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Quarterly Projection Model for Vietnam: A Hybrid Approach for Monetary Policy Implementation

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Quarterly Projection Model for Vietnam: A Hybrid Approach for Monetary Policy Implementation

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ABSTRACT: We present a newly developed Quarterly Projection Model (QPM) for Vietnam. This QPM represents an extended version of the canonical New Keynesian semi-structural model, accounting for Vietnam-specific factors, including a hybrid monetary policy framework. The model incorporates the array of policy instruments, specifically interest rates, indicative nominal credit growth guidance, and exchange rate interventions, that the authorities employ to meet the primary objective of price stability. The calibrated model embeds a theoretically consistent monetary transmission mechanism and demonstrates robust in-sample forecasting accuracy, both of which are important prerequisites for the richer analysis and forecast-based narratives that support a forward-looking monetary policy regime.

WORKING PAPERS

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Contents

I. INTRODUCTION

The paper presents a quarterly projection model (QPM), which underlies the development of the Forecasting and Policy Analysis System (FPAS) at the State bank of Vietnam (SBV). This QPM builds on the model structure and foundations developed in Berg et al. (2006a, 2006b), adjusted to reflect Vietnam-specific characteristics, including those associated with SBV's hybrid monetary policy framework. Practical aspects of FPAS implementation in the context of IMF Capacity Building activities are covered in Mæhle et al. (2021).

As specified in the 2010 SBV Law, the central bank pursues several objectives, aimed at preserving the stability of the currency, securing the soundness of its banking and credit institutions, maintaining the safety and effectiveness of the payments system, and contributing to the socioeconomic development (Article 4). According to the SBV Law, monetary policy aims at ensuring price stability (Article 3). The central bank is a ministerial-level agency of the Government, and the SBV Governor decides on "the use of tools for the implementation of the national monetary policy, including re-financing, interest rates, exchange rates, compulsory reserves, open-market operations and other tools and measures according to the Government's regulations" (Article 10).[2] To achieve the primacy of the price stability objective, the SBV also utilizes several administrative tools, including the annual indicative nominal credit growth (both at economy-wide and individual financial institution levels). Similar to other Asian countries, both price- and quantity-based instruments have emerged as a defense mechanism in the face of numerous shocks hitting small open economies while they develop and become integrated in the international economic and financial system, as described in IMF (2015).

Over the past two decades, Vietnam has witnessed a significant economic transformation, with fast real GDP growth and active participation in the global value chains (including as a result of joining the World Trade Organization in 2007) and the international financial system, which allowed tapping capital markets at a large scale. These developments brought indisputable benefits; however, they also pose multiple risks and require close monitoring from the policymakers. While the SBV was successful in overcoming major disruptions to price and financial stability over the past, the central bank lacks full operational independence.

The literature generally acknowledges monetary policy in Vietnam as being eclectic: multiple goals and low level of transparency, both price- and quantity-based administrative instruments,[3] and exchange rate smoothing via FXIs, which undermine the effectiveness of the monetary policy transmission. For example, see Dizioli and Schmittmann (2015) for a QPM-based analysis with short-term interbank interest rate reflecting the only monetary policy instrument used to attain the

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[2] According to the SBV Law "The Prime Minister or the Governor of the State Bank shall decide on the use of tools and measures to obtain objectives of the national monetary policy according to the Government's regulations" (Article 3.4).

[3] Interest rates have generally been liberalized, including in the context of Vietnam's 2007 WTO accession, although occasionally the SBV imposes administrative mechanisms, e.g. in the context of the global financial crisis, interest rate caps were applied for specific loans and for both local currency and USD deposits (caps are still imposed on VND deposits of maturities shorter than 6 months and on USD deposits of all maturities), while the open market operations have been conducted on both price- and quantity-based indicators.

central objective of price stability; Bhattacharya (2013), Bui Van Hai and Tran Thi Minh Trang (2015), and Tuan Anh Pham (2016) for the quantification of interest rate-based monetary policy transmission using vector autoregressions; and Maliszewski (2010) for a Bayesian estimation of Vietnam's output gap. A key contribution of our modelled monetary policy framework to this literature is the explicit use of both price- and quantity-based instruments, as a close approximation of the current regime in place.

The QPM presented in this paper builds on a standard semi-structural New Keynesian gap model, routinely applied in inflation-targeting and inflation-forecast targeting[4] central banks. It allows for the presence of rational (forward-looking) expectations and the open economy dimension. The model parameters are calibrated based on the historical post-WTO accession macroeconomic data for Vietnam. The extensions considered in the model reflect SBV's current monetary policy framework, including the intersection of price- and quantity-based policy instruments, providing a practical QPM approach to a hybrid monetary policy regime setting.

The SBV's monetary policy main characteristics embedded within the QPM reflects the primacy of the price stability objective, alongside other macroeconomic goals, and three corresponding operational rules and instruments: (i) inflation target, which is an exogenous goal announced by the National Assembly, achieved primarily with the use of a policy interest rate guided by a Taylor-type rule; (ii) exchange rate objective, with a corresponding operational rule endogenized within the model; and (iii) annual indicative nominal credit growth for the aggregate banking system level, which is set and announced publicly by the SBV. The calibration of the policy rules puts emphasis on price stability as the primary central bank's objective, but at the same time allows for interaction and spillover effects, e.g. via interest rates reacting not only to inflation deviation from the target and the output gap, but also to the deviation of nominal exchange rate from its implicit objective. In this respect, the model specification represents an extension over the model design and analysis in Ghosh et al. (2016). The model allows for more exchange rate variability as compared to earlier episodes of highly managed exchange rate dynamics, e.g., during 2011-2015. Accordingly, the QPM is more representative for the current period, matching inter alia the widening of the exchange rate fluctuations corridor since 2016. More broadly, the model structure and calibration documented in this paper represent an analytical device in support of the ongoing and planned modernization of the SBV's monetary policy framework and operations, including the orientation toward more forward-looking policy making.

The present paper adds to the existing literature on semi-structural models for policy analysis and forecasting, which builds on the contributions of Berg et al. (2006a, 2006b). More recent works focus on modeling the observed complexity of exchange rate regimes and emergence of financial stability considerations. The proposed exchange rate block is similar in terms of specification and

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[4] See Svensson (1997) who developed the concept of inflation-forecast targeting, which has provided a systematic way to implement the notion of flexible inflation targeting. The term "flexible inflation targeting" has been used to describe a policy regime under which the central bank pursues the primary objective of maintaining low and stable inflation while taking into account other objectives (e.g. output, financial stability) and ensuring that pursuit of those other objectives remains consistent with the primacy of the inflation objective; see Adrian et al. (2018) for additional details.

technical implementation to Vlcek et al. (2020), who develop a QPM for the National Bank of Rwanda; the major difference is reflected in the interpretation of the anchor as "exchange rate objective" in the present paper and as "exchange rate target" in case of Vlcek et al. (2020). For QPMs with explicit exchange rate peg regimes, see Baksa et al. (2020) for the case of Cambodia (hard peg) and Baksa et al. (2021) for the case of Morocco (peg with horizontal band and central bank reserves influencing sovereign risk premium). The addition of credit cycle dynamics and macroprudential measures to ensure financial stability is implemented in Karam et al. (2021). For a practical application of macroeconomic frameworks – including QPM – to analyze the impact of the COVID-19 pandemic on economic outcomes, see Gonzales and Rodriguez (2021). Mæhle et al. (2021) provide an extensive overview of FPAS practice in the context of IMF technical assistance on macroeconomic frameworks.

As discussed in Chansriniyom et al. (2020), the choice and specification of a hybrid regime depend on the nature and configuration of the shocks, as well as on the country characteristics. For example, aggregate demand shocks produce procyclical effects on inflation and credit conditions, making it possible to rely exclusively on standard monetary policy tools (interest rates) to restore equilibrium. However, in practice, shocks tend to arrive simultaneously and are imperfectly identified, implying major uncertainty and tradeoffs with respect to the optimal configuration of the policy response, both in terms of the number of instruments deployed and their individual intensities. These challenges are at the forefront of the IMF Integrated Policy Frameworks (IPF) agenda, with preliminary considerations and results presented in Basu et al. (2020) and Adrian et al. (2020). We view the QPM presented in this paper as a contribution to this literature, including as an analytical toolkit that can be operationalized by central banks to address key challenges related to hybrid policy frameworks.

The paper is organized as follows. Section II discusses the stylized facts about the Vietnamese economy and its monetary policy regime. Section III describes the model structure and its key features. Section IV presents the model properties and results, including impulse response functions, equation decompositions, and in-sample forecasting accuracy for the 2007-2019 period. Section V concludes.

II. Stylized Facts and Model Motivation

Vietnam is a small open economy, with high contribution of international trade and foreign direct investments (FDIs) to the economic growth. Following a key USA-Vietnam bilateral trade agreement in 2001, the country became a member of WTO in early 2007 and committed to pursue trade and investment liberalization. Vietnam has signed up 15 Free Trade Agreements as of December 2020, with China, USA, European Union (EU), Japan and South Korea being the main trading partners. The export sector has evolved from predominantly focused on commodities to manufacturing-oriented (electronics and apparel), and has grown substantially, with the trading

value exceeding 200 percent of GDP. Integration into the global economy has been very beneficial for Vietnam but has also increased exposure to external shocks.

The country maintained a high real GDP growth rate of 7-8 percent on average before the global financial crisis (GFC).[5] Massive capital inflows following the WTO accession in early 2007 contributed to the emergence of asset price bubbles in also real estate and stock markets, and rapid nominal credit growth, which subsequently generated high inflation and exchange rate depreciation. The economic growth slowed down to 5-6 percent during 2009-2014, owing to both the lingering effects of the GFC and to domestic imbalances during the period of 2007-2011, including high and volatile inflation, exchange rate depreciation, and impaired financial assets. In 2011, the Vietnamese authorities launched a package of structural reforms anchored around three key pillars: banking, state owned enterprises and public investment reforms, and have made commendable progress in achieving macroeconomic stability since 2014. The reforms, coupled with the ongoing structural transformation of the domestic economy, have contributed to a recovery in economic growth, which reached 6-7 percent during 2014-2019 (Figure 1). See also IMF (2019) and IMF (2021) for an overview of recent economic developments in Vietnam.

Figure 1: Real GDP growth decomposition (percent, percentage points)
(2011-2019)
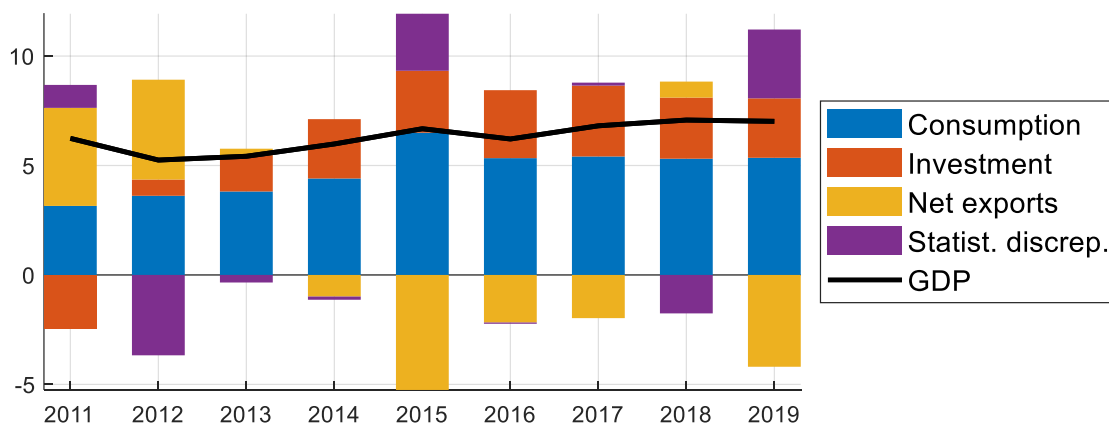
The SBV's monetary policy main characteristics – also embedded within the QPM – reflect the key policy objective of price stability and three corresponding operational rules and instruments: (i) inflation target, which is an exogenous goal announced by the National Assembly and achieved mainly with the use of policy interest rates; (ii) exchange rate objective, which partly changes with economic conditions; and (iii) annual indicative nominal credit growth set and announced publicly by the SBV for the aggregate banking system.

