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Assessing the Spillover Effects of Federal Open Market Committee and European Central Bank Monetary Policy Announcements on Georgia

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Abstract

The recent surge in global inflation, and the sharp disinflationary responses it triggered in major advanced economies, has made the study of international monetary spillovers especially timely. Inflationary episodes heighten market sensitivity, amplify policy uncertainty, and create an environment in which cross-border transmission becomes both stronger and more observable. This paper examines the spillover effects of monetary policy announcements by the Federal Open Market Committee (FOMC) and the European Central Bank (ECB) on Georgia, an emerging economy with high dollarization, a flexible exchange rate, and evolving external linkages.

Monetary spillovers are inherently heterogeneous, shaped by differences in trade and financial linkages, exchange rate regimes, macro-financial vulnerabilities, and local monetary policy stances. Using local projections and vector autoregressions, this study estimates Georgia's real economic response to high-frequency monetary policy shocks, distinguishing between pure monetary policy (MP) shocks and central bank information (CBI) shocks. Findings indicate heterogeneous spillovers: ECB spillovers are more pronounced due to strong trade ties, while FOMC spillovers are more complex, influenced by indirect channels and the U.S. dollar's safe-haven status. State-dependent local projections reveal that economic fundamentals, such as dollarization and volatility in the financial markets, significantly shape spillover magnitudes. These results underscore how inflation and its policy responses can magnify monetary interdependence, raising important challenges for small open economies in managing external shocks and maintaining monetary autonomy.

Keywords

Monetary policy spillovers, Spillover Heterogeneity, Local projections, State-dependent models

Table of Contents

Table of Contents 0
Introduction 1
Literature Review 3
Methodology 4
- Monetary Policy Shocks Identification Methods 4
- Local Projections or Vector Autoregressions 7
- Linear Local Projection Models 8
- State-Dependent Local Projections 9
- Robustness check: VAR 11
- Data 12

Results 13
- Expected Results 13
- Results from the Baseline Models 15
  - Linear Local Projections 15
  - State Dependent Local Projections 23
- Georgian Monetary Policy Rate Response to FOMC and ECB Shocks 34
- Robustness Checks 35
  - Robust to crises periods 35
  - Models with the broader set of controls. 35
  - VAR 35

Conclusion 37
References 40
Appendix A 46
Appendix B 47

Introduction

The study of monetary policy spillovers has been a subject of long-lasting interest among scholars, tracing its origins to seminal works by Fleming (1962), Mundell (1963), Dornbusch (1976), and Obstfeld and Rogoff (1995), among others. These studies investigated the impact of foreign monetary policies on domestic variables, paving the way for subsequent research. Up until now, recent years have been characterized by continuous monetary policy tightening by major institutions such as the Federal Reserve's FOMC and the European Central Bank (ECB), sparking renewed concerns about spillover effects. The current era, characterized by intricate trade and financial interdependencies, emphasizes the necessity of addressing spillover concerns. Moreover, the forces of globalization are inexorable, despite their potential to act as catalysts for spillovers, and therefore for risks and crises emanating from them. As a result, policymakers' decisions extend beyond their domestic economies, shaping global economic welfare.

There exists a body of literature suggesting that US monetary policy can increase the probability of crises in Emerging Market and Developing Economies (EMDEs). For instance, Kose et al. (2021) demonstrate that a 2-percentage point increase in US real interest rates markedly increases the likelihood of currency crises in such economies. This highlights the need to identify and assess spillovers systematically, recognizing their channels and magnitudes.

Spillovers are inherently difficult to generalize due to their heterogeneity, which depends on various factors such as robust trade and financial linkages, exchange rate flexibility, macro-financial vulnerabilities, interest parity frictions, monetary policy stances, foreign currency dependence, sticky dollar-based export pricing, and overall economic fundamentals (e.g. Małgorzata & Walerych, 2021; Kucharčuková et al., 2016; Camara et al., 2024; Eichenbaum et al., 2021). These factors determine whether transmission channels are muted or amplified, leading to varying spillover effects across countries.

For instance, emerging economies with weak fundamentals are particularly sensitive to changes in US interest rates—sometimes even more so than the US economy itself— as highlighted by Iacoviello & Navarro (2019) and Ugazio & Xin (2024). High levels of dollarization further intensify these dynamics, as rising US interest rates and a stronger dollar increase borrowing costs for EMDEs, heightening financial crisis risks. In contrast, advanced economies (AEs) are less likely to adjust their portfolios in response (Eichenbaum et al., 2021; Gourinchas et al., 2022). This instability also disrupts financial markets in EMDEs, discouraging capital inflows and exacerbating financial vulnerabilities, as noted by Arteta, Kamin, & Ruch (2022). Additionally, countries with limited trade linkages experience a weaker expenditure-switching effect—important positive spillover channel—compared to economies more closely integrated with the policy-setting country.

With this in mind, the analysis examines the spillover effects of monetary policy decisions by the FOMC and the ECB on Georgia. This approach identifies how an emerging economy with a flexible exchange rate system, evolving financial linkages, and high dollarization is affected by external monetary shifts while also assessing the role of Georgia's fundamental economic variables in shaping these spillovers. A key aspect of this investigation is the comparison between the effects of ECB policy decisions—given Georgia's close trade ties with the euro area (EA)—and those of the FOMC,

where direct trade links are weaker. However, spillovers from US policy may still occur indirectly through shared trade partners.

Another challenge in estimating spillovers lies in measuring monetary policy shocks. The standard strategy for measuring monetary policy shocks, accounting for high-frequency changes in interest rates (HFI) around policy announcements, has faced challenges due to empirical findings. Eichenbaum (1992) coined the term the “Price Puzzle,” to describe the phenomena when contractionary monetary policy led to higher price levels in the short run. Ilzetzki & Jin (2021) observe that in the 1980s and early 1990s, a tightening of US monetary policy led to conventional outcomes. However, in the last two decades, there has been a change as increases in US interest rates result in a appreciation of the US dollar, but contrary to conventional logic, stimulate economic activity in the rest of the world. Similarly, Jarociński & Karadi (2020) find that over the past 3 decades, one-third of FOMC announcements and half of the ECB policy announcements were characterized by a positive correlation between interest rates and stock market changes. These findings led to a reassessment of traditional outcomes.

The proposed rationale for these inconsistencies is that when evaluating the causal influence of policy, it is imperative to consider the economic fundamentals to which the policy naturally reacts, as suggested by Jarociński & Karadi (2020). Monetary policy announcements not only reflect changes in policy stance but also convey information about the central bank's economic projections, termed "central bank information shock", "Fed information effect" or "information disclosure shock" (Romer & Romer, 2000; Nakamura & Steinsson, 2018; Jarociński & Karadi, 2020; Jarociński, 2022). As Jarociński (2022) puts it, “the impact of a positive i^{CBI} (unlike i^{MP}) is similar to the impact of positive economic news”.

These two shocks, pure monetary policy (MP), and central bank information shocks (CBI) are orthogonal to each other, offering a method to separate unforeseen policy adjustments and evaluate their effects on actual economic activity and price levels (Gertler & Karadi, 2015; Nakamura & Steinsson, 2018). A monetary policy shock is associated with policy tightening leading to lower stock market valuation due to increased discount rates and lower expected dividends. Conversely, a positive co-movement suggests an accompanying information shock, which is either based on private information the Fed possesses or on common information. The literature posits that these shocks yield contrasting spillovers on economic variables, with information shocks notably exacerbating the impact of ECB monetary policy spillovers compared to the HFI strategy (Jarociński & Karadi, 2020; Jarociński, 2022; Ugazio & Xin 2024; Camara, 2022, 2023). Therefore, in addition to considering fundamentals, this paper will examine spillovers resulting from US and ECB monetary policy shocks by employing both the HFI and disaggregating strategies.

The organization of the forthcoming sections is as follows: the second section presents an in-depth review of relevant literature, emphasizing the contributions made by this paper; the third section delineates the methodology employed, encompassing the estimation of monetary policy and information news shocks, along with their spillover effects; the fourth section details results from the baseline models and robustness checks; the final section will conclude the paper and propose ways of further expanding this research.

Literature Review

This paper relates to three main strands of literature. Firstly, it contributes to the extensive body of literature on the international transmission of US monetary policy shocks into open economies, a subject that has been explored by numerous authors over the span of decades, e.g. (Eichenbaum & Evans, (1995); Dedola, Rivolta, & Stracca, 2017; Vicondoa, 2019; Saxegaard, Firat, Furceri, & Verrier, 2022). Furthermore, Miranda-Agrippino & Ricco (2021) find that "quantitative easing" shocks initiated by the ECB produce notable global spillover effects, although they are relatively less economically significant compared to those generated by the Fed. Contrarily, according to Camara (2023) it is evident that for ECB monetary policy, both monetary policy and information shocks have significant quantitative effects. The paper's contribution is firstly that it will focus on Georgia specifically, secondly, it will identify any atypical movements with respect to foreign monetary policy shocks.

