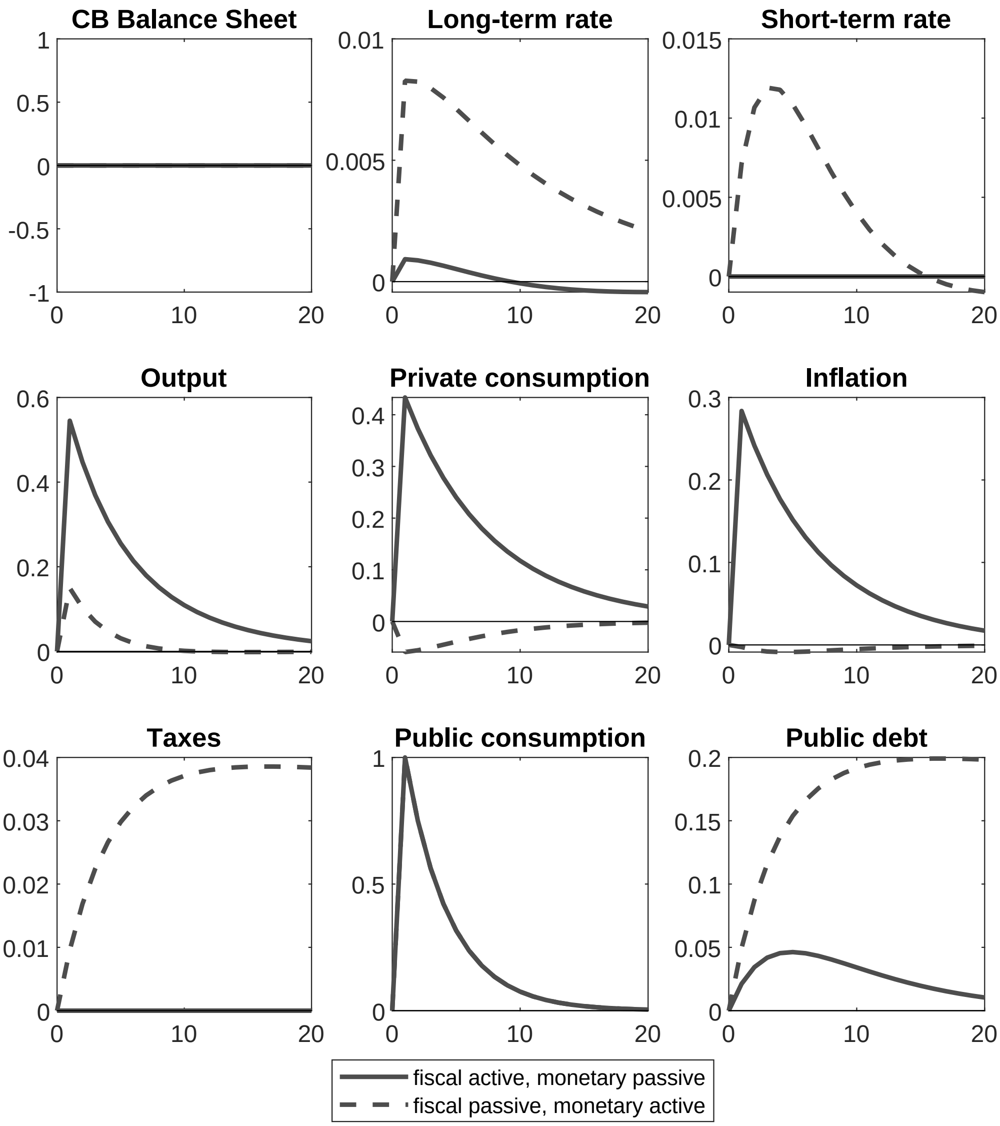
Note: The solid lines in the figure present the differences in the responses to an APP expansion from the mean response in the sample, depending on the degree of domestic fiscal accommodation depicted on the horizontal axis. More accommodative (restrictive) policies are described by positive (negative) values on the horizontal axis. All differences are calculated for the second quarter after the shock. The dashed lines depict +/- one standard deviation interval while the dotted lines correspond to +/- two standard deviation intervals.

Figure 8: Responses to asset purchases



Note: The figure presents dynamic responses to asset purchase programs, introduced as in the upper-left panel, which shows the market value of long-term bonds held by the central bank relative to total outstanding bonds issued by the fiscal authority. Output, private consumption, public consumption, and taxes are expressed in log percent. The long- and short-term rates as well as inflation are presented in annualized percentage points. The public debt is expressed in percent of steady-state annual output. All variables are plotted as deviations from their initial (steady state) levels.