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[5] The sources of the data presented in this section are: State Bank of Vietnam, Vietnam General Statistics Office, General Department of Vietnam Customs, International Financial Statistics and International Monetary Fund calculations.

The SBV has started to gradually introduce exchange rate flexibility since 2016, but the market stability is still a major concern for the central bank, aiming at strengthening the public confidence in domestic currency. The overnight interbank rates have slid well below the repo rate since 2012 as a result of excess liquidity, in the context of large capital inflows, which also largely contributed to the stability in the nominal exchange rate of VND against USD.

The current monetary policy regime in place is approximated within the model structure by considering a multiple instrument setting. Price dynamics are anchored by the inflation target, primarily via interest rate measures; nominal exchange rate stability is partly achieved by the exchange rate objective; and economy-wide nominal credit growth, with a direct impact on aggregate demand, is converging in equilibrium to the exogenously-set indicative target.

By law, the SBV proposes a CPI inflation target to the National Assembly on annual basis, to be approved as a component of broader national policy agenda. Fresh food accounts for around 17 percent of the CPI basket, goods with administered prices and fuel for another 19 percent, and the remaining are accounted for by the core component (data as of 2020). In practice, inflation (both headline and core, which excludes fresh food, administered prices and fuel) has slowed down considerably since 2013, owing to some extent to the post-GFC structural reforms in the financial and public sectors, better central bank monetary and exchange rate policy management, and more recently – also thanks to low global commodity prices (2014-2018). As a result, CPI inflation has remained below the 4 percent target for most of the recent years (Figure 2). Given that the prices of various items included in the aggregate consumption basket are likely to be driven by different factors, the QPM considers the decomposition of headline inflation into core and non-core (rest) components, with different specification of the underlying dynamic processes and factors.

Figure 2: Inflation developments (percent year-on-year)
(2007Q1-2019Q4)
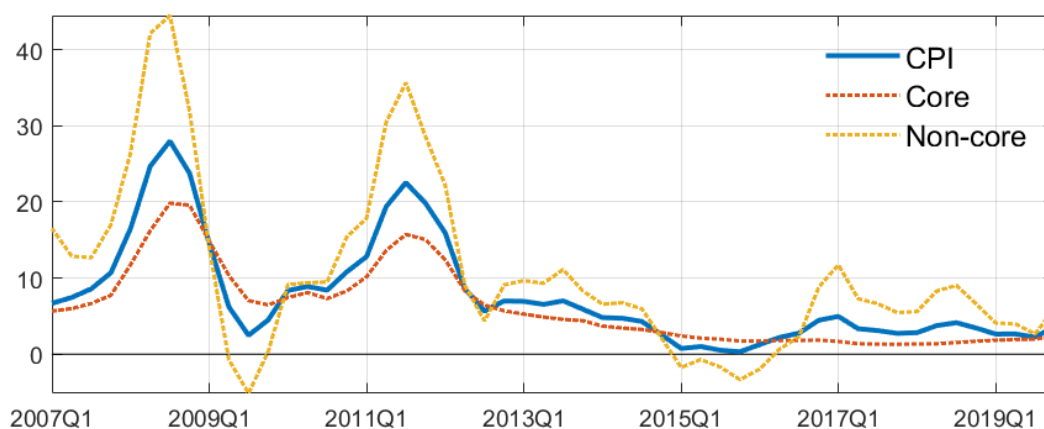
After a period of sustained depreciation between 2008 and early-2011, the nominal exchange rate has remained relatively stable thanks to favorable external balance and the restoration of public confidence in the dong. At the same time, since early-2011 the dong has appreciated by over 30 percent in real effective terms, due to persistent inflation differentials relative to foreign trading partners (Figure 3). Since January 2016, the SBV announces a central parity exchange rate against the U.S. dollar on a daily basis, currently with a trading band of +/–3 percent. The official central parity exchange rate is determined based on the interbank exchange rate the day before and on developments in the exchange rate of a basket of currencies, while also taking into account the monetary policy objectives and domestic economic conditions. This mechanism is approximated within the QPM by formulating a nominal exchange rate (implicit) objective process that considers a range of structural determinants, which reflects the fact that the SBV's exchange rate policy partly reacts to the inflation deviation from the target and exchange rate misalignment. It should be noted that in practice the SBV does not have any exchange rate target; neither does it aim to appreciate or depreciate the VND. The goal is to control inflation, stabilize macroeconomic conditions and the foreign exchange market. In fact, the central rate is managed flexibly in both directions (appreciation and depreciation), with fluctuations of up to +/–2-3 percent. Accordingly, it should be understood that the implicit nominal exchange rate objective mechanism developed in the QPM is just a simplification of reality, rather than assuming that the SBV has been targeting a certain level of exchange rate or has any appreciation/depreciation target.

Figure 3: Exchange rate developments
(Jan-2007—Dec-2019)
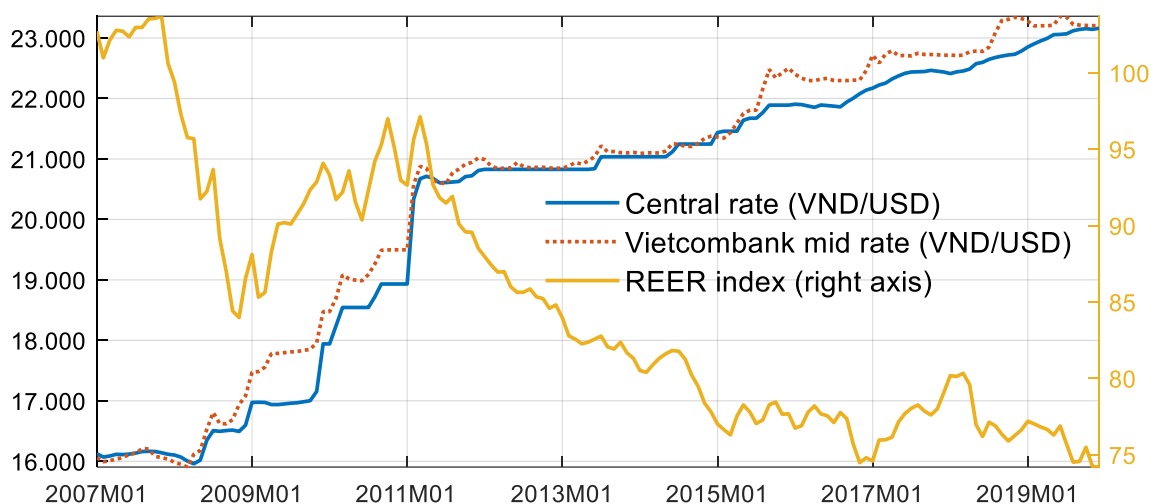
In response to inflationary and exchange rate depreciation pressures during 2008-2011, the interest rates were adjusted frequently and were generally at high levels as compared to the pre-GFC period

(Figure 4). Since 2013, the macroeconomic stability has gradually improved, and the policy rates have been lowered, in line with declining inflation.

Figure 4: Interest rates (percent p.a.)
(Jan-2007—Dec-2019)
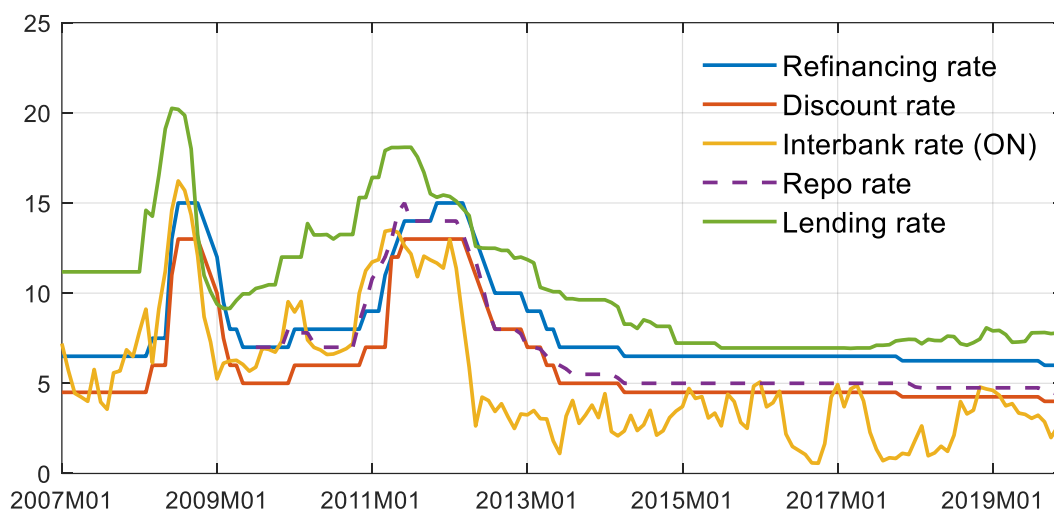
Nevertheless, the monetary policy transmission remains weak, as also documented in relevant empirical works mentioned in the previous section. Market interest rates tend to react to policy rate adjustments slowly and incompletely. In terms of the registered values, with the exception of very short-term maturities, market rates stay generally above policy rates. Overnight interbank rate is typically below the policy rates due to the excess liquidity. This observation is incorporated within the QPM by assuming that current monetary policy stance, which directly impacts broad economic activity, is accurately reflected by the short-term interbank rate rather than solely by the policy rates.

Credit expansion has moderated in recent years but is still higher than nominal GDP growth (Figure 5). Excessive nominal credit growth of more than 35 percent per year on average during 2007-2010 and low loan quality in the aftermath of the GFC left Vietnam with twin legacies of high credit-to-GDP ratio and elevated levels of non-performing loans (NPLs). In recent years, concerned about financial stability, the authorities have gradually brought nominal credit growth down (below 13 percent in 2018 and 2019). The SBV has also introduced several changes to the financial regulations framework: tightened macroprudential regulations on real estate lending, imposed higher risk weights on riskier loans, limited short-term funding to finance long-term loans, introduced a cap on the share of cash loans and prohibited lending to borrowers with weak credit. Most recently, in 2019 the SBV had relaxed the indicative nominal credit growth for banks that already comply with Basel II regulations. Bank credit remains one of the main supporters of macroeconomic developments and the SBV is monitoring closely the evolution of private sector

loans, motivating the inclusion in the QPM of both the credit channel and the indicative nominal credit growth.