This paper also relates to the more recent growing literature that unbundles the monetary policy shocks following the announcements of FOMC and ECB. Various studies have accounted for the role of information effects (Romer & Romer, 2000; Campbell, Evans, Fisher, & Justiniano, 2012; Nakamura & Steinsson, 2018; Bauer & Swanson, 2020; Acosta, 2021; Ciminelli, Rogers, & Wu, 2022; Camara (2022,2023)). Nakamura & Steinsson (2018) emphasize that, unlike professional forecasters, central banks possess superior information regarding aggregate variables. Their suggestion posits that policy actions function as informational signals, prompting adjustments in beliefs and expectations among private sector agents. This paper aims to contribute to the existing literature by quantifying the impacts of distinct shocks on Georgia. I will assess the prevalence of shocks not only stemming from the FOMC or the ECB announcements but also additionally of CBI or MP shocks originating from them.

Third, this paper relates to studies examining how country-specific factors shape the transmission of foreign monetary policy shocks. While Eichengreen & Gupta (2014) find that country fundamentals played little role in mitigating the negative spillovers from Fed policy, other studies argue that weaker fundamentals exacerbate the effects of monetary tightening, while stronger fundamentals provide resilience (Mishra et al., 2014; Chen, Griffoli & Sahay, 2014; Ahmed, Akinci, & Queralto, 2021; Ugazio & Xin, 2024). Nevertheless, intriguingly, improved fiscal balances do not consistently lead to better growth outcomes, implying that nations with weaker fundamentals might derive greater benefits from positive news shocks, stemming from reduced uncertainty and enhanced investor sentiment (Ugazio & Xin, 2024). Relevant fundamentals vary country by country, for instance, Mishra et al. (2014), and Aizenman et al. (2014) have investigated aspects such as fiscal deficit, FX reserves, and external debt. Additionally, studies by Bowman et al. (2014) and Ahmed et al. (2015) have examined public debt, financial openness, and exchange rate regimes. These studies shed light on how different economic variables influence the response of EMDEs to external shocks. This paper will analyze the role of fundamentals for Georgia and will also assess the role of global risk appetite and oil prices to also evaluate the role of the global economic state, similar to the paper by Ugazio & Xin (2024). Its contribution will be through implementing a new methodology, fit for a single-country analysis.

Country-specific factors shape how monetary policy shocks transmit through key channels. Recent literature identifies three primary mechanisms: the expenditure switching, trade, and financial channels. The Mundell-Fleming framework emphasizes the expenditure switching channel, where

exchange rate movements affect trade competitiveness—dollar (or euro) appreciation reduces domestic GDP while stimulating foreign economies, though the magnitude depends on trade ties (Camara, 2024). In Georgia's case, however, competitive gains from GEL depreciation are limited because key trade partners experience similar depreciations, while higher import costs suppress demand. The trade channel operates through aggregate demand, as rising US interest rates reduce imports, transmitting negative spillovers to trade partners, particularly EMDEs with strong trade linkages (Arteta, Kamin, & Ruch, 2022). The financial channel further amplifies these effects, as GEL depreciation increases the burden of foreign-denominated debt, restricting investment and output. Capital outflows intensify in EMDEs due to interest rate parity frictions, exacerbating recessions that coincide with currency depreciation (Gabaix & Maggiori, 2015; Christiano et al., 2021; Itskhoki & Mukhin, 2023). These mechanisms collectively explain why EMDEs often experience sharper downturns than AEs following US or EA monetary tightening.

Methodology

Monetary Policy Shocks Identification Methods

According to Ramey (2016), when identifying monetary policy shocks, several foresight problems pose a challenge, for example, the foresight on the part of policymakers. Following Ramey (2016), if we suppose that the central bank (CB) takes into consideration the lagged effects of monetary policy and sets the Fed funds rate based on its expectations of the future path of output and inflation, we can consider this trivial rule:

$$i_t = \alpha_1 E_t(\Delta_h y_{t+h}) + \alpha_2 E_t(\Delta_h \pi_{t+h}) + \varepsilon_{ft}$$

Where i is the monetary policy rate, y – the log of output, π – the inflation, and Δ_h - the change in a variable over h periods. From this equation, monetary policy shock is ε_{ft}. The typical SVAR setup assumes that the CB's forward-looking expectations regarding output and inflation can be adequately represented by the current and past values of a few macroeconomic variables within the SVAR framework, which is a rather strong assumption. As a potential solution, Bernanke et al. (2005) introduced the FAVAR method, which typically includes a wide range of series. It offers the advantage of conditioning on a broader set of relevant information for shock identification. However, this method also assumes that linear combinations of publicly available series fully encapsulate the Fed's expectations.

Furthermore, Romer & Romer (2000) provided evidence suggesting the Fed possessed more accurate inflation forecast information compared to the private sector, the "Fed information effect", which could explain the price puzzles. Ramey (2016) demonstrated the issue of this information asymmetry likewise:

$$f_t = \alpha_1 E_t^p(\Delta_h y_{t+h}) + \alpha_2 E_t^p(\Delta_h \pi_{t+h}) + \alpha_1[E_t^f(\Delta_h y_{t+h}) - E_t^p(\Delta_h y_{t+h})] + \alpha_2[E_t^f(\Delta_h \pi_{t+h}) - E_t^p(\Delta_h \pi_{t+h})] + \varepsilon_{ft}$$

Where, E_t^p stand for expectations based on private agents' information, whereas E_t^f are expectations based on Fed's information. The asymmetry disappears and monetary policy shock is simply ε_{ft}, if Fed's and private agents' information sets are identical and all information is public. However, in the case of information asymmetry, both SVAR and FAVAR biasedly identify the monetary policy shock which includes both the true shock and the Fed's excess information:

$$\widetilde{\varepsilon_{ft}} = \alpha_1[E_t^f(\Delta_h y_{t+h}) - E_t^p(\Delta_h y_{t+h})] + \alpha_2[E_t^f(\Delta_h \pi_{t+h}) - E_t^p(\Delta_h \pi_{t+h})] + \varepsilon_{ft}$$

A proposed solution to this problem was using the Fed's Greenbook forecasts in VARs, by Barth & Ramey (2002) but it still could not eliminate the price puzzle. Romer & Romer (2004), combined Greenbook forecasts and narrative techniques to create a new measure of monetary policy shocks. Using narrative methods, from the FOMC meetings they garnered intended federal funds rate adjustments and regressed them against current rates and Greenbook forecasts for future output growth and inflation to separate policy responses from external shocks. As Cochrane (2004) posited, as long as Greenbook forecasts account for all of the Fed's information, Romer & Romer's (2004) identification methodology can create valid exogenous instruments. The concept proposes that if the Federal Reserve reacts to a shock based on factors unrelated to its impact on future macroeconomic variables, such a response can serve as a tool for analyzing that macroeconomic variable (Ramey, 2016).

Another type of foresight is information regarding future policy actions. CBs, with their foreword guidance, create anticipations about changes in fed funds rates, and this premeditation on future policy variable shifts can result in a non-fundamental moving average representation, making it difficult to identify shocks using standard VARs. According to Campbell et al. (2012), the Fed has been employing forward guidance since the 1990s.

In response to this challenge, emerged a new identification that to pinpoint unexpected Fed policy measures, leverages movements in federal funds and other interest rate futures in small windows surrounding FOMC announcements. This methodology gives high-frequency interest rate changes or monetary policy surprises, and it has been researched by multiple scholars, among Cochrane & Piazzesi (2002), Faust et al. (2003), Gurkaynak et al. (2005), Bernanke & Kuttner (2005), Piazzesi & Swanson (2008), Barakchian & Crowe (2013), Gertler & Karadi (2015), and Nakamura & Steinsson (2015), Stock & Watson (2018), Swanson (2021). As argued by Bauer & Swanson (2022), high-frequency identification (HFI) is attractive because it potentially mitigates the issues of reverse causality and other endogeneity concerns, as FOMC and ECB decisions are finalized shortly before public announcements, it is unlikely for the committee to have reacted to market changes within a narrow timeframe surrounding the announcements. Also, monetary policy surprises are unforeseeable with available public information, otherwise, market participants could exploit this predictability for profitable trading activities, ultimately eroding the predictability. Thus, monetary policy surprises are considered as plausibly exogenous concerning all macroeconomic variables publicly known before the FOMC announcement, making them a credible instrument for analyzing the impacts of monetary policy in Structural VARs (SVARs) and local projections (LPs), as elucidated in Stock & Watson (2018).

Other than, identified monetary policy shock which includes both the true shock and the Fed's excess information, asymmetric information also poses another complication through private agents extracting information from signals following actions and announcements from the Fed. Private agents observe $\widetilde{\varepsilon_{ft}}$ and they know that it potentially includes targets for macroeconomic variables unobserved by the public. Jarocinsky & Karadi (2020) tackle this problem by separating the "central bank information shocks" and pure monetary policy shocks from high-frequency interest rate changes. In my paper, the identification of shocks crucially relies on the disaggregated shocks proposed by Jarociński (2022), as it borrows from its data. The methodology in Jarociński (2022) is derived from Jarociński & Karadi (2020), assessing the rapid fluctuations observed in various financial assets surrounding FOMC meetings to separate two distinct shocks: MP and CBI shocks. Using HFI and separating the types of shocks mitigates the two major problems of monetary policy shock identification proposed by Ramey (2016): foresight and asymmetric information problems, moreover, Jarociński & Karadi (2020) emphasized the effectiveness of their methodology in capturing the nuanced impacts of FOMC meetings by demonstrating the robustness of their methodology, particularly the information disclosure shock, against criticisms raised by Bauer & Swanson (2022).