Figure 9: Model-based responses to increase in public consumption



Note: The figure presents dynamic responses to asset purchase programs, introduced as in the upper-left panel, which shows the market value of long-term bonds held by the central bank relative to total outstanding bonds issued by the fiscal authority. Output, private consumption, public consumption, and taxes are expressed in log percent. The long- and short-term rates as well as inflation are presented in annualized percentage points. The public debt is expressed in percent of steady-state annual output. All variables are plotted as deviations from their initial (steady state) levels.

Tables

Table 1: APP announcement dates

Country	**Dates**
Brazil	26.06.2020, 21.07.2020
Canada	13.03.2020, 16.03.2020, 17.03.2020, 19.03.2020, 23.03.2020, 24.03.2020, 27.03.2020
	30.03.2020, 31.03.2020, 06.04.2020, 09.04.2020, 15.04.2020, 30.04.2020, 19.05.2020
	20.05.2020, 03.06.2020, 21.07.2020
Chile	16.03.2020, 19.03.2020, 08.04.2020
Colombia	23.03.2020, 14.04.2020, 15.05.2020
Hungary	16.03.2020, 07.04.2020, 28.04.2020, 21.07.2020
India	18.03.2020, 20.03.2020, 23.03.2020, 23.04.2020, 29.06.2020
Indonesia	02.03.2020, 19.03.2020, 31.03.2020, 21.04.2020, 06.07.2020
Israel	15.03.2020, 23.03.2020, 06.07.2020
Korea	19.03.2020, 26.03.2020, 09.04.2020, 10.04.2020, 24.04.2020, 20.05.2020
Mexico	12.03.2020, 20.03.2020, 21.04.2020, 15.07.2020
Norway	16.03.2020, 20.03.2020, 29.03.2020
Poland	16.03.2020, 17.03.2020, 20.03.2020, 08.04.2020, 28.05.2020, 14.07.2020
Romania	20.03.2020, 29.05.2020, 05.08.2020
South Africa	25.03.2020
Thailand	17.03.2020, 22.03.2020, 07.04.2020

Source: Fratto et al. (2021); Rebucci et al. (2020)

Table 2: Data used to calculate monetary policy shocks

Country	**Interest rate tenors**	**Bloomberg tickers**
Brazil	1m	BZAD1M Index
	1x2	BZAD1M Index, BZAD2M Index
	2x3	BZAD2M Index, BZAD3M Index
	3x6	BZAD3M Index, BZAD6M Index
	6x12	BZAD6M Index, BZAD1Y Index
	2y	GEBR02Y Index
	10y	GEBR10Y Index
Canada	1m	CDOR01 Index

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Table 2 – *Continued from previous page*

Country	Interest rate tenors	Bloomberg tickers
	1x2	CDOR01 Index, CDOR02 Index
	2x3	CDOR02 Index, CDOR03 Index
	3x6	CDFR0CF Curncy
	6x9	CDFR0FI Curncy
	9x12	CDFR0I1 Curncy
	2y	GCAN2YR Index
	5y	GCAN5YR Index
	10y	GCAN10YR Index
Chile	1m	CLTN30DN Index
	1x3	CLTN30DN Index, CLTN90DN Index
	3x6	I35103M Index, I35106M Index
	6x12	I35106M Index, I35101Y Index
	2y	I35102Y Index
	5y	I35105Y Index
	10y	I35110Y Index
Colombia	1m	COOVIBR1 Index
	1x3	COOVIBR1 Index, COOVIBR3 Index
	3x6	I21703M Index, I21706M Index
	6x12	I21706M Index, I21701Y Index
	2y	I21702Y Index
	5y	I21705Y Index
	10y	I21710Y Index
Hungary	1m	BUBOR01M Index
	1x2	BUBOR01M Index, BUBOR02M Index
	2x3	BUBOR02M Index, BUBOR03M Index
	3x6	HFFR0CF Curncy
	6x9	HFFR0FI Curncy
	9x12	HFFR0I1 Curncy
	3y	GHGB3YR Index
	5y	GHGB5YR Index
	10y	GHGB10YR Index
Indonesia	1m	JIIN1M Index
	1x3	JIIN1M Index, JIIN3M Index

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Table 2 – *Continued from previous page*