Figure 5: Nominal credit growth (percent year-on-year)
(2007Q1-2019Q4)
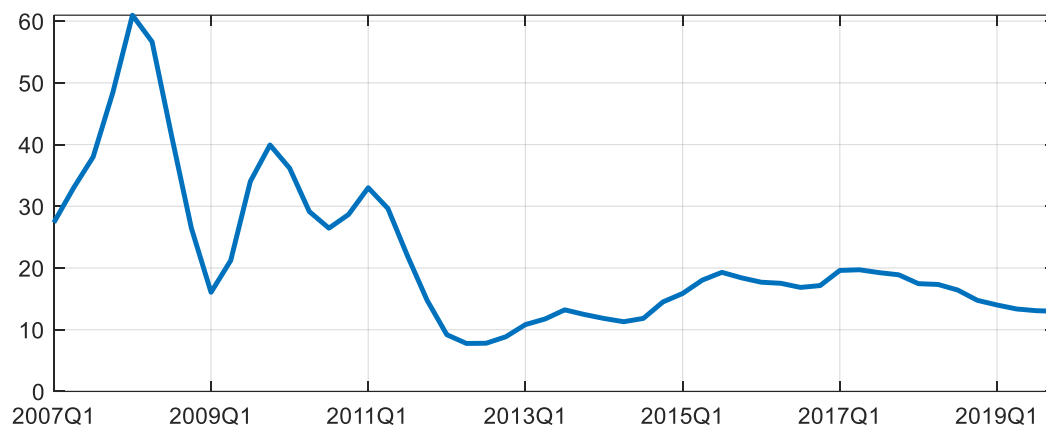
On the account of strong export-led FDI sector, Vietnam has experienced persistent trade balance surpluses staring 2012 (Figure 6). Integration in global value chains – the result of persistent FDI flows via large multinational corporations – facilitated rapid development in international trade. USA, Eurozone and China are the major trading partners, with trade turnovers (combined exports and imports) accounting for 15 percent, 13 percent and 23 percent in 2019, respectively. The diversification of export destinations and import origins is captured in the model by considering foreign variables in effective terms, i.e. a weighted average of the USA, China and Eurozone indicators. In addition, the model allows for international oil prices to impact non-core inflation, matching the fact that Vietnam became a net oil importer in 2015, with the net imported value reaching USD 5.5 billion in 2019.[6]

In terms of fiscal policy, since 2015 Vietnam has made considerable progress in consolidating the fiscal stance. Before the COVID-19 pandemic, the ongoing rationalization of current spending and curtailment of new sovereign guarantees, concurrent with robust economic growth, led to a decline in GDP share of public and publicly guaranteed debt from 60 percent in 2016 to 53 percent in 2019, well below the 65 percent statutory limit. While the current version of the QPM focuses on accommodating the complexity of the SBV's monetary policy framework and abstracts from directly incorporating fiscal policy, it represents a relevant avenue for future extensions of the modelling framework.

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[6] Although not directly modelled in the QPM, the FDI sector plays a crucial role in recent economic developments. It is highly integrated within global value chains, while still maintaining domestic linkages. About 70 percent of trade and 30 percent of total capital formation is accounted for by the FDI sector.

Figure 6: External trade (2007-2019)
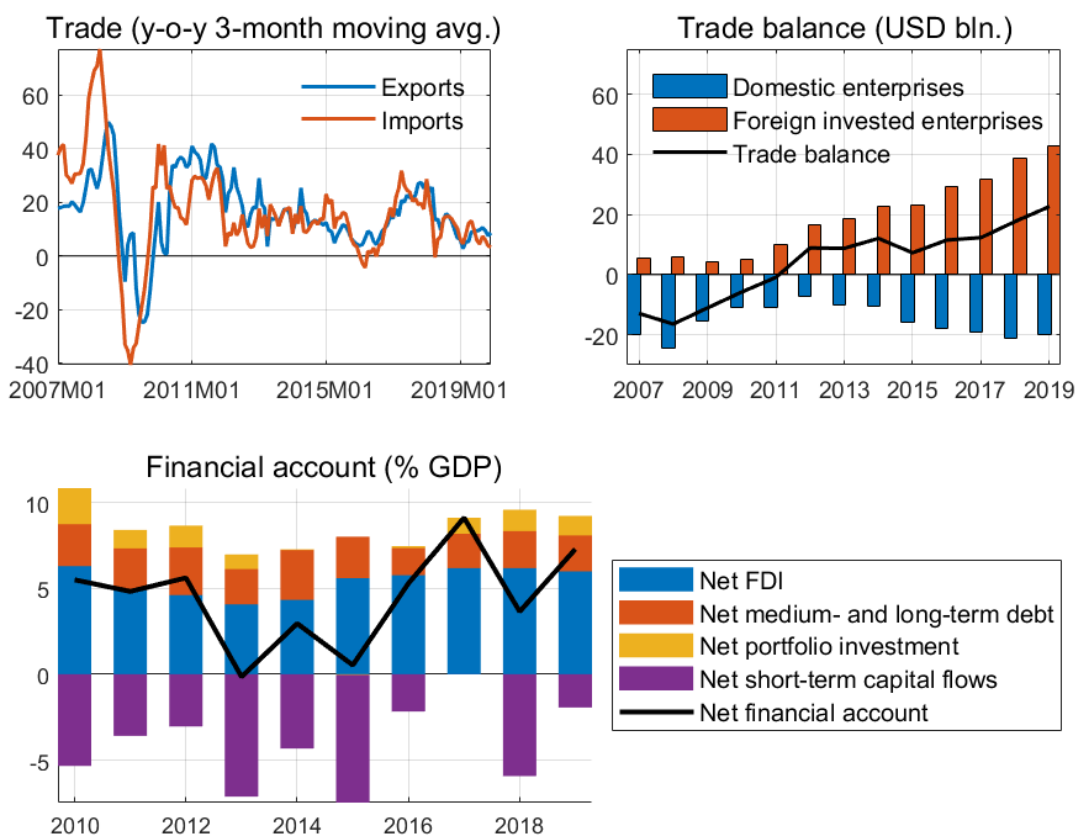
III. MODEL STRUCTURE

The stylized facts introduced in the previous section are incorporated into the QPM framework. The structure of the model and its calibration thus reflect mainly the current monetary policy regime in place in Vietnam, key transmission channels and the salient characteristics of the economy. Accordingly, the Vietnamese semi-structural QPM extends and adjusts the canonical model introduced in Berg et al. (2006a, 2006b), which consists of four key relations – aggregate demand, Phillips curve, uncovered interest rate parity, and interest rate rule. The main extensions refer to decomposing headline inflation into core and non-core indices (implying two Phillips curves), incorporating credit dynamics as a determinant of monetary conditions, and enriching monetary policy toolkit with indicative nominal credit growth targets and nominal exchange rate objective. In this section, we focus on these amendments and adjustments that are introduced in order to capture the economic features of Vietnam and SBV's monetary policy implementation, which represent an important departure from the standard QPM formulation.

The model for the Vietnamese economy is a semi-structural quarterly model designed for monetary policy analysis and forecasting. It captures and describes long-term trends and gaps in the

economy. It is a New Keynesian type model which includes nominal and real rigidities, rational expectations and forward-looking endogenous monetary policy. Its structure allows for significant flexibility, making it possible to be extended or adjusted in order to properly capture changes in the Vietnamese economy or the continuously evolving monetary policy framework.

Given the assumed price rigidities and a relatively rich array of propagation channels, the stance of monetary policy impacts output growth in the short- to medium-run. This, together with exchange rate and inflation expectations, drives price dynamics in the economy. The expectations are in general based on a combination of lagged effects and model-predicted future outcomes (rational expectations). The monetary authority is operating under a hybrid regime and adjusts its instruments (nominal interest rate, indicative nominal credit growth and nominal exchange rate objective) in a consistent manner in order to achieve its primary goal of price stability, i.e., inflation in line with the announced target. At the same time, the economy is operating under the influence of main trading partners, as well as structural shocks. Altogether, there are several mutually interconnected main model blocks: real economy, price dynamics, exchange rate developments, nominal interest rate, nominal credit growth, and foreign economy. The global economy is exogenous from the standpoint of the domestic economy, considering Vietnam is a small open economy.

The model is calibrated to match Vietnam-specific features, including assessed efficiency of the monetary transmission mechanism. The calibration covers parameters describing the steady state of the model, dynamic coefficients – especially those in structural equations for domestic variables – and equations for foreign variables and long-term trends. The standard deviations of all modelled shocks are calibrated as well. The calibration of the parameters reflects observed sample averages, views about cyclical developments and structural changes in the economy, impulse response analyses and in-sample forecasting performance of the model. Calibration is also guided by matching the observed data and by interpreting long-term trends. Standard deviations of the shocks are set by accounting for the observed variance in the available data sample, delivering coherent structural stories, and considering that unobserved trends are in general less volatile than the corresponding gaps. Consistent macroeconomic intuition and meaningful relationships among variables, underpinned by standard economic theory, are other important considerations for the current model calibration. See Table 1 for the specific calibrated values for the most relevant dynamic coefficients.

A. Inflation

Headline inflation is decomposed into two main components: core and non-core inflation. Each of them is described by a New Keynesian Phillips curve. The breakdown allows to capture different driving forces behind the subcomponents, especially through sector-specific real marginal costs.

The headline CPI is a weighted average of the core and non-core consumer price sub-indices: [7]

$$p_t = w \cdot p_t^C + (1 - w) \cdot p_t^{NC} + \varepsilon_t^p, \tag{1}$$

where p_t is (log) CPI, while p_t^C and p_t^{NC} are its core and non-core subcomponents. The error term, ε_t^p, captures non-additivity in the identity owing to the fact that the weight of the core component, w, is constant in the model, while it has been changing over time in the data. The value of parameter $w = 0.631$ reflects the observed weight of the core component as of 2019.

The Phillips curve for annualized quarter-on-quarter core inflation, π_t^C, incorporates expectations (both forward- and backward-looking) and the pass-through from real marginal costs:

$$\pi_t^C = a_{11} E_t \pi_{t+1}^C + (1 - a_{11})[a_{12} \pi_{t-1}^C + (1 - a_{12})(\pi_{t-1} + \Delta \overline{rp}_{t-1}^C)] + a_{13}\, rmc_{t-1}^C + \varepsilon_t^{\pi C}, \tag{2}$$

$$rmc_t^C = a_{14} \cdot \hat{y}_t + (1 - a_{14}) \cdot (\hat{z}_t - \widehat{rp}_t^C). \tag{3}$$

Interpreting the two equations above, core inflation depends on expected one-quarter ahead core inflation, $E_t \pi_{t+1}^C$, and its past dynamics. The latter is a weighted average of previous quarter core inflation, π_{t-1}^C, and the past headline inflation π_{t-1} adjusted by the lagged relative price trend growth, $\Delta \overline{rp}_{t-1}^C$. The backward-looking term (in brackets) ensures that there is a pass-through effect from headline inflation, including spillovers from the non-core subcomponent, into core price dynamics. The term rmc_t^C captures real marginal costs of producers of core goods and services, and $\varepsilon_t^{\pi C}$ is a core inflation supply shock. Since Vietnam is a small open economy, the real marginal costs of producers are driven by both domestic and imported components. This evidence is incorporated via core inflation depending positively on real marginal costs capturing the effects of domestic output gap, $\hat{y}_t$, and real effective exchange rate gap, $\hat{z}_t$, adjusted by a relative price gap term, $\widehat{rp}_t^C$ (thus $\hat{z}_t - \widehat{rp}_t^C$ defines the real exchange rate gap in terms of core segment prices). The latter represents the gap in the relative price of the core subcomponent to the headline price index, which is defined in the model as:

$$rp_t^C = p_t^C - p_t. \tag{4}$$

It is further decomposed into the trend and gap components:

$$rp_t^C = \overline{rp}_t^C + \widehat{rp}_t^C. \tag{5}$$

The relative price trend growth of the core components ($\Delta \overline{rp}_t^C$) follows an AR(1) process.