The approach proposed by Jarociński & Karadi (2020) utilizes sign restriction conditions on the co-movement of interest rates and the stock price surprises: S&P 500 index or Euro Stoxx 50 index (for the US and ECB, respectively) around FOMC and ECB announcements to decompose the total interest rate surprises. The total interest rate surprises are the first principal component of the surprises in interest rate derivatives with maturities of up to 1 year. In the case of the Federal Reserve, drawing from studies like Gürkaynak et al. (2005) and Nakamura & Steinsson (2018), the analysis incorporates current month and 3-month forward fed funds futures, along with 2-, 3-, and 4-quarter ahead 3-month Eurodollar futures. Meanwhile, for the European Central Bank (ECB), the focus is on Overnight Index Swaps (OIS) across different maturities, including 1-, 3-, and 6-months, as well as 1-year. This co-movement illustrates the anticipated response of financial markets to changes in monetary policy.

Jarociński (2022) decomposes the total interest rate surprise based on the methodology in Jarociński & Karadi (2020):

$$i^{Total} = i^{MP} + i^{CBI} \qquad (1)$$

where i^{MP} is negatively correlated with s and i^{CBI} is positively correlated with s, where s is the stock price surprise and i^{Total} is the interest rate surprise. Since MP shocks lead to a negative co-movement between these high-frequency financial variables, while ID shocks are identified by observing positive co-movements, i^{MP} and i^{CBI} can work as proxies for pure monetary policy and central bank information shocks, respectively.

More specifically, Jarociński (2022)'s decomposition satisfies:

$$M = UC, \quad with \quad U'U = diagonal\, matrix \quad and.\ C = (1 < C_{MP} < 0\ 1 < C_{CBI} > 0)$$

Where if T denotes the number of CB announcements, M and U are both a $T \times 2$ matrices, $M = (i^{Total}, s)$ and $U = (i^{MP}, i^{CBI})$. i^{MP} and i^{CBI} are mutually orthogonal, by construction. Matrix C's first column captures equation (1) and the second contains the elasticities of stock prices to i^{MP} and i^{CBI}, the negative and positive respectively. The proposed decomposition can be altered based on chosen

rotational angles, by rotating U and C with an orthogonal matrix. As we increase the rotational angles, C_{MP} become more negative and C_{CBI} is still positive but small in magnitude, and MP shocks explain more variation in s, whereas CBI explain more variation in interest rates. As Jarociński (2022), I will be using shocks derived by median rotational angle.

Local Projections or Vector Autoregressions

In the literature, when estimating the effects of monetary policy shocks on macroeconomic variables, economists predominantly utilize either LP's or VAR's, or both as a robustness check. In my paper, I will use LP as the principal model and will conduct a robustness check with a VAR.

Introduced by Oscar Jordà in 2005, Local Projections (LP) is a form of direct multistep forecasts that provide an alternative to the iterative method of VARs. Estimating LP involves using linear regressions to derive impulse response functions directly. The coefficient βh indicates the response of x at time t + h to the shock at time t. As a result, one creates impulse responses by compiling the sequence of βh estimates from individual regressions at each horizon (Ramey & Zubairy, 2014). The Jordà method is advantageous in that it does not restrict the form of the impulse response function, and it allows for not all variables to be included in every equation, enabling a more concise specification, making it less susceptible to inaccuracies in specifying the VAR or SVAR. This approach differs from the conventional method of estimating VAR parameters for horizon 0 and subsequently using them for the iterative construction of impulse response functions (Ramey & Zubairy, 2014).

According to studies in forecasting, direct methods are noted for their comparatively reduced bias, while iterated methods tend to exhibit relatively lower variance. However, the latter are more susceptible to parametric misspecifications, especially noticeable for longer time horizons. Though VAR and LP procedures theoretically asymptotically estimate the same impulse response function with a scaling factor, small sample sizes pose a bias-variance trade-off challenge (Plagborg-Møller & Wolf, 2021). Moreover, when dealing with near-unit roots and longer horizons, different inferential conclusions may arise, as highlighted in recent research by Plagborg-Møller & Montiel-Olea (2020). Especially for larger horizons, the variance for β(h) increases as e(h)t compounds (Ferroni & Canova, 2021). During the evaluation of monetary policy shock effects following Romer and Romer's methodology using both VAR and LP, Ramey (2016) observes that the LP responses, despite exhibiting increased volatility, demonstrate a more consistent pattern. Specifically, when switching from recessions to expansions, the LP estimates indicate a prolonged decrease in output that gradually reverts to standard levels, whereas the VAR estimates suggest higher fluctuations.

The LP methodology, other than having a higher variance, also comes with the loss of observations at the end of the sample and its residuals are predominantly autocorrelated and necessitate the use of Heteroskedasticity and autocorrelation consistent (HAC) estimators. Moreover, if the true data-generating process (DGP) is known, VAR imposes more structure and is more efficient than LP (Ramey, 2016). However, since my preference is to correctly identify the effect rather than have small confidence intervals, and since it cannot be claimed in my paper that the true DGP is known, I will use LP methodology for my main model. However, as a robustness check I will also estimate impulse response using the VAR. Moreover, I intend to evaluate the role of economic states on the spillover effects, which is more feasible using the LPs (Ramey & Zubairy, 2014).

Linear Local Projection Models

(i) Model with extra controls:

$$y_{t+h} = \alpha_h + \beta_h^{FMP} i_t^{FMP} + \beta_h^{FCBI} i_t^{FCI} + \sum_{j=1}^{2} \alpha_j x_{t-j} + \sum_{j=1}^{2} \gamma_j y_{t-j} + \sum_{j=1}^{2} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + \epsilon_{t+h}$$

(ii) Model with only shocks and lags of the dependent variable and the shocks:

$$y_{t+h} = \alpha_h + \beta_h^{FMP} i_t^{FMP} + \beta_h^{FCBI} i_t^{FCBI} + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FMP}) + \epsilon_{t+h}$$

These two specifications are the most frequently used when identifying transmission of monetary policies and for robustness both of them will be considered. These equations measure the outcome variable y_{t+h} of Georgia at a time horizon of h quarters from date t. With these models will be estimated the spillovers up to 12 quarters. y_{t+h} stands for macro-financial variables of interest, which includes real GDP, exchange rates against the USD and the EUR, CPI, GDP deflator, government expenditure, government revenue, exports, and imports. In F, FMP, and FCBI, F stands for FOMC announcements, MP for pure monetary policy shock, and CBI for central bank information shock. In a model for ECB announcements, there would be E, EMP, and ECBI. β_h^{MP} and β_h^{CBI} give the impulse response of outcome variable y at horizon h of an MP and CBI shocks, respectively.

The first specification includes 2 lags of the outcome variable, y, the country-specific variables, x, and the FOMC and ECB shocks. The country-specific variables are always log real effective exchange rate, log CPI, and log real GDP (unless these are the dependent variables themselves, or the GDP deflator in which case I exclude log CPI), following Arteta, Kamin, & Ruch (2022). I also estimate the impact of monetary policy spillovers using the Standard HFI by replacing i^{MP} and i^{ID} with the high-frequency surprises of the policy interest rate.

The second specification is also very common in the monetary policy spillovers literature, in this case higher lag polynomial should incorporate the information that would be provided by additional controls. In this case, the number of lags is 4 for both the shocks and lagged dependent variables, following common practice in quarterly data.

As my baseline model, I will estimate model (ii), and model (i) will act as a **robustness check**. Given that the shocks are exogenous, additional controls should not affect the impulse responses, only their confidence bands. It is a common practice for checking the orthogonality and exogeneity of shocks, for example Bachmann and Gödl-Hanisch (2022) use this methodology to see if "a shock on the right-hand side of local projection regression is truly exogenous".

In all models I reject the recursiveness assumption and omit the contemporaneous values of all variables other than the shocks. According to the recursiveness assumption, the current values of macroeconomic variables, such as output or CPI determine the monetary policy rate, and therefore in the same period monetary policy rate cannot affect those variables, thus output and prices are not allowed to respond to changes in the monetary policy rate within the period. Recursiveness assumption makes the shocks orthogonal to current macroeconomic variables. This assumption is

usually used as an “exogeneity insurance’ when the estimated shock is not pure (Ramey, 2016). But that this assumption is at odds with some later estimated New Keynesian DSGE models and shouldn’t be needed based on the construction of shocks by Jarociński (2022).