Country	Interest rate tenors	Bloomberg tickers
	3x6	JIIN3M Index, JIIN6M Index
	6x12	JIIN6M Index, JIIN12M Index
	2y	GIDN2YR Index
	5y	GIDN5YR Index
	10y	GIDN10YR Index
Israel	1m	TELBOR01M Index
	1x3	TELBOR01M Index, TELBOR03M Index
	3x6	ISFR0CF Curncy
	6x12	ISFR0FI Curncy, ISFR0I1 Curncy
	2y	I32502Y Index
	5y	I32505Y Index
	10y	I32510Y Index
Korea	1m	KRBO1M Index
	1x3	KRBO1M Index, KRBO3M Index
	3x6	KRBO3M Index, KRBO6M Index
	6x12	KRBO6M Index, KRBO12M Index
	2y	GVSK2YR Index
	5y	GVSK5YR Index
	10y	GVSK10YR Index
Mexico	1m	MPTBA Curncy
	1x3	MPTBA Curncy, MPTBC Curncy
	3x6	MPTBC Curncy, MPTBF Curncy
	6x12	MPTBF Curncy, MPTB1 Curncy
	2y	GMXN02YR Index
	5y	GMXN05YR Index
	10y	GMXN10YR Index
Norway	1m	NIBOR1M Index
	1x2	NIBOR1M Index, NIBOR2M Index
	2x3	NIBOR2M Index, NIBOR3M Index
	3x6	NIBOR3M Index, NIBOR6M Index
	6x12	G0078Z 6M BLC2 Curncy, G0078Z 1Y BLC2 Curncy
	2y	G0078Z 2Y BLC2 Curncy
	5y	G0078Z 5Y BLC2 Curncy

Continued on next page

Table 2 – *Continued from previous page*

Country	Interest rate tenors	Bloomberg tickers
	10y	G0078Z 10Y BLC2 Curncy
Poland	1m	WIBR1M Index
	1x2	PZFR0AB Curncy
	2x3	PZFR0BC Curncy
	3x6	PZFR0CF Curncy
	6x9	PZFR0FI Curncy
	9x12	PZFR0I1 Curncy
	2y	POGB2YR Index
	5y	POGB5YR Index
	10y	POGB10YR Index
Romania	1m	BUBR1M Index
	1x3	BUBR1M Index, BUBR3M Index
	3x6	BUBR3M Index, BUBR6M Index
	6x12	BUBR6M Index, BUBR12M Index
	2y	ROMGGR02 Index
	5y	ROMGGR05 Index
	10y	ROMGGR10 Index
South Africa	1m	JIBA1M Index
	1x3	JIBA1M Index, JIBA3M Index
	3x6	SAFR0CF Curncy
	6x9	SAFR0FI Curncy
	9x12	SAFR0I1 Curncy
	2y	I09003Y Index
	5y	I09005Y Index
	10y	I09010Y Index
Thailand	1m	BOFX1M Index
	1x3	BOFX1M Index, BOFX3M Index
	3x6	BOFX3M Index, BOFX6M Index
	6x12	BOFX1Y Index
	2y	GTTHB2Y Govt
	5y	GTTHB5Y Govt
	10y	GTTHB10Y Govt

Table 3: Bloomberg tickers of stock indices

Country	**Bloomberg ticker**
Brazil	IBOV Index
Canada	SPTSX60 Index
Chile	IPSASD Index
Colombia	VLCOC Index
Hungary	BUX Index
Indonesia	JCI Index
Israel	TA-125 Index
Korea	KOSPI Index
Mexico	MEXBOL Index
Norway	OSEBX Index
Poland	WIG20 Index
Romania	BET Index
South Africa	TOP40 Index
Thailand	SET Index

Table 4: Data sources

Variable	Source
Industrial production	
Brazil, Canada, Chile, Colombia, Hungary, Israel, Korea, Norway, Poland	OECD
Indonesia, Thailand	Bloomberg
Romania	Eurostat
Production in total industry, including construction	
Mexico	OECD
Production in total manufacturing	
South Africa	OECD
Retail sales	
Brazil, Canada, Chile, Colombia, Hungary, Israel, Korea, Mexico, Norway, Poland, South Africa	OECD
Indonesia	Bank of Indonesia
Romania	Eurostat
Thailand	Bloomberg
GDP, private final consumption expenditure, government final consumption expenditure	
Brazil, Canada, Chile, Colombia, Hungary, Indonesia, Israel, Korea, Mexico, Norway, Poland, Romania, South Africa	OECD
Thailand	IMF Financial Statistics
Consumer price index	
Brazil, Canada, Chile, Colombia, Hungary, Indonesia, Israel, Korea, Mexico, Norway, Poland, South Africa	OECD
Romania, Thailand	IMF Financial Statistics
Real effective exchange rate	
Brazil, Canada, Chile, Colombia, Hungary, Indonesia, Israel, Korea, Mexico Norway, Poland, Romania, South Africa, Thailand	BIS
Interest rates, stock prices, exchange rate of the domestic currency against the USD	
Brazil, Canada, Chile, Colombia, Hungary, Indonesia, Israel, Korea, Mexico Norway, Poland, Romania, South Africa, Thailand	Bloomberg
Other variables	
VIX	FRED
US industrial production, US GDP	OECD
Mobility index	Google

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