The non-core part of the consumption basket (with a share of more than one third of the total) includes prices of volatile fresh food, fuel, and administrative prices which are under the control of the Vietnam authorities. The associated non-core Phillips curve and real marginal costs are:

$$\pi_t^{NC} = a_{21} \cdot E_t \pi_{t+1}^{NC} + (1 - a_{21} - a_{22}) \cdot \pi_{t-1}^{NC} + a_{22} \cdot \pi_t^{IO} + a_{23} \cdot rmc_{t-1}^{NC} + \varepsilon_t^{\pi NC}, \tag{6}$$

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[7] All variables in the model are expressed in natural logs unless stated otherwise. Behavioral equations are usually represented in terms of gaps, which express deviations from their corresponding trend values (gaps are denoted with a "hat", while trends with a "bar").

$$rmc_t^{NC} = a_{24} \cdot \hat{y}_t + (1 - a_{24}) \cdot (\hat{z}_t - \widehat{rp}_t^{NC}). \tag{7}$$

Annualized quarter-on-quarter non-core inflation π_t^{NC} depends on its expected and lagged values, $E_t\pi_{t+1}^{NC}$ and π_{t-1}^{NC} respectively, lagged costs of production – comprising real marginal costs, rmc_{t-1}^{NC}, and imported oil inflation, π_t^{IO} – as well as supply shocks hitting the non-core prices, $\varepsilon_t^{\pi^{NC}}$. Real marginal costs in the non-core sector reflect domestic and imported contributions, with the real exchange rate gap being adjusted by a relative price gap term. The relative prices and the corresponding gap for non-core prices, $\widehat{rp}_t^{NC}$, are defined analogously to the core counterparts as in equations (4) and (5). In addition to this mechanism, the fuel content of non-core inflation is approximated and explained by imported oil prices (annualized quarter-on-quarter price of imported oil denominated in domestic currency, π_t^{IO}), reflecting the price of Brent oil on the global markets. The world oil price is adjusted by the nominal exchange rate against US dollar.

Not only does the different specifications of the Phillis curves, but also adjusted calibration of structural parameters distinguishes between the core and non-core price dynamics – see Table 1. The inertia in non-core inflation is lower compared to the core component, reflecting the volatility of fresh food and oil prices. At the same time, in line with observed data, there is a distinguishably higher volatility of the supply shocks for non-core inflation compared to the core inflation ones.

B. Interest Rate, Exchange Rate and Credit Growth

The specification of this block of the model includes idiosyncratic features of the Vietnamese economic policy setting, in particular the SBV's monetary policy implementation. It assumes that the monetary authority uses interest rate, nominal exchange rate and nominal credit growth as its operational instruments; thus, they constitute principal operational targets. However, the control over the nominal exchange rate and the volume of credit is only partial, allowing to establish price stability as the primary objective and the use of nominal interest rates as the central instrument to achieve it. The flexibility of the model allows to adjust the relative importance of these instruments, including a possible switch to different policy regimes. Accordingly, the monetary authority decides and sets the instruments so that the economy smoothly returns to its equilibrium.

Monetary policy follows a forward-looking Taylor-type interest rate reaction function and focuses on stabilization of the expected headline inflation close to the implied inflation target. The interest rate is set according to:

$$i_t = g_1 i_{t-1} + (1 - g_1)\left[i_t^N + g_2\left(E_t\pi_{t+1}^4 - \pi_{t+1}^{4,Tar}\right) + g_3\hat{y}_t + g_4\left(\Delta s_t - \Delta s_t^{Obj}\right)\right] + \varepsilon_t^i. \tag{8}$$

The setting of the nominal interest rate, i_t, reflects inertia through the lagged value i_{t-1} and a response to the current and future economic conditions – the deviation of the one-quarter ahead expected year-on-year headline inflation from the target, $E_t\pi_{t+1}^4 - \pi_{t+1}^{4,Tar}$, the current output gap, $\hat{y}_t$, and the deviation of annualized quarter-on-quarter nominal exchange rate change from its corresponding implicit objective, $\Delta s_t - \Delta s_t^{Obj}$. Neutral interest rate, i_t^N, refers to the equilibrium

rate that prevails when the economy is stabilized and operating without the occurrence of any shocks. The last term of the equation, ε_t^i, captures occasional deviations of the actual interest rate from the reaction function (8).

Overnight interbank interest rate series is used as observations for the specified interest rate rule. It accurately reflects the situation in the interbank market, including overall liquidity conditions, and thus expresses appropriately the current monetary policy stance. The policy rates operated by the SBV are thus implicitly assumed to impact the interbank rate, potentially with a specific term premium that would account for the observed discrepancy between these.

The relative importance of the response of the interest rate to macroeconomic conditions is reflected in the calibration of the Taylor rule (8). Whilst the weights for output gap and exchange rate change are of comparable magnitudes, the relevance of expected inflation deviation is roughly four-to-five times higher, reflecting the ultimate mandate of the SBV to ensure price stability.

The deviation of the nominal exchange rate change from its objective, $\Delta s_t - \Delta s_t^{Obj}$, in the interest rate rule captures the importance of the exchange rate development for the SBV policy implementation. The central bank is assumed to set the nominal exchange rate change objective to be in line with economic fundamentals, supporting the price stability objective and also partially responding to the real exchange rate gap:

$$\Delta s_t^{Obj} = c_1 \Delta s_{t-1}^{Obj} + (1 - c_1)\left[\Delta \bar{z}_t + \pi_t^{4,Tar} - \pi^* - c_2\left(E_t \pi_{t+1}^4 - \pi_{t+1}^{4,Tar}\right) - c_3 \hat{z}_t\right] + \varepsilon_t^{\Delta s^{Obj}}, \quad (9)$$

According to equation (9), the annualized quarter-on-quarter VND/USD exchange rate change objective, Δs_t^{Obj}, is smoothly evolving with respect to its previous value, Δs_{t-1}^{Obj}, while reflecting also country fundamentals that determine the equilibrium nominal exchange rate change, $\Delta \bar{z}_t + \pi 4_t^{Tar} - \pi^*$, where $\Delta \bar{z}_t$ is the growth rate of the real effective exchange rate trend and π^* is the steady-state value for foreign inflation. If the economy is in a situation when expected headline inflation deviates from its target, the adjustment of the exchange rate change objective will support the gradual removal of this misalignment. Similarly, if the real effective exchange rate gap indicates a situation of external imbalance, the adjustment of the objective will support the convergence of the economy back to its equilibrium. Deviations of SBV behavior from relation (9) are captured by the shock term $\varepsilon_t^{\Delta s^{Obj}}$, which reflect, for example, SBV's response to the adverse impact on the psychology of market participants caused by Federal funds rate hikes.

Contrary to the interest rate rule, the importance of the expected inflation deviation in guiding the exchange rate change objective is calibrated to be smaller as compared to the real exchange rate misalignment ($c_2 < c_3$). This reflects the more direct relation observed in practice between the nominal exchange rate and the real exchange rate gap as opposed to inflation deviations from the target, while the opposite is true for the interest rate instrument. At the same time, the calibration of the model shows that the persistency in the exchange rate change objective is reduced, allowing the monetary authority to flexibly adjust exchange rate policy in order to timely and properly reflect the current overall macroeconomic situation.

The market nominal exchange rate is partially driven by the corresponding objective of the SBV. As such, in order to incorporate the notion that the exchange rate is used by the central bank as a short-term objective, the market nominal exchange rate, s_t, is a weighted average of the exchange rate change objective and the uncovered interest rate parity (UIP) condition:

$$s_t = e_1 \cdot \left(s_{t-1} + \frac{\Delta s_t^{Obj}}{4}\right) + (1 - e_1) \cdot [e_2 \cdot E_t s_{t+1} + (1 - e_2) \cdot (s_{t-1} + \frac{\Delta \bar{z}_t + \pi_t^4 - \pi^*}{2}) + \dots$$

$$+(i_t^* - i_t + prem_t)/4] + \varepsilon_t^s. \tag{10}$$

Parameter e_1 shows the importance of the exchange rate change objective and can be flexibly adjusted with respect to the strength of the nominal exchange rate management applied by the SBV. By setting $e_1 = 1$ the equation collapses into a form of fixed exchange rate regime (peg).

The UIP part (in square brackets) models current exchange rate as a function of expectations – both forward looking, $E_t s_{t+1}$, and backward looking, $s_{t-1} + (\Delta \bar{z}_t + \pi_t^4 - \pi^*)/2$ – and nominal interest rate differential adjusted by a time-varying country risk premium, $(i_t^* - i_t + prem_t)/4$.

To replicate the exchange rate dynamics from the data, in particular the observed rigidity, the interest rate parity condition is modified to account for the situation of limited role for forward-looking expectations. The backward-looking part takes the last observation of the exchange rate and updates it by the equilibrium rate of the nominal exchange rate depreciation, i.e. the equilibrium real exchange rate depreciation adjusted by inflation differential (approximated for the foreign economy by its steady state value). By calibrating $e_2 = 1$, the backward-looking part is removed, and the equation yields the standard UIP condition. Both inertia terms in (9) and (10), as measured by c_1 and $(1 - e_2)$ respectively, contribute to obtain in the model a data-consistent smooth nominal exchange rate dynamic. While the shock $\varepsilon_t^{\Delta s^{Obj}}$ in the exchange rate change objective (9) is interpreted as a policy shock in terms of setting the nominal exchange rate change objective, the shock ε_t^s in relation (10) can be understood as a white noise exchange rate shock.

The policy block is further extended to allow for a more detailed and realistic treatment of the Vietnam monetary policy framework and transmission mechanisms. The credit channel is operating through lending activity directly impacting aggregate demand. The link between the short-term interest rates and credit interest rates (i_t^C) is specified as

$$i_t^C = h_1 \cdot i_{t-1}^C + (1 - h_1) \cdot [(i_t + E_t i_{t+1} + E_t i_{t+2} + E_t i_{t+3})/4 + prem_t^C] + \varepsilon_t^{i^C}. \tag{11}$$

Credit interest rate is a weighted average of its past value and the compounded short-term interest rate adjusted with the term premium. More precisely, the relation between the policy rate and the lending rate depends on the term structure – in line with the expectations hypothesis – and a term premium, $prem_t^C$ (square brackets). The term structure is given by the four-quarter ahead average of the short-term rate. The deviations from this relation are captured by the shocks $\varepsilon_t^{i^C}$.

A Fisher-type equation is used to define real credit interest rate, which is further decomposed into trend and gap components. The letter $(\hat{r}_t^C)$ represents an important determinant of the credit demand:

$$\Delta c_t = d_1 \cdot \Delta c_{t-1} + (1 - d_1) \cdot \left(\Delta c_t^{4,Ind} + d_2 \cdot \hat{y}_t - d_3 \cdot \hat{r}_{t-1}^C\right) + \varepsilon_t^{\Delta c}, \tag{12}$$

where Δc_t captures annualized quarter-on-quarter growth in nominal credit volume, that depends on its lagged values and a set of economic conditions. These are year-on-year indicative nominal credit growth set by the SBV ($\Delta c_t^{4,Ind}$), output gap ($\hat{y}_t$), and credit conditions approximated by the lagged real credit interest rate gap ($\hat{r}_{t-1}^C$); unmodelled factors are captured by a shock, $\varepsilon_t^{\Delta c}$.