State-Dependent Local Projections

It is well established in the monetary policy transmission literature, that monetary policy spillover effects differ in different states of economy, strong fundamentals may shield Georgia from negative spillovers induced by monetary policy shocks and potentially amplify positive spillovers from information shocks as outlined in the findings of Ugazio & Xin (2024) when assessing the effect of US monetary policy shocks on emerging economies. By following Ramey & Zubairy’s (2018) methodology and incorporating dummy variables that indicate the state of the economy at the time of the shock occurrence, while enabling all model coefficients to adjust based on the economic state, we allow for variations in the forecast of *yt+h* to depend on and vary with the economic state when the shock occurred.

In the Jordà approach, as separate regressions are conducted for each horizon h, no iterative process is required. The parameter estimations rely on the behavior of the economy between periods t and t + h, considering the shock, initial state, and control variables. The parameters of control variables capture the average economic tendencies between states. Therefore, if State A is shorter than State B, the forecast for h quarters ahead adjusts accordingly. This approach amalgamates both the inherent and endogenous transitions between different states observed in the data (Ramey & Zubairy, 2018).

This paper will explore two different specifications that account for state variables. The example will be demonstrated using model (ii) of the linear LP.

(i) Model according to Ramey & Zubiary (2018), Ugazio & Xin (2024), Arteta, Kamin, & Ruch (2022) specification:

$$y_{t+h} = S_{t-1}[\alpha_{R,h} + \beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI} + \sum_{j=1}^{4} \gamma_{R,j} y_{t-j} + \sum_{j=1}^{4} (\delta_{R,j} i_{t-j}^{FMP} + \tau_{R,j} i_{t-j}^{FCBI})] + (1 - S_{t-1})[[\alpha_{X,h} + \beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI} + \sum_{j=1}^{4} \gamma_{X,j} y_{t-j} + \sum_{j=1}^{4} (\delta_{X,j} i_{t-j}^{FMP} + \tau_{X,j} i_{t-j}^{FMP})] + \epsilon_{t+h}$$

(ii) I will also use the specification that was used in the paper by Pragyan (2023):

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + (1 - S_{t-1})[\beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI}] + \epsilon_{t+h}$$

S_{t-1} is a dummy which is equal to 1 if the median at time t of the state variable is above the sample mean, zero otherwise. Each state will be considered separately. X subscript is for expansionary because, for my choice of state variables, higher values mean a slack state, except for the FX reserves dummy, R is for recessionary. Here, expansionary, and recessionary simply imply a positive and negative impact on the economy, respectively, given the value of a state-defining variable. For example, high oil prices would have a negative impact on the economy. The difference between the two specifications is that in the second one state is only interacted with shocks. Likewise, fewer degrees of freedom will be lost.

The state-defining variables were selected based on their availability and economic relevance to Georgia, drawing from the existing literature. A comprehensive list of state-determining variables used in previous studies can be found in Table A.1 in the appendix.

Sate determining variables for Georgia	**Reasons behind their inclusion**
VIX index	VIX reflects higher stock market volatility and lower risk appetite (global proxy)
VSTOXX index	VSTOXX reflects higher stock market volatility and lower risk appetite for Europe
Oil prices (US and European)	To account for oil-importer sensitivity to oil prices
FX reserves	Low FX reserves means that a country has weak fundamentals
Foreign currency denominated debt as a share of total debt (fd)	High fd means that a country has weak fundamentals
Deposit Dollarization rate	To account for country's tendency to rely on a haven currency
Global Wheat Price	To account for the effect on an important commodity price

All models, described above, will be followed by cumulative impulse response functions. This specification was chosen because when a dependent variable is log-first differenced, cumulative impulse responses, will provide accumulated percentage changes which can be interpreted as a regular log-level regressions impulse level could be (Stock & Watson, 2018). As Kilian & Lutkepohl

(2017) put it, cumulative impulse responses of dependent variables that are first-differenced will correspond to the responses of variables in levels. In Stata I will follow the methodology of Ramey & Zubairy (2018), who propose that cumulative IRFs can be generated by cumulating the dependent variable up to horizon h.

Robustness check: VAR

Other than control augmented model, to test the robustness of the main model, this paper will also estimate a VAR with a Cholesky decomposition.

According to economic logic proposed by Ramey (2016), Stock & Watson (2018), and other scholars, the shocks from the Fed and the ECB are positioned at the beginning of the system. This positioning designates them as contemporaneously exogenous with regard to Georgia's real variables, indicating that they do not react to Georgia's economic variables. Instead, variables within Georgia's economy respond to the shocks from the Fed and ECB, following the sequence of influence as per economic theory, making them contemporaneously endogenous. Firstly, two FOMC shocks will be positioned, with MP preceding CBI. This arrangement implies that the first FOMC shock can influence the second FOMC shock simultaneously, while the reverse impact is not allowed. As these shocks are mutually orthogonal by design, these ordering choices are expected to result in efficiency losses without introducing any systematic bias.

The benchmark VAR will be based on the following specification to derive IRFs:

$$\begin{bmatrix} 1 & 0 & 0 \\ \theta^{MP} & 1 & 0 \\ \beta^{MP} & \beta^{CBI} & 1 \end{bmatrix} \begin{bmatrix} MP\ shock \\ CBI\ shock \\ Georgian\ Real\ Variable \end{bmatrix}$$

Data

The dataset consists of quarterly observations, with most series spanning from 2003Q1 to 2024Q1. Table below summarizes the variables used in the analysis, their transformations, types, and sources.

For details on data characteristics, refer to Appendix B.

Variable	Transformation	Variable Type	Source	Abbreviation(s)
Real GDP 2019 prices	100Ln, First difference	Dependent, Control	Geostat	dlnrgdp
GDP deflator 2019 base	100Ln, First difference	Dependent, Control	Geostat	dlndefl
Imports/exports	100Ln, First difference	Dependent, Control	Geostat	dlnimp
CPI same month of the previous year	100Ln, First difference	Dependent, Control	Geostat	dlnlnexp
USD/GEL quarterly average	First difference	Dependent	NBG	dusdgel
EUR/GEL quarterly average	First difference	Dependent	NBG	deurgel
Georgian Monetary policy rate	None	Control	NBG	gmp
REER 2019=100	Ln, First difference	Control	NBG	dlnreer
Government revenue GEL	Ln, First difference	Dependent	Ministry of Finance of Georgia	dlngovr
Government expenditure GEL	Ln, First difference	Dependent	Ministry of Finance of Georgia	dlngovx
FX debt share (to residents)	None, construct dummy	Control	NBG	df
Crude oil price (Brent)	None, construct dummy	Control	FRED	oileu
Crude oil price (WTI)	None, construct dummy	Control	FRED	oilus
VSTOXX	None, construct dummy	Control	Stoxx.com	vstx
VIX	None, construct dummy	Control	FRED	vix

Global Wheat Price Index	None, construct dummy	Control	FRED	wheat
Gross International Reserves (GEL)	None, construct dummy	Control	NBG	fxr
Deposit Dollarization	None, construct dummy	Control	NBG	dolz
Output Gap	None, construct dummy	Control	Derived by HP filter	gdpg
FED and ECB monetary policy shocks	Standardized	Control, Instrument	Jarocinsky	fmp, fcbi, fhfi, emp, ecbi, ehfi
FED and ECB shadow rates	Scale by dividing 0.0025	Endogenous for LP-IV	Jing Cynthia Wu	ffr, ecbr

Results

Expected Results

An increase in the monetary policy rate by the ECB or the Fed is expected to impact countries like Georgia through both direct and indirect channels. Directly, the monetary policy change affects the economy from which the spillover is assessed. Indirectly, it impacts neighboring countries also affected by the ECB and Fed's policy changes. The effects of the ECB's policies are expected to be more pronounced than those of the Fed due to Georgia's close trade ties with the EA and its neighboring countries' strong ties to the EA. Weak trade ties stifle some spillover channels, like the expenditure switching, or exchange rate channel, and weakens trade channel. Georgia's specific political and economic conditions also play a role in how these spillovers manifest, which weigh the heaviest on the effects stemming from US.

In the standard Mundell-Fleming framework, exchange rate fluctuations drive **expenditure switching channel**, shaping how economies respond to monetary policy shifts. A US (or EA) interest rate hike appreciates the dollar (or euro), making domestic goods more expensive for foreign buyers and imports cheaper. This reduces domestic GDP while stimulating economic activity abroad (Camara, 2024). However, this effect varies depending on trade relationships. For economies with limited US trade ties, simultaneous currency depreciations against the dollar mean no relative competitive advantage emerges, leaving their effective exchange rates largely unchanged. While a weaker GEL could boost exports, its key trade partners—such as Turkey and Russia—also see their currencies depreciate, limiting any competitive advantage. Additionally, GEL depreciation raises import costs, suppressing domestic demand. The negative effects on imports lag behind, as they stem from declining export-driven income. Over time, the downward pressure on prices may turn into upward pressure as the effects of currency depreciation and aggregate demand return to normal levels.