The indicative nominal credit growth is set by the SBV on annual basis exogenously from the standpoint of the model. The term "indicative" means that the actual credit growth in the economy can deviate from it, being only under a partial control of the monetary authority. Nevertheless, it represents an important part of the monetary conditions in Vietnam.

The credit component of the monetary conditions is represented by the difference between the growth of credit in real terms and its equilibrium counterpart. In gap terms $(\widehat{\Delta rc_t})$, it is expressed as:

$$\widehat{\Delta rc_t} = \Delta rc_t - \left(\Delta c_t^{4,N} - \pi_t^{4,Tar} - \Delta \bar{y}_t^4\right), \tag{13}$$

where the real credit growth, Δrc_t, is expressed as a ratio to nominal GDP, and the term in parentheses represents its implied equilibrium. The latter is defined as the neutral annual credit growth adjusted by the inflation target and year-on-year potential growth. Equation (13) defines the credit block variable that is relevant from the perspective of producing inflationary pressures through aggregate demand effects, reflecting the discrepancy between actual nominal credit growth and nominal GDP growth (hence the transformation as a GDP ratio).

Neutral credit growth is only in part determined by the SBV indicative credit growth policy, reflecting the imperfect and gradual convergence in line with country fundamentals:

$$\Delta c_t^{4,N} = k_1 \cdot \Delta c_{t-1}^{4,N} + (1 - k_1) \cdot \Delta c_t^{4,Ind} + \varepsilon_t^{\Delta c^N}, \tag{14}$$

All three components of the monetary policy implementation – interest rate, exchange rate and credit growth – capture the monetary policy stance and enter the monetary condition index, which affects the dynamics of the real economy through the aggregate demand curve.

C. Aggregate Demand

Domestic real GDP is decomposed into potential product and output gap. Output gap, $\hat{y}_t$, is modelled using an extended investment-savings (IS) curve framework:

$$\hat{y}_t = b_1 \cdot \hat{y}_{t-1} - b_2 \cdot mci_t + b_3 \cdot \hat{y}_t^* + \varepsilon_t^{\hat{y}}, \tag{15}$$

$$mci_t = b_4 \cdot \hat{r}_t - b_5 \cdot \widehat{\Delta rc_t} - (1 - b_4 - b_5) \cdot \hat{z}_t. \tag{16}$$

Equation (15) specifies the output gap as being driven by its persistency, and both domestic and foreign demand-side factors: monetary conditions, aggregated within the corresponding index mci_t, and effective foreign output gap $\hat{y}_t^*$, respectively. The unmodelled influences are attributed to the aggregate demand shock $\varepsilon_t^{\hat{y}}$.

The monetary conditions index (16) reflects the specific monetary policy implementation in Vietnam and the portfolio of instruments available to the SBV. It is defined as a weighted average of gaps in the real interest rate, real credit-to-GDP growth and real effective exchange rate. Compared to the canonical QPM, the present model includes the direct impact of the credit channel on the real economy. Since the IS curve parameter capturing the efficiency of the monetary policy transmission, b_2, is positive, we normalize loose monetary stance to be represented by negative values for mci_t. This means that a loosening in the monetary policy stance can be reached, ceteris paribus, via lower interest rates, higher credit volume growth, or faster exchange rate depreciation.

Table 1: Calibrated parameters (structural equations)

Core inflation		Interest rate		Output gap	
a_{11}	0.55	g_1	0.7	b_1	0.65
a_{12}	0.8	g_2	1.1	b_2	0.1
a_{13}	0.15	g_3	0.2	b_3	0.2
a_{14}	0.7	g_4	0.3	b_4	0.5
Non-core inflation		Exchange rate objec.		b_5	0.2
a_{21}	0.5	c_1	0.5	Credit	
a_{22}	0.04	c_2	0.1	d_1	0.5
a_{23}	0.4	c_3	0.4	d_2	0.5
a_{24}	0.5	Exchange rate (UIP)		d_3	0.5
		e_1	0.4	h_1	0.5
		e_2	0.75		

D. External Sector

Vietnam is a small open economy, with a high share of imports and exports to GDP (summing over 200% in recent years), and thus the foreign block of the model is particularly relevant. The global economy is approximated by the main trading partners of Vietnam – the USA, Eurozone and China. The selection of only three main international traders reflects the balance between realism and tractability (or the requirement for keeping the model as simple as possible). This approximation is considered to be sufficiently relevant given that the share of the three foreign economies represents about half of the international trade in goods and services in recent years.

Foreign demand variable ($\hat{y}_t^*$) entering the IS curve, equation (15), approximates the effective demand for Vietnamese exports and is defined as a weighted average of the three main trading partners' output gaps. Similarly, foreign inflation is a weighted average of inflation rates in the foreign economies, with their shares matching the Vietnamese imports' origins and exports' destinations. Since the world trade is conducted in USD, effective foreign inflation is transformed into USD as well.

The foreign interest rate (i_t^*), included in the exchange rate equation (10), is approximated by the Federal funds rate (mid-level). The world economy block also includes an equation describing the dynamics of the global oil prices, based on Brent quotations denominated in USD. All foreign variables are considered to be exogenous and the equations for the external sector are not structural in nature. These are modelled as AR(1) processes with the steady state values reflecting the corresponding sample averages. All foreign variables are observed over the historical sample, while for the practical forecasting exercises their outlook will be provided exogenously based on relevant sources (e.g. forecasts published by the respective central banks and IMF).

IV. MODEL RESULTS

In this section we present the main model results. First, we showcase the dynamic responses to several structural shocks, highlighting the corresponding transmission mechanisms. Second, we provide a narrative for the historical evolution of output gap and inflation rate in terms of model-specific structural factors. Third, we analyze the model's in-sample forecasting accuracy and data fit.

A. Impulse Response Functions

The transmission mechanisms embedded in the semi-structural model can be depicted using impulse response functions (IRF). These trace the dynamic effects on endogenous variables following an unexpected one-off shock. We illustrate the responses of main macroeconomic variables over a period of 20 quarters (five years) – expressed in deviations from their equilibrium values – to the key structural shocks of one-unit size, if not stated otherwise.

Figure 7 displays the IRFs to an aggregate demand shock. The innovation increases the output gap by about 0.9 percentage points in the initial period, and the effects are dissipating over two years following the shock. Through the real marginal costs, positive output gap contributes to the emergence of inflationary pressures in both core and non-core goods production sectors. Given core inflation presents relatively more persistence, the effects of the unexpected demand shock are longer-lasting as compared to the non-core inflation. As a result of positive output gap and above-target inflation, the central bank is reacting by gradually increasing the nominal interest rate up to 0.3 percentage points at the peak. The increased interest rate differential (in Vietnam vis-à-vis rest of the world) results in dong appreciation. To smooth the nominal exchange rate dynamics, the

exchange rate objective is adjusted toward a more depreciated currency – owing to stronger real exchange rate having a larger effect as compared to the temporary positive expected inflation deviation from the target (see equation (9) above). As a result, the nominal exchange rate is appreciating less as compared to an alternative formulation of the model with no exchange rate objective (not shown here but see additional related results below). The favorable evolution of economic activity creates additional demand for loans, fueled also by the real cost of credit decreasing initially. The components of monetary conditions index evolve as follows. Real interest rate gap is initially negative but reverses once the effects of the monetary policy rate increases make their way through the real economy. Real exchange rate gap points to an overvalued dong and a temporary loss in competitiveness in international trade markets, contributing to lower positive output gap. Finally, the growth in credit-to-GDP ratio registers a spike initially, given the increase in output contemporaneous with the aggregate demand shock, but once the initial effects dissipate, it becomes positive and then follows a gradual closing-up. Overall, the gradual return of monetary conditions to the steady state – under the impulse of monetary policy actions – leads the economy back to its long-run equilibrium.

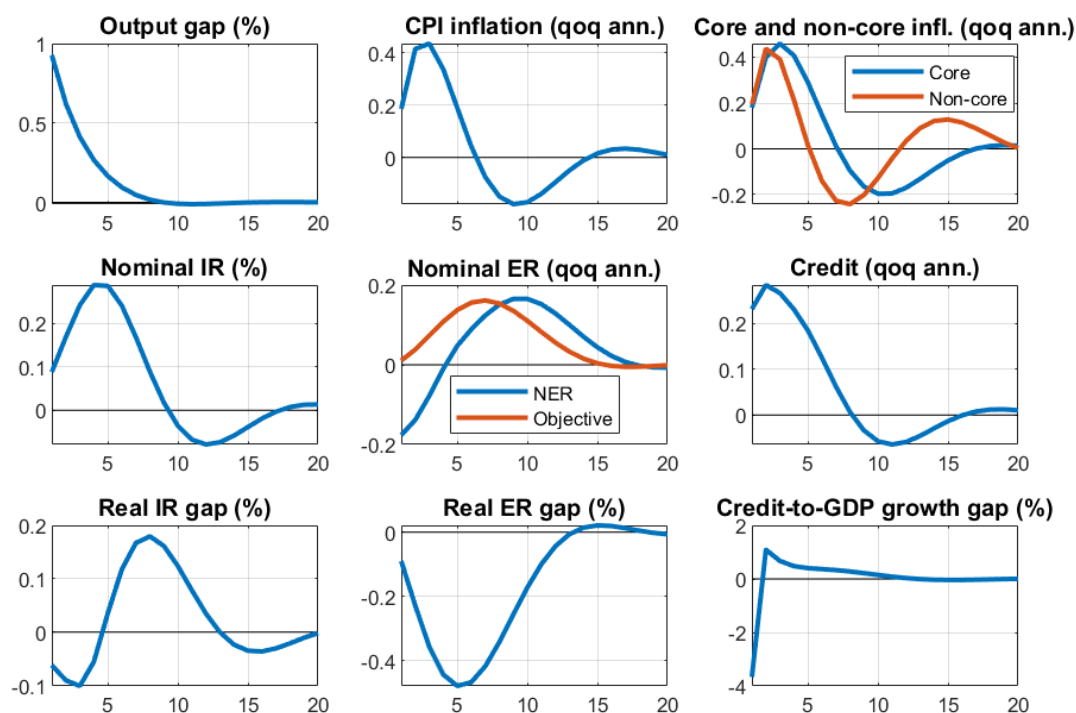Figure 7: Aggregate demand shock

Figure 8 illustrates the dynamic responses of the economy to a core inflation shock. Given the spillover effects among the production sectors, the shock generates also a minor increase in non-core goods' prices. However, the trajectory of headline inflation is driven largely by the core

inflation evolution. The expectations of above-target CPI inflation call for an interest rate hike. Notice that in line with the observed stability of economic growth over the analyzed sample (as shown in Section II) and the calibrated small pass-through of monetary conditions index to aggregate demand (as discussed in Section III), the output gap declines by a small amount. Despite the increased nominal interest rate, the shock results in a mild nominal exchange rate depreciation. This outcome is driven by the nominal exchange rate following the corresponding objective, adjusted in reaction to a temporary overvalued currency in real terms.[8] The increasing inflation is causing more favorable (real term) financing conditions, leading to marginally higher credit growth rates. While in nominal terms the interest rate, exchange rate and credit growth increase, the corresponding real-term gaps – which embody the monetary policy conditions – are negative during the initial quarters following the shock, owing mainly to the inflation effects.