Other than expenditure switching channel, recent research highlights alternative transmission mechanisms of US monetary policy shocks. One is the **domestic demand—or trade—channel**,

where rising interest rates contract aggregate demand, reducing imports and negatively impacting trade partners. Arteta, Kamin, and Ruch (2022) find that declining demand from major economies spills over to EMDEs, primarily through trade linkages. For economies with weaker trade ties to the policy-making economy, the negative spillover from the indirect channel—stemming from trade partners closely linked to the policy-maker, that experienced low demand on exports—would still occur, but its impact would be weaker.

Another key channel is **financial channel**, wherein the **balance sheet effect** is very important. Many Georgian firms hold foreign-denominated debt, so monetary tightening in the US or EA depreciates the GEL and the currencies of its trading partners. Weaker local currencies increase debt burdens, restricting investment, and reducing output, with spillovers to trade partners resulting in similar effects. Following a rate hike, **interest differentials** prompt people to reallocate their portfolios toward assets denominated in the policy-making economy's currency. Moreover, capital outflows are more severe in EMDEs than in advanced economies (AEs) due to **interest rate parity frictions** (Camara et al., 2024; Gabaix & Maggiori, 2015; Eichenbaum et al., 2021; Gourinchas et al., 2022; Itskhoki & Mukhin, 2021). These frictions imply that AE investors are less inclined than EMDE investors to reallocate towards dollar assets despite higher returns, due to financial constraints, regulations, capital controls, or preferred habitat effects. Additionally, in EMDEs, where recessions coincide with exchange rate depreciations (Dalgic, 2024), holding dollars (euros) provides business cycle income insurance (Christiano et al., 2021), increasing demand for dollars (euros) as output declines (Camara et al., 2024). This could explain why EMDEs experience sharper GDP contractions than AEs following US monetary tightening.

Another variable of interest is government expenditure and revenue. As proposed by Arteta, Kamin, & Ruch (2022), when a monetary policy shock reflects anticipation of weakening economic activity, such as MP shocks, it induces reduced revenue collection and higher expenditures. However, this scenario holds true primarily for developed economies with automatic stabilizers. In these economies, a decline in economic activity leads to increased unemployment, and the government automatically provides stabilizer, for example, unemployment insurance. In contrast, Georgia lacks such automatic stabilizers. After a decline in economic activity, more people may fall below the subsistence level. Although Georgia does provide aid in such cases, the process is significantly slower. Regarding government revenue, it will decline as output and imports decrease, leading to lower a tax base and resulting in a lower tax revenue. Given the budget constraints, reduced government revenues translate into Georgian government not having means to markedly increase its expenditures. This is particularly challenging as Georgia has a small market for government bonds.

Above I described the expected effects and channels of the MP shocks, however the effects of CBI shock would be almost the exact opposite of those of MP shocks. The effect of HFI is a weighted average of CBI and MP shocks, thus when CBI shock outweighs the MP shock, there are economically unreasonable spillovers, when observing only the impacts following high-frequency interest rate changes.

Results from the Baseline Models

Linear Local Projections

In these models, the estimated cumulative impulse response functions can be interpreted similarly to a regular IRF. When the dependent variable is log-first differenced, the interpretation is akin to a scenario where the dependent variable is in logs and the independent variable is in levels. For variables that are simply first-differenced, the cumulative IRFs are interpreted as level-level effects. The issue of high standard errors stemming from small sample size and the nature of LPs result in the spillover effects being mostly insignificant. Nonetheless, the direction of effects remains meaningful, as described above the advantage of LPs is a lower bias. The challenges of large confidence intervals and coefficient volatility stem from the limitations of the sample size. While techniques such as bootstrapping could address these issues, they will not be explored in this version of the analysis.

ECB Spillovers

1. High-frequency interest rate changes (monetary policy surprises) (90% confidence intervals)

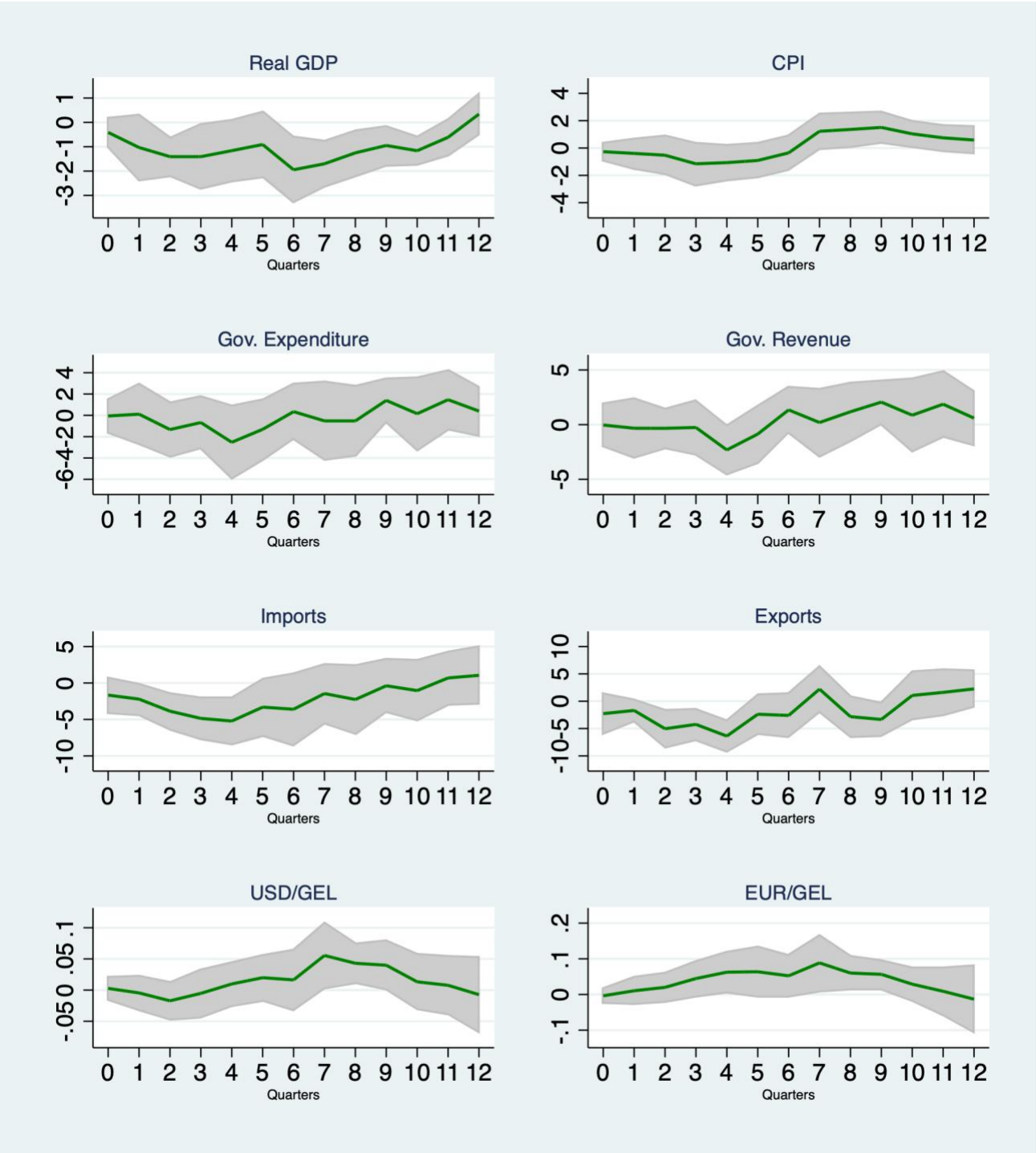


Figure 1. The effect of ECB shocks on Georgian real variables: elasticity β_h^{EHFI} from local projections:

$$\sum_{j=0}^{h} y_{t+j} = \alpha_h + \beta_h^{EHFI} i_t^{EHFI} + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} \delta_j i_{t-j}^{EHFI} + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{EHFI} at different horizons h. The shaded areas show 90% confidence interval, HAC- corrected standard deviations.

When observing the impact of a one standard deviation increase in the high-frequency interest rate surprise in the Euro Area, the results align with the literature, where positive expenditure switching channel is dominated by negative channels and show no anomalies. Both exports and imports decline, the GEL depreciates, output decreases, and prices initially fall and then rise. Government expenditure and revenues also decrease, as previously explained. However, the impact of the shock is not significant for most variables at a 10% significance level, including EUR/GEL, USD/GEL, CPI, and government revenue and expenditure.