Figure 8: Core inflation shock
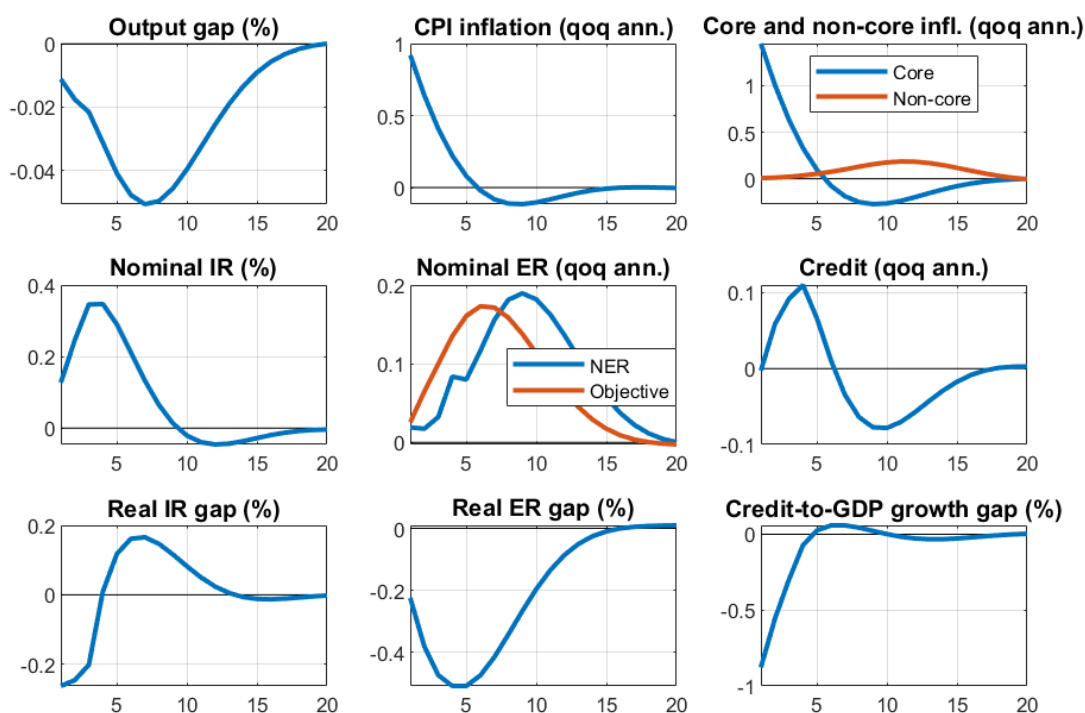
The effects produced by non-core inflation shocks and the associated policy actions are qualitatively similar to the core inflation shocks described above. However, there are important quantitative differences owing to the distinct calibration of the two Phillips curves. More precisely, the effects of non-core inflation shocks are generally less persistent, matching the relatively shorter-lived fluctuations in the corresponding price indices' dynamics observed in the data. In

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[8] In an alternative model version with a more standard formulation of the exchange rate framework – equivalent to exogenising the exchange rate objective by calibrating the coefficients in equation (9) to zero – the nominal exchange rate is appreciating in the short-run.

addition, the weight of the non-core component in the representative consumption basket is almost twice lower as compared to the core goods, rendering the aggregate effects quantitatively smaller.

Figure 9: Exchange rate shock
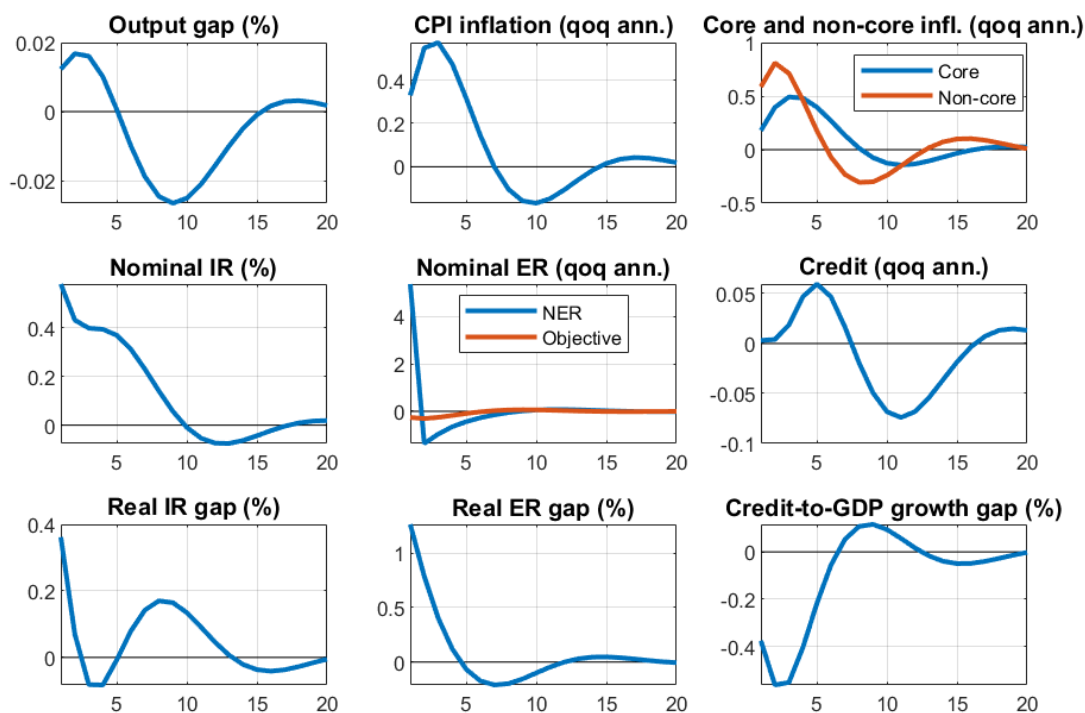
The high degree of trade openness of the Vietnamese economy – as measured by the ratio of imports plus exports to GDP exceeding 200% in recent years – reflects the importance of external developments for the domestic economy. This evidence suggests the relevance of understanding the transmission of shocks originating in foreign economies or having a significant effect on the allocation of domestic versus foreign flows, including financial ones. One shock of particular interest in the model is the exchange rate innovation in equation (10). Figure 9 shows that a one-unit shock leads to an immediate depreciation of about 5.5 percent (in quarterly annualized terms); this overshooting is gradually reversed via a subsequent nominal appreciation. The dynamics of the nominal exchange rate are also determined by the exchange rate change objective, which is set to mildly appreciate in reaction to both above-target inflation and undervalued currency in real terms, thus directly contributing to faster and smoother return of the economy to the medium-run equilibrium. The nominal depreciation passes through to higher inflation, especially in the non-core segment given the calibrated larger sensitivity of these prices to the exchange rate movements as compared to the core prices. Despite a significant gain in competitiveness, as suggested by the positive real exchange rate gap, the aggregate demand benefits only marginally, as the other two components of the aggregate monetary conditions – real interest rate gap and credit gap – are

contractionary in the short-run. Following the specified interest rate rule, all determinants call for a hike in the interest rate, which increases by about 0.6 percentage points in the first quarter and steers the economy back to the medium-term equilibrium.

Figure 10: Exchange rate shock: baseline (solid) and alternative (dotted) models
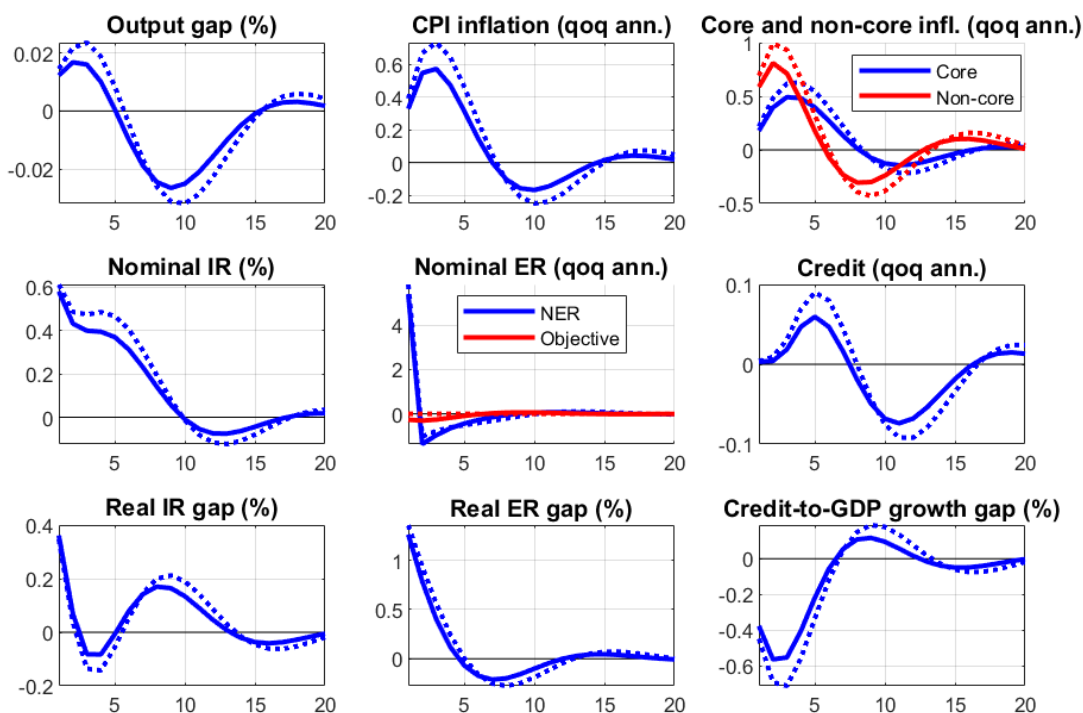
In order to motivate the inclusion of the nominal exchange rate change objective as a device to match the empirically observed nominal exchange rate smoothing in Vietnam – which translates further into only limited fluctuations of the other macroeconomic variables – in Figure 10 we illustrate the IRFs to an exchange rate shock in the baseline model (solid lines) alongside the corresponding IRFs in a model without this extension (dotted lines). The fluctuations in virtually all variables have smaller amplitudes in the baseline model, suggesting the shock effects are attenuated relative to the model with no exchange rate objective mechanism. This exercise and the associated results can be interpreted in connection with the recent literature on integrated policy frameworks, which explores the opportunity of using an effective combination of policy instruments in reaction to shocks in order to achieve (potentially conflicting) multiple objectives; see Basu et al. (2020) and Adrian et al. (2020).

Given the credit sector extension considered in the model, which marks a departure from the canonical gap model set up in Berg et al. (2006a, 2006b), in Figure 11 we present the IRFs to a shock to nominal credit growth (equation 12); note the size of the shock is set to 10 percentage points in order to illustrate an innovation of a more conventional size, as opposed to the one-unit

size in case of the other shocks analyzed above. The credit-to-GDP growth gap produces a stimulative effect on aggregate demand, with output gap rising by 0.2 percentage points over the first year following the shock. This creates inflationary pressures through higher domestic real marginal costs, especially in the core goods market, prompting the central bank to react with an interest rate hike of more than 0.1 percentage points at the peak. As a result, the nominal exchange rate appreciates initially; the effect on the dong is attenuated by the exchange rate change objective adjusted towards a slight depreciation, consistent with the temporarily overvalued currency in real terms.