2. Disaggregated high-frequency interest rate changes or monetary policy surprises into pure monetary policy and central bank information shocks (90% confidence interval)

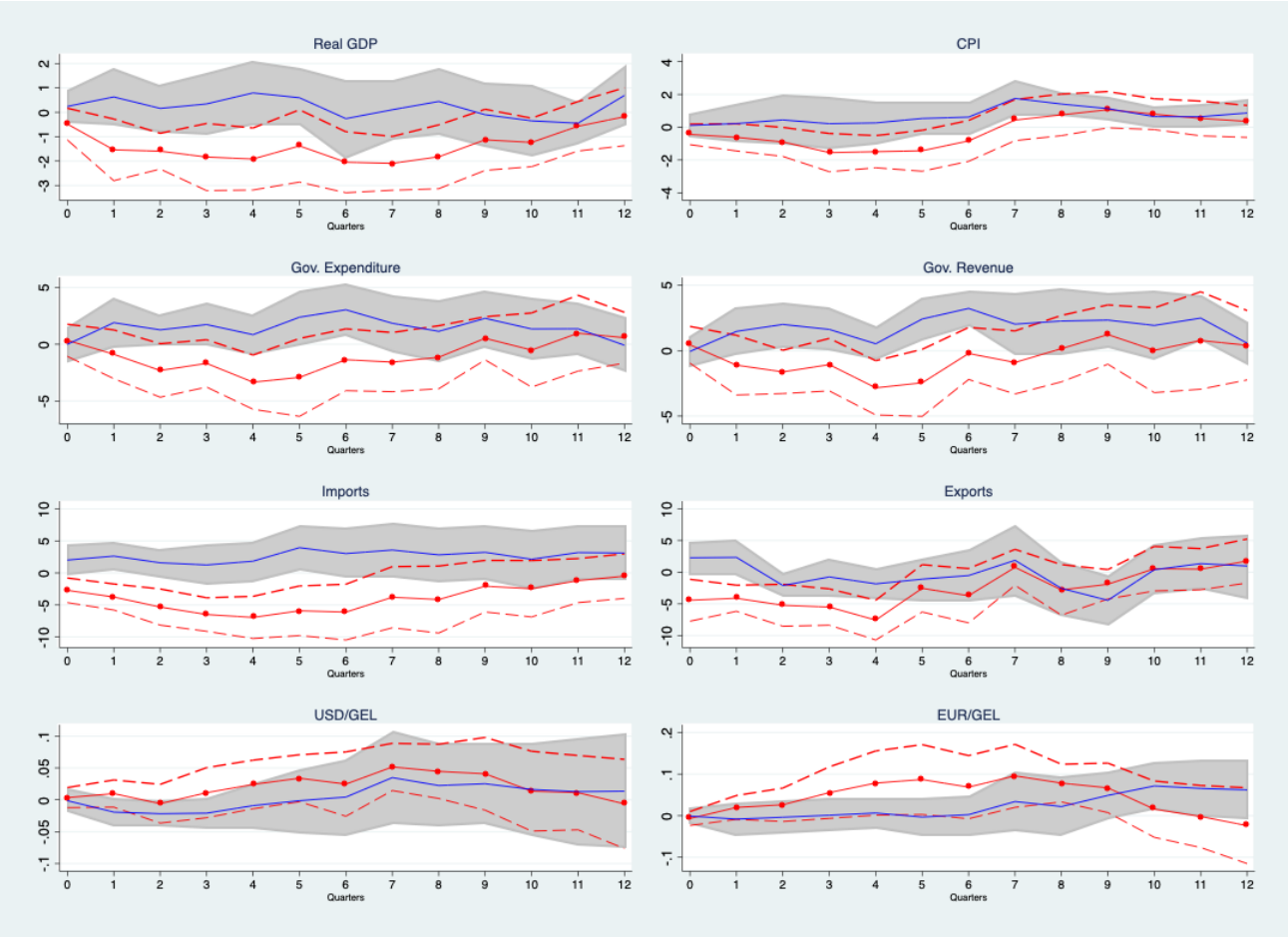


Figure 2. The effect of ECB shocks on Georgian real variables: elasticities β_h^{EMP} and β_h^{ECBI} from local projections:

$$\sum_{j=0}^{h} y_{t+j} = \alpha_h + \beta_h^{EMP} i_t^{EMP} + \beta_h^{ECBI} i_t^{ECBI} + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{EMP} + \tau_j i_{t-j}^{ECBI}) + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{EMP} and β_h^{ECBI} at different horizons h. The shaded areas show 90% confidence interval, HAC- corrected standard deviations. Red lines show the effects of MP shocks, β_h^{EMP}; blue lines – CBI effects, β_h^{ECBI}.

After disaggregating the shocks, it becomes clear that the CBI and MP shocks move in opposite directions, as anticipated. The shock from the HFI identification successfully captures the expected

effects of the MP shocks, because while the CBI shock has the expected impact, it is notably lower in magnitude compared to the MP shock. However, the HFI fails to fully capture the significant impact of ECB shocks, an aspect highlighted by Camara (2023).

Unlike HFI identification, the MP shock demonstrates a notable impact on government expenditure and revenue over multiple periods. Through strong demand and financial channels, real GDP experiences a 2% decline, which is statistically significant for a span of nine quarters. Both shocks have an insignificant impact on currencies, though the signs are as expected. For exports and imports, both MP and CBI shocks show statistical significance. A CBI shock, akin to a positive news shock in the Euro Area, leads to increased aggregate demand in the Euro Area, thereby positively affecting both ours and our neighboring countries' exports, albeit marginally.

Government expenditure and revenue are most significantly affected by the CBI shock, potentially influenced by increased output and exports, as well as financial aid inflows from the Euro Area with a time lag, aligning with expectations. The slight rise in output from the CBI shock has a marginally increasing effect on the CPI, consistent with the existing literature.

Overall, when considering both types of shocks, the ECB's monetary policy exerts a more substantial influence on Georgia's real variables than when viewed in isolation. This is particularly striking given the large standard errors inherent in the LP models. This finding underlines the importance of accounting for both types of shocks and not underestimating the impact of the ECB's monetary policy.

FOMC spillovers

1. High-frequency interest rate changes or monetary policy surprises (90% confidence intervals)

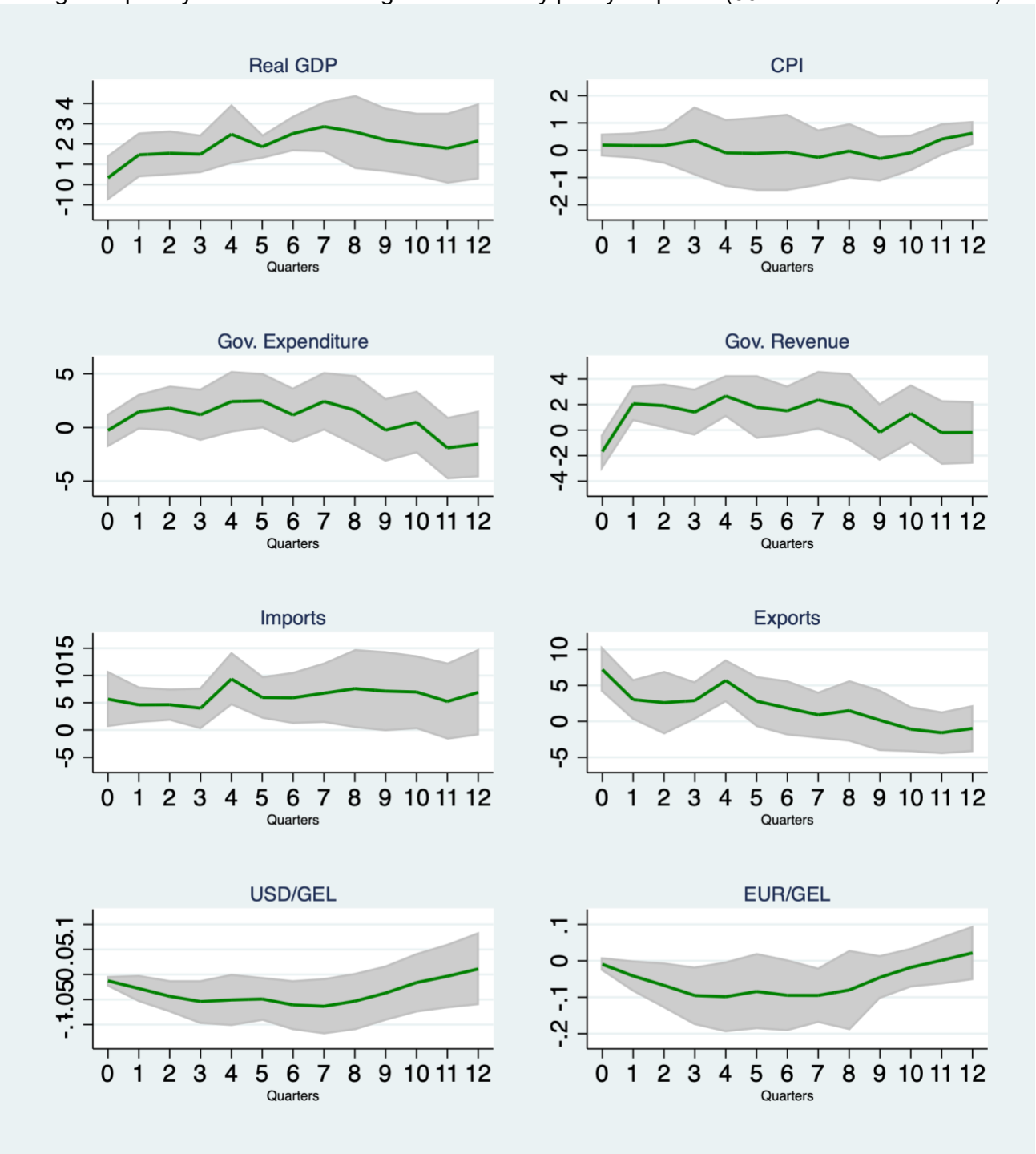


Figure 3. The effect of Fed shocks on Georgian real variables: elasticity β_h^{FHFI} from local projections:

$$\sum_{j=0}^{h} y_{t+j} = \alpha_h + \beta_h^{FHFI} i_t^{FHFI} + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} \delta_j i_{t-j}^{EHFI} + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FHFI} at different horizons h. The shaded areas show 90% confidence interval, HAC- corrected standard deviations.