Figure 11: Credit growth shock (10 units size)
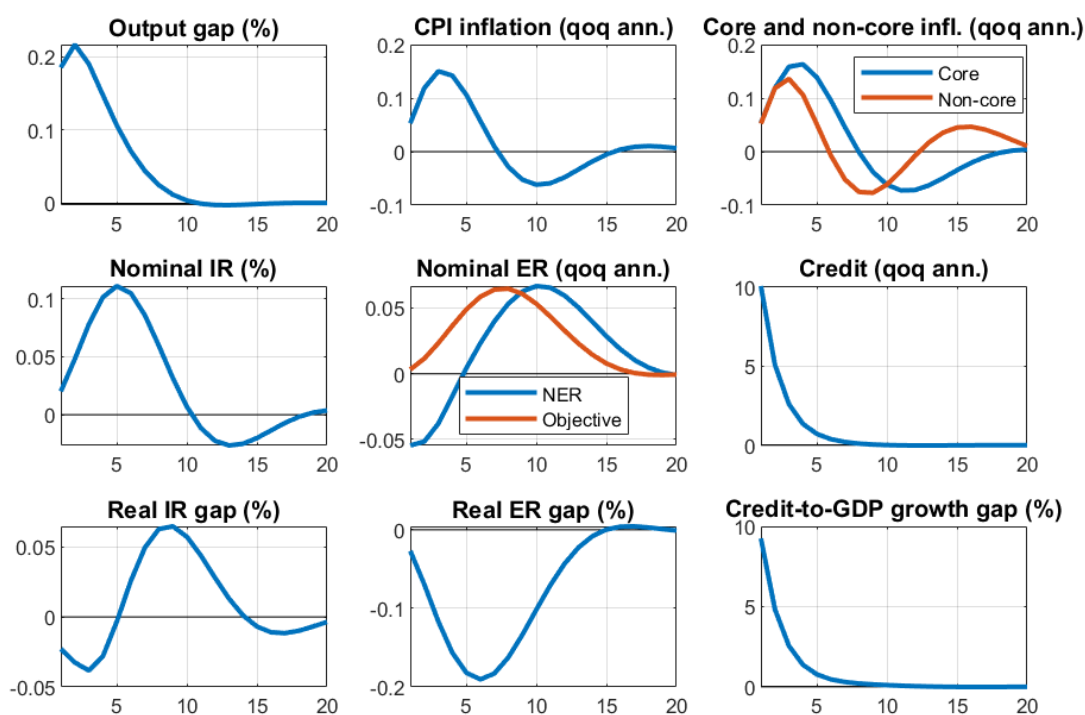
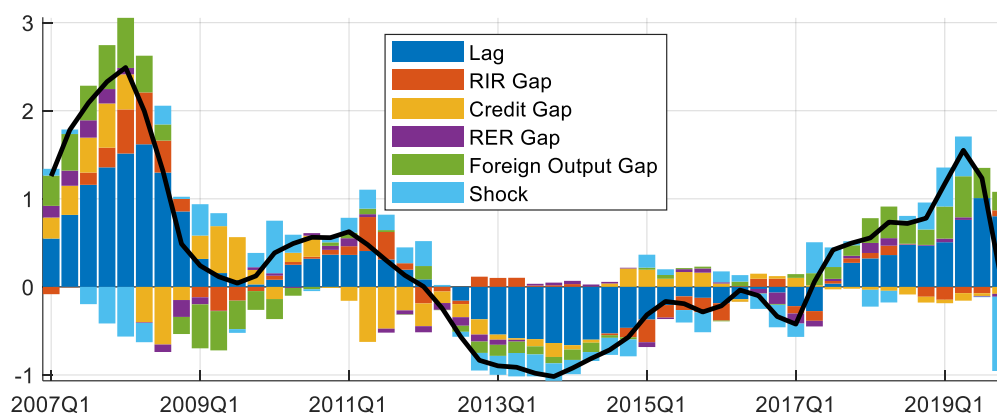
B. Equation Decompositions

In order to reveal the ability of the semi-structural model to interpret the historical developments through the mechanisms and channels embedded in it, we apply the Kalman filtration technique for the sample covering the period from 2007Q1 to 2019Q4. The sample does not include most recent data, since economic developments during 2020 were driven by the multidimensional and complex nature of the COVID-19 pandemic-related shocks, with both external and internal sources, both demand- and supply-side effects, both economy-wide and sector-specific repercussions, etc. In addition, these interreacted with the government-mandated non-economic interventions, which severely impacted economic activity in certain sectors, disrupted labor supply

and limited population mobility. The QPM does not completely capture these aspects – and the associated disruptions in the policy transmission mechanism – such that a comprehensive identification of structural factors, assessment of business cycle conditions and policy stance as of 2020 would require further adjustments and expert judgement to be implemented. Preliminary results using the most recent observations (until 2020Q4) point to a sharp decrease in output gap, bottoming-out in 2020Q2 at significantly negative values and recovering only partially afterwards, consistent with the below-target inflation during 2020. However, additional analysis, potentially using satellite analytical tools (e.g. detailed economic sector-level assessments, granular item-level perspective at headline inflation, estimation of the impact of various containment measures and economic policies, etc.), are required for a proper identification of driving forces and building a realistic narrative. The filtration results for the pre-COVID-19 sample presented below offer a compelling narrative of the macroeconomic developments.[9] Practical implementation of similar decompositions is used in real time in central bank practice to inform and advise policymakers.

Figure 12 displays the decomposition of output gap into the contributions of the determinants specified in aggregate demand equation (15). The estimated output gap trajectory implies strongly positive values before the global financial crisis (GFC), mild fluctuations around zero during and after the GFC, then a period of persistently (though marginally) negative output gap during 2012– early-2017, followed by the recent period of above-trend evolutions. The lag component – which captures the cumulative impact of past structural determinants (monetary conditions, foreign demand, aggregate demand shocks) – displays important contributions. The small open economy dimension is mirrored by the significant effects of foreign effective demand, particularly favorable during the boom period 2007–mid-2008, negative during the GFC, and again positive in the recent period (given synchronized excess demand positions in all major trading partners – China, US and Eurozone – during 2017-2019). The notable credit gap contributions reflect the importance of the credit channel extension considered in the model. After the GFC, it presents mostly countercyclical evolutions, in line with the implementation of a careful credit growth management strategy aimed at enhancing macroeconomic stability. The impact of real interest rate gap and real exchange rate gap components of the monetary conditions appear to be almost neutral during the second half of the analyzed sample. This reflects the observed relative stability of nominal interbank rate, nominal exchange rate, and inflation. Finally, the unmodelled factors – e.g. fiscal policy or consumer confidence – are captured by the aggregate demand shock.

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[9] Interpretation of the structural decompositions over 2007-2019 is not significantly affected by extending the sample to 2020Q4. These minor revisions suggest the robustness of the model-based historical filtration despite unprecedented and complex combination of Covid-related shocks during 2020.

Figure 12: Output gap decomposition (aggregate demand equation), percent
(2007Q1–2019Q4)

The Phillips curve decomposition of core inflation (quarterly annualized) is displayed in Figure 13. It shows the dominant contribution of inflation expectations: in line with the hybrid specification of the formation mechanism, both backward- and forward-looking components are important. Note that since expectations reflect the accumulation of past (backward-looking component) and expected (forward-looking component) real marginal costs, the decomposition trivializes the role of aggregate demand pressures in driving prices. At the same time, the minor role assigned to output gap and real exchange rate gap is in line with the historical account of limited macroeconomic transmission in Vietnam economy (implying also a high sacrifice ratio), as estimated in the empirical literature presented in Section I.

While during 2007-2013 the relative weight of the lagged inflation was somewhat higher, in the second half of the sample the forward-looking (rational expectations) component becomes as important as the backward-looking one. One of the motivations for this result is the broad achievement of the SBV price stability objective in the recent years, with close-to- and below-target headline inflation dynamics contributing to better anchoring of inflation expectations regarding future price developments. The real marginal costs – which are a weighted average of domestic (output gap) and imported (real exchange rate gap) components – shows limited contributions, reflecting a weak transmission through aggregate demand and exchange rate channels in case of core goods segment, but also the situation of output and real exchange rate gaps having opposite signs and thus partly counterbalancing each other; see more on the relation between inflation and real marginal costs below. Aggregate supply shocks affecting core inflation were more pronounced during the period of high macroeconomic instability in 2008-2012, and of a significantly smaller magnitude in the recent years.

Figure 13: Core inflation decomposition (core Phillips curve), quarterly annualized
(2007Q1–2019Q4)
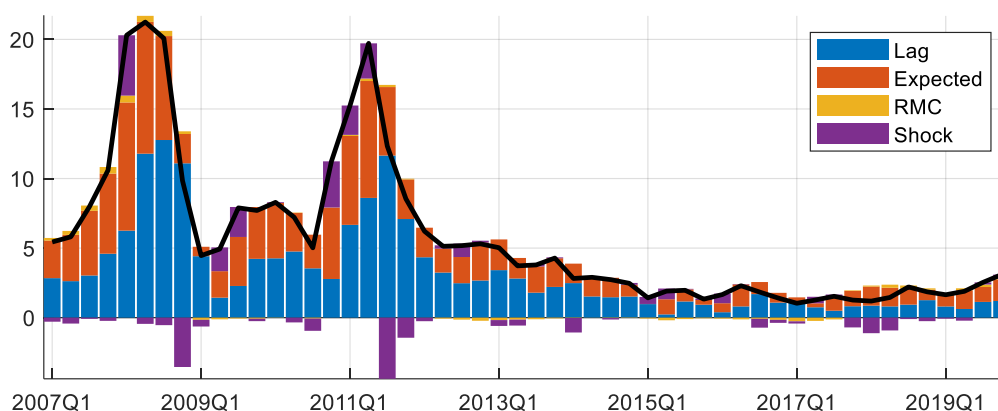
A similar decomposition for the non-core inflation is illustrated in Figure 14. Given the relatively ampler fluctuations and higher volatility of non-core inflation as compared to core inflation, the contribution of non-modelled factors, i.e. non-core supply shocks, is more important, including over the second half of the sample. The relevance of imported oil prices to domestic price developments is reflected in non-negligible weights of the corresponding factor. Similar to core goods segment, the contribution of real marginal costs is limited.