The outcomes resulting from the Fed's contractionary monetary policy differ from those of the ECB and straightforward economic logic, as can been in Figure 3. When the Fed implements a contractionary monetary policy, the impulse responses from HFI surprises indicate an appreciating GEL, leading to increased exports, imports, government revenue and expenditure, output, and a slight rise in the CPI. Conventional economic wisdom suggests that a contractionary monetary policy by the Fed would cause the USD to appreciate, thereby weakening the Euro due to their close financial and trade ties. A weak EUR would imply an appreciating GEL against the EUR. However, the seemingly paradoxical relationship between the USD and GEL can be clarified by the USD's role as a *safe-haven currency*, appreciating during global turmoil and normalising during positive global news.

The impulse response function following the Fed's contractionary monetary policy shows an appreciation of the GEL against the USD. This suggests that during periods of global distress, when the Fed adopts an expansionary stance, investors and governments still seek refuge in the USD despite lower interest rates, leading to its appreciation against other currencies, including the GEL. The strong safe-haven effect often outweighs the weakening impact of expansionary policy, particularly for countries like Georgia, where financial and trade linkages with the US are limited, and spillover effects occur mainly through trading partners.

During global economic downturns, the Fed cuts interest rates to stimulate the economy. However, as a safe-haven asset, the USD tends to appreciate, causing the GEL to depreciate and reducing Georgia's purchasing power for imports. This pattern is evident in the impulse response analysis, where US expansionary monetary policy leads to a weaker GEL. Graphically, this relationship appears as an inverse correlation, with expansionary policy corresponding to a lower Fed Funds rate.

Continuing with the expansionary perspective, while the USD may experience appreciation, particularly during economic crises when it serves as a safe haven, this does not necessarily lead to a significant increase in US demand for imports. As a result, the benefit to Georgia and its trading partners - such as the EU, Russia, Turkey, Kyrgyzstan, Azerbaijan, Armenia, etc. - is limited until the US economy experiences the positive effects of expansionary monetary policy, which usually takes some time. Only once the global economy starts to pick up, will exports from these countries potentially increase. Following interest rate reduction in the US, the lower levels of exports in Georgia can contribute to reduced aggregate demand and output, further exacerbated by the challenges posed by a depreciated GEL in terms of importing goods. The declining effect on government expenditure and revenue would follow the logic given above.

Another feature contributing to Georgia's limited financial and trade connections with the US, is divergent factors affecting Georgia compared to US. The US seldomly hikes its monetary policy rate and when it does, Georgia's economic state differs significantly, it would explain the observed outcomes. While there may also be disparities in driving factors between the EA and Georgia, yet less significant, the stronger linkages between them influences results strongly enough to offset it. Analyzing the three notable rate changes by the US during the period in this study, figure 7, reveals that the impulses align with economic logic.

A. Until the major interest rate cuts in 2007-2008 due to the housing bubble burst, both the US and Georgia were growing steadily. Georgia, as a newly emerging country, was experiencing currency strengthening and increased productivity. However, the ensuing financial crisis, heavily aggravated by the 2008 war, severely impacted Georgia's economy. This led to Georgia's currency depreciation (with a lag) and overall economic weakness, despite the US pursuing an expansionary monetary policy.

B. At the onset of the COVID pandemic, despite rate cuts by the Fed, Georgia experienced depreciation, low output, and high prices, due to the severity of its impact on the country, coupled with the USD's safe-haven status.

C. Amid the Fed's significant contractionary monetary policy post-COVID to counteract supply chain, food and commodity price shocks following 2022, Georgia saw robust economic growth, accompanied by a strengthening GEL and aggregate demand attributed to increased remittances and migrants' influx following the Russian-Ukrainian conflict.

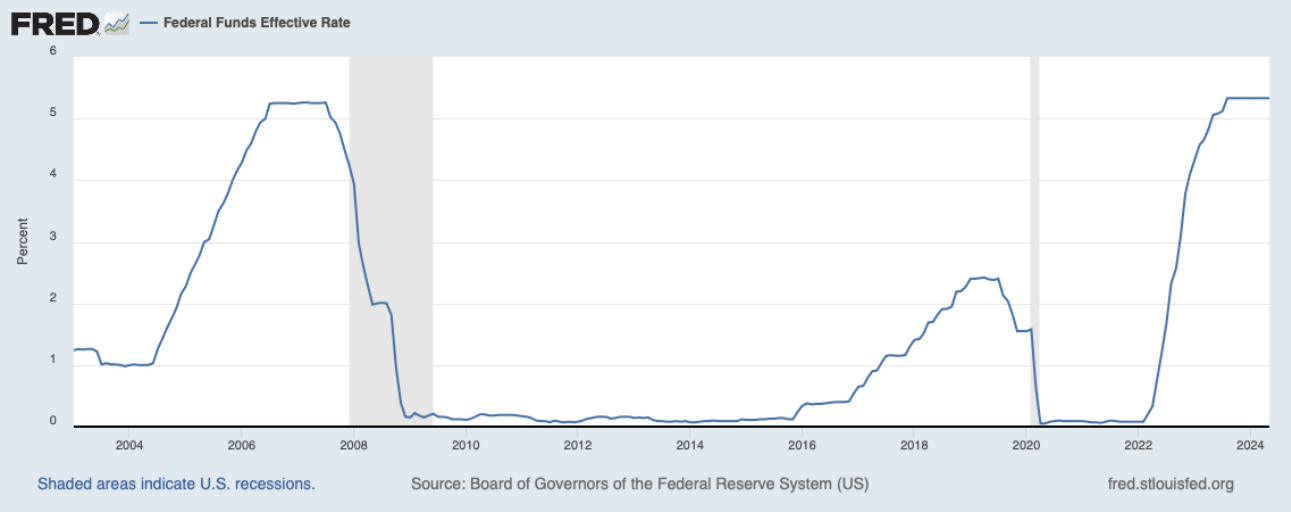


Figure 4. Fed Funds Effective Rate

Source: FRED

2. Disaggregated high-frequency interest rate changes or monetary policy surprises into pure monetary policy and central bank information shocks (90% confidence interval)

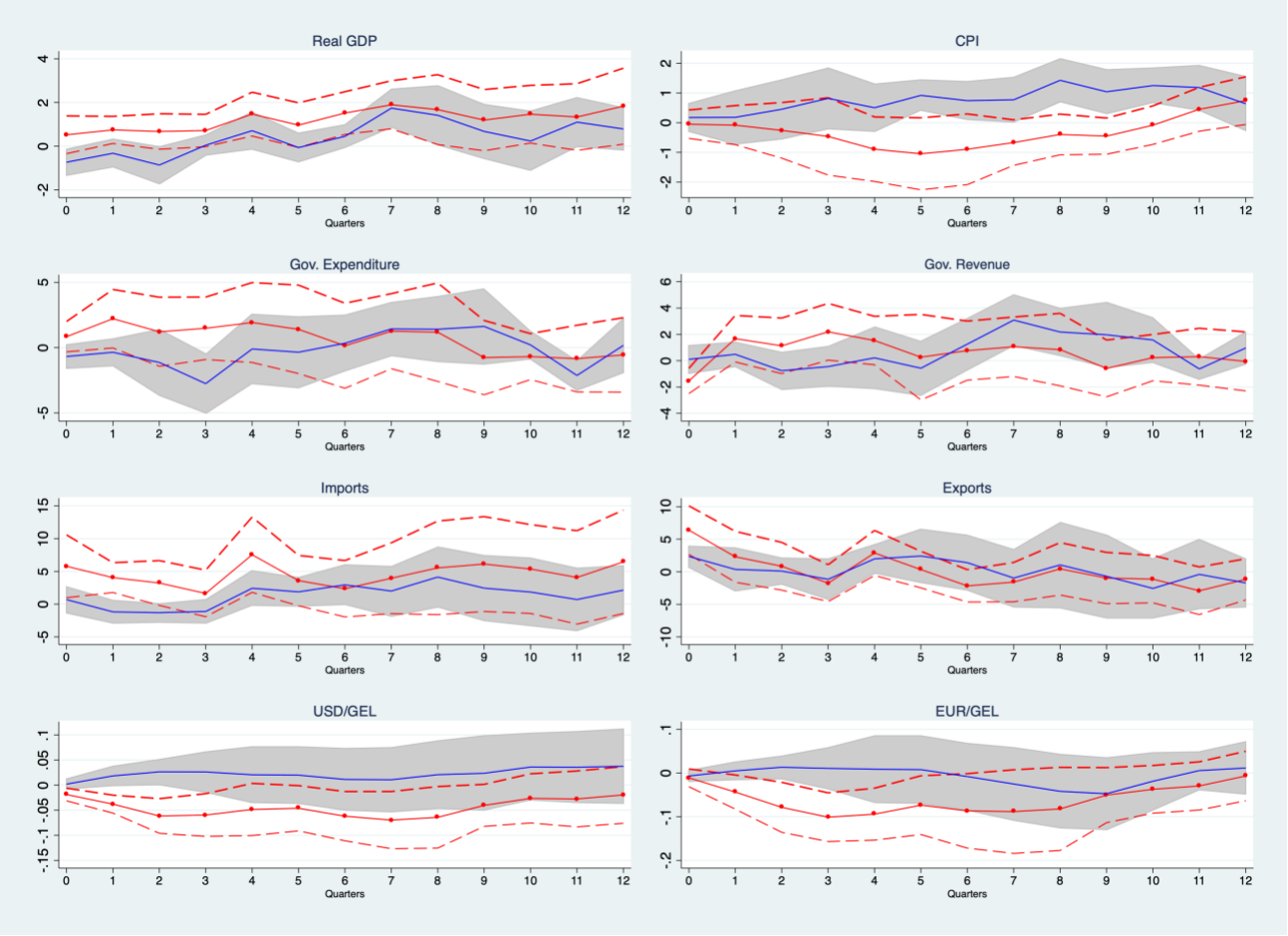


Figure 5. The effect of Fed shocks on Georgian real variables: elasticities β_h^{FMP} and β_h^{FCBI} from local projections:

$$\sum_{j=0}^{h} y_{t+j} = \alpha_h + \beta_h^{FMP} i_t^{FMP} + \beta_h^{FCBI} i_t^{FCBI} + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FMP} and β_h^{FCBI} at different horizons h. The shaded areas show 90% confidence interval, HAC- corrected standard deviations. Red lines show the effects of MP shocks, β_h^{FMP}; blue lines – the CBI effects, β_h^{FCBI}.

Upon observing the dissected shocks, a similar pattern emerges for the US, where one standard deviation CBI and MP shocks exhibit mostly opposing movements. It is to be noted, that unlike the case in HFI, here, increase in real GDP is modest a few quarters after the shock. Interestingly, the CBI shocks show limited significance across the board, except for their effect on the CPI. Under the HFI identification scenario, the impact of monetary policy contraction on CPI was noted to be negative yet statistically insignificant.

Considering the concept of divergent economic states between Georgia and the US during the Federal Reserve's policy tightening and loosening phases, a distinct pattern emerges. In the first two instances given above, Georgia experienced low output alongside high prices, while in the third case,

there was high output paired with declining prices. This would explain the unexpected sign of the shock effect on Georgian CPI.

The benchmark model highlights that ECB spillovers exhibit a more consistent relationship with the existing literature as compared to Fed monetary policy rate spillovers. It can be attributed to the strong financial and trade linkages between Georgia, the EA, and Georgia's primary economic partners associated with the EA. The results of the ECB spillovers, particularly in terms of disaggregated shocks, are in line with expectations and demonstrate the interconnectedness of Georgia's economy with the EA. The overall trends observed in response to ECB shocks are in line with anticipated effects based on economic theory and empirical evidence, emphasizing the importance of considering the broader economic context shaped by the ECB's policies.

Conversely, the spillovers from the Fed's monetary policy rate changes present a more complex and less straightforward relationship due to lower linkages between Georgia and the US. The Fed monetary policy spillovers show a less direct influence on Georgia's economic variables compared to the ECB, emphasizing the stifled transmission channels and nuanced nature of the relationship between the US economy and Georgia. This complexity is further compounded by the divergent economic states between the US and Georgia, as highlighted by the contrasting reactions observed during various phases of the Fed's harsh monetary policy adjustments. It is notable that even when the Fed spillover effects are so complex, spillovers from the CBI and MP shocks still diverge.

State Dependent Local Projections

By examining how different fundamental factors influence spillover effects, we can gain a better understanding of the aforementioned results. Research by Ugazio & Xin (2024) and Deb et al. (2023) indicates that a robust economy enhances resilience against negative spillovers while increasing receptiveness to positive spillovers. For clarity, this section will concentrate on examining the influences of different states on exports, and the binary exchange rate. These variables can provide insights into the effects on output, CPI, government expenditure, and government revenue. Given that the results above suggests that MP and CBI shocks align well with the economic reasoning and the literature, the discussion in this section will focus on a state-dependent model solely for disaggregated shocks. If the state dependent model shows that impact of the shock has opposing direction on the variables interest, then it means that the linear model underestimated the impact.

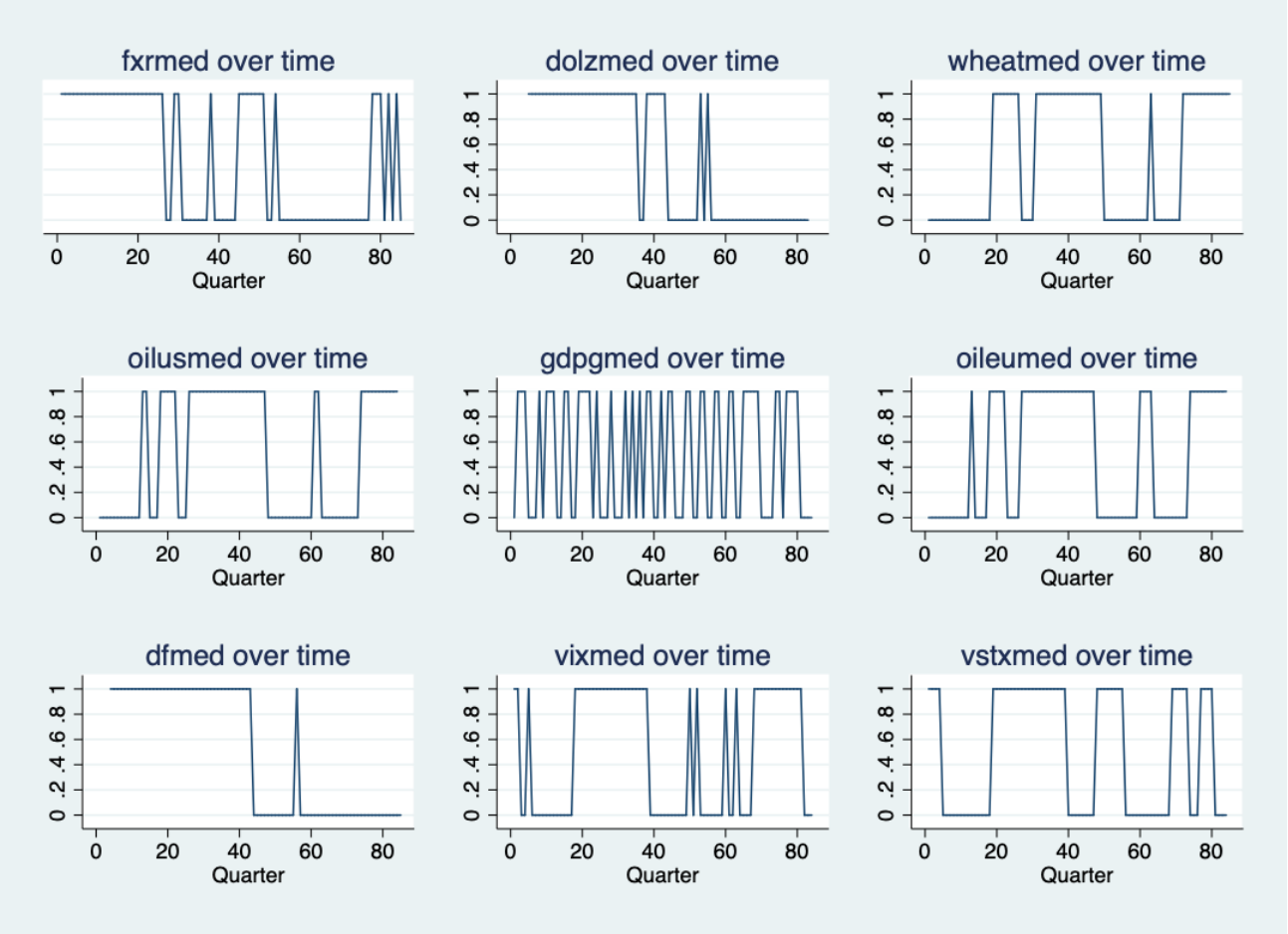


Figure 6. State variables plotted against time.

In essence, the introduction of state dummies divides the data sample into distinct periods. A state is labeled as 'expansionary' when values below or above the median are anticipated to bolster the economy, they are denoted by 0. Figure 6 illustrates how dollarization and foreign denominated debt state dummies partition time evenly. This factor will be duly considered when analyzing the outcomes.

ECB spillovers

EUR/GEL