Figure 14: Non-core inflation decomposition (non-core Phillips curve), quarterly annualized
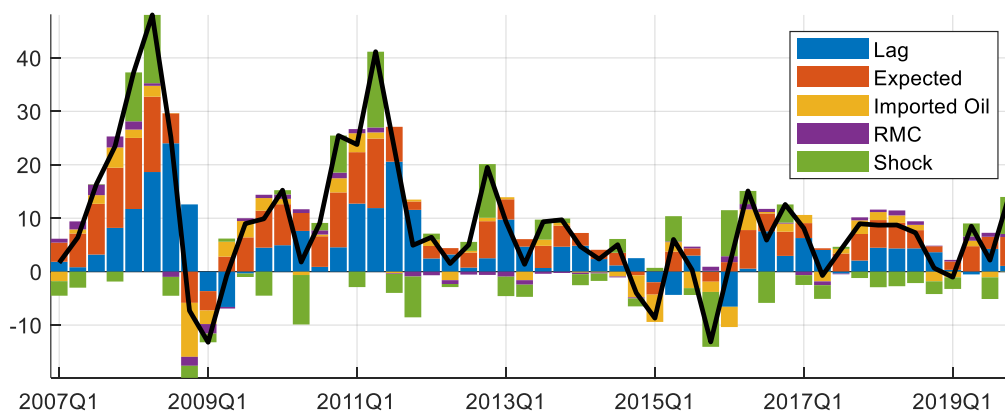(2007Q1–2019Q4)

Figure 15 depicts the dynamics of inflation rate and real marginal costs for the core (left panel) and non-core (right panel) segments. Despite the visibly small contribution of real marginal costs to the inflation developments in both sectors, as documented in Figures 13 and 14 above, the comovement between the two indicators is apparent, especially during the initial half of the

sample, characterized by somewhat more macroeconomic volatility. The estimated real marginal costs are also in line with the narrowing of the fluctuations observed in inflation data over 2013-2019 as compared to 2007-2012.

Figure 15: Inflation and real marginal costs
(2007Q1–2019Q4)
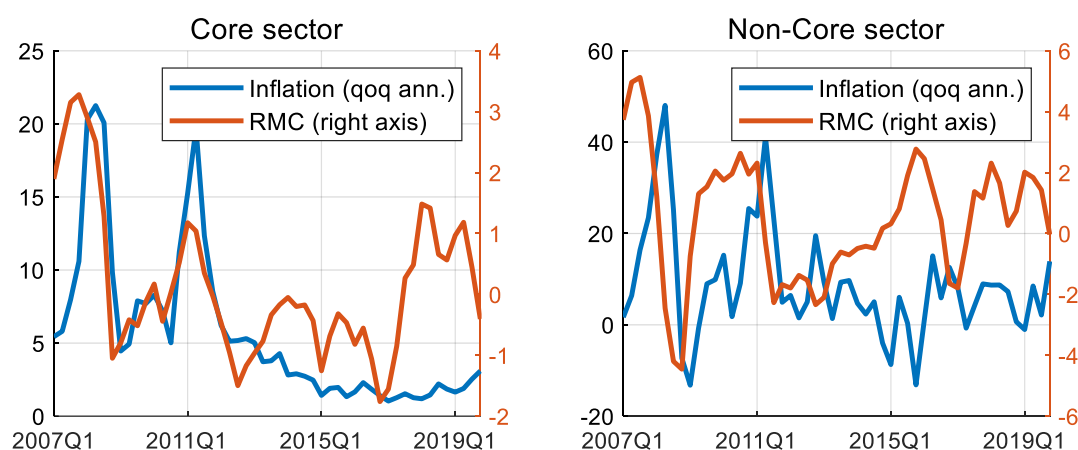
C. In-sample Simulations and Forecasting Accuracy

In order to demonstrate the ability of the Vietnam QPM to capture the salient proprieties of available data, we perform an in-sample simulation exercise. More precisely, we run recursive one- to eight-quarter ahead forecasts for the period 2008Q1-2019Q4, conditioning on the full-sample estimates for the trajectories of foreign variables, output trend, real exchange rate trend, inflation target, indicative nominal credit growth target and nominal exchange rate objective.[10] The results for a subset of observed variables are presented in Figure 16. The recursive in-sample model simulations are represented with various colors, while actual data is displayed in black thick lines.

For most variables, the model matches actual data reasonably well. Despite occasional visible forecast errors for all variables, to a large extent, the QPM manages to capture the relevant turning points in most indicators, including during the initial subsample of higher macroeconomic volatility. Focusing on the recent period, model simulations recommended lowering the interest rate during end-2014–2015, in line with the core inflation (both actual and recursive forecasts) registering below-target values, in the context of stable and largely-predictable output growth and exchange rate dynamics. The reverse situation is observed for 2017–early-2018: recursive forecasts predicted higher interest rate as compared to the ex-post values, given the model

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[10] As compared to an actual real-time forecasting exercise, we don't consider any near-term forecasts or expert judgements. In addition, note that part of the deviations of recursive forecasts from the ex-post actual data can be explained by the differences between observed implementation of monetary policy (in particular, interest rate dynamics) and model-consistent recommendations.

expectations of core inflation returning and temporary exceeding the 4 percent headline inflation target, following a significant period of below-target inflation rate in this sector. At the same time, the model is remarkably well-tailored to approximate the non-core inflation dynamics, considering the inherent less-predictable nature of this segment (however note the scale differences between core inflation and none-core inflation figures).

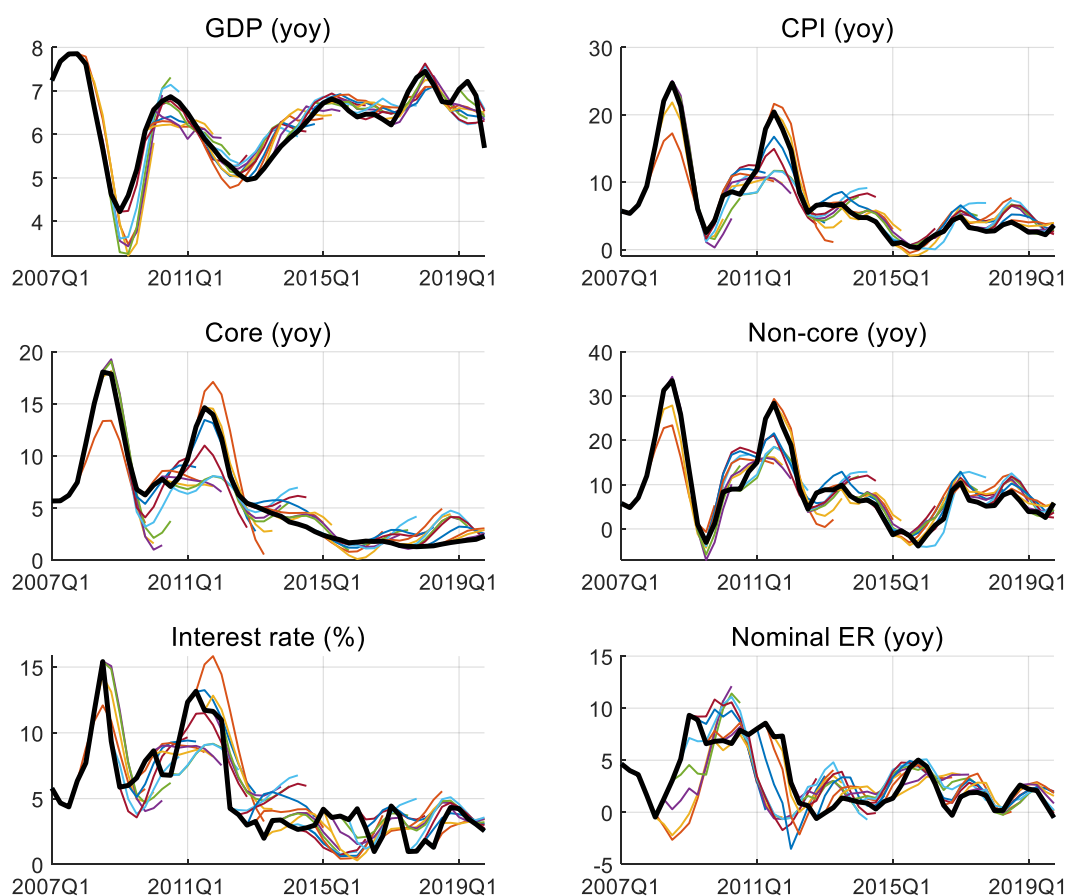Figure 16: In-sample simulations and actual data (black)
(2007Q1–2019Q4)

Table 2 bellow shows a numerical assessment of the model's ability to match the data in comparison to a simple random walk (no-change forecast) model. More precisely, the table represents the ratio of QPM-based root mean square forecast errors (RMSFE) to the random walk model RMSFE, across various macroeconomic indicators and forecast horizons; a value below one (bold in Table 2) indicates that the QPM is preferred to the random walk. According to the results, for virtually all variables and forecast horizons the QPM is outperforming the random walk. The margin is especially important for CPI inflation – owing to an exceptionally good

prediction record for the non-core segment – proving the usefulness of the gap model as a tool for policy analysis and forecasting in a monetary policy framework anchored around the price stability objective. While the model is performing relatively worse at shorter horizons as compared to longer ones in the case of GDP growth, interest rate and nominal exchange rate dynamics, in a practical real-time environment next-quarter values for most variables (and possibly at longer horizons for certain variables) would be exogenised to near-term forecasts estimated with satellite tools. Accordingly, in combination with robust methods for near-term forecasting, the QPM – as medium-term analysis and prediction tool – constitute a well-design and analytically consistent system for conducting policy analysis and providing relevant recommendations.

Table 2: Root mean square forecast errors relative to random walk model

Variable	*1Q*	*2Q*	*3Q*	*4Q*	*5Q*	*6Q*	*7Q*	*8Q*
GDP (yoy)	0.63	0.52	0.45	0.41	0.41	0.42	0.41	0.39
CPI (yoy)	0.32	0.34	0.36	0.38	0.38	0.41	0.44	0.46
Core (yoy)	0.34	0.40	0.45	0.49	0.50	0.54	0.59	0.62
Non-core (yoy)	0.34	0.33	0.31	0.33	0.32	0.35	0.37	0.39
Interest rate (%)	0.84	0.74	0.69	0.69	0.63	0.58	0.57	0.55
Nominal ER (yoy)	0.94	1.01	1.04	1.04	0.92	0.83	0.79	0.78

V. CONCLUSION

In this paper we introduced a QPM that can be utilized for macroeconomic forecasting and policy analysis in Vietnam. This family of semi-structural models, routinely applied in inflation-targeting and inflation-forecast targeting central banks, nests a New Keynesian core model with rigidities – allowing monetary policy to have real effects in the short- to medium-term. The canonical structure is extended to account for Vietnam-specific features: significant openness to international trade; decomposition of headline inflation into core and non-core segments, with sector-specific dynamic processes; explicit role for credit developments in driving aggregate demand; and, importantly, a hybrid monetary policy regime. Macroeconomic data for Vietnam is used to ensure model parameterization and calibration reflect accurately the statistical proprieties of observed data and provide a coherent narrative for the historical economic developments.

An important contribution of this QPM is the idiosyncratic modelling of the Vietnamese monetary policy framework, which has the primary objective of price stability using multiple operational targets and policy instruments. The QPM reflects the primacy of the price stability objective, alongside other macroeconomic goals, and three corresponding operational rules and instruments: (i) inflation target, which is an exogenous goal announced by the Vietnamese government, and achieved primarily with the use of a policy interest rate guided by a Taylor-type rule; (ii) exchange

rate objective, with a corresponding operational rule endogenized within the model; and (iii) annual indicative nominal credit growth for the aggregate banking system, which is set and announced publicly by the SBV. These endogenous interactions are further enriched by direct spillover effects, i.e. the interest rate reacts also to exchange rate dynamics, while the exchange rate objective is also adjusted to inflation deviations from the target.

The formulation of this QPM reflects the current and planned SBV monetary policy regime configuration; the model can be usefully recalibrated, adjusted or extended to reflect ongoing modernization of SBV's monetary policy. Indeed, the flexibility of the QPM is crucial to building analytical and institutional capacity intended to further advance the modernization initiated by the SBV.

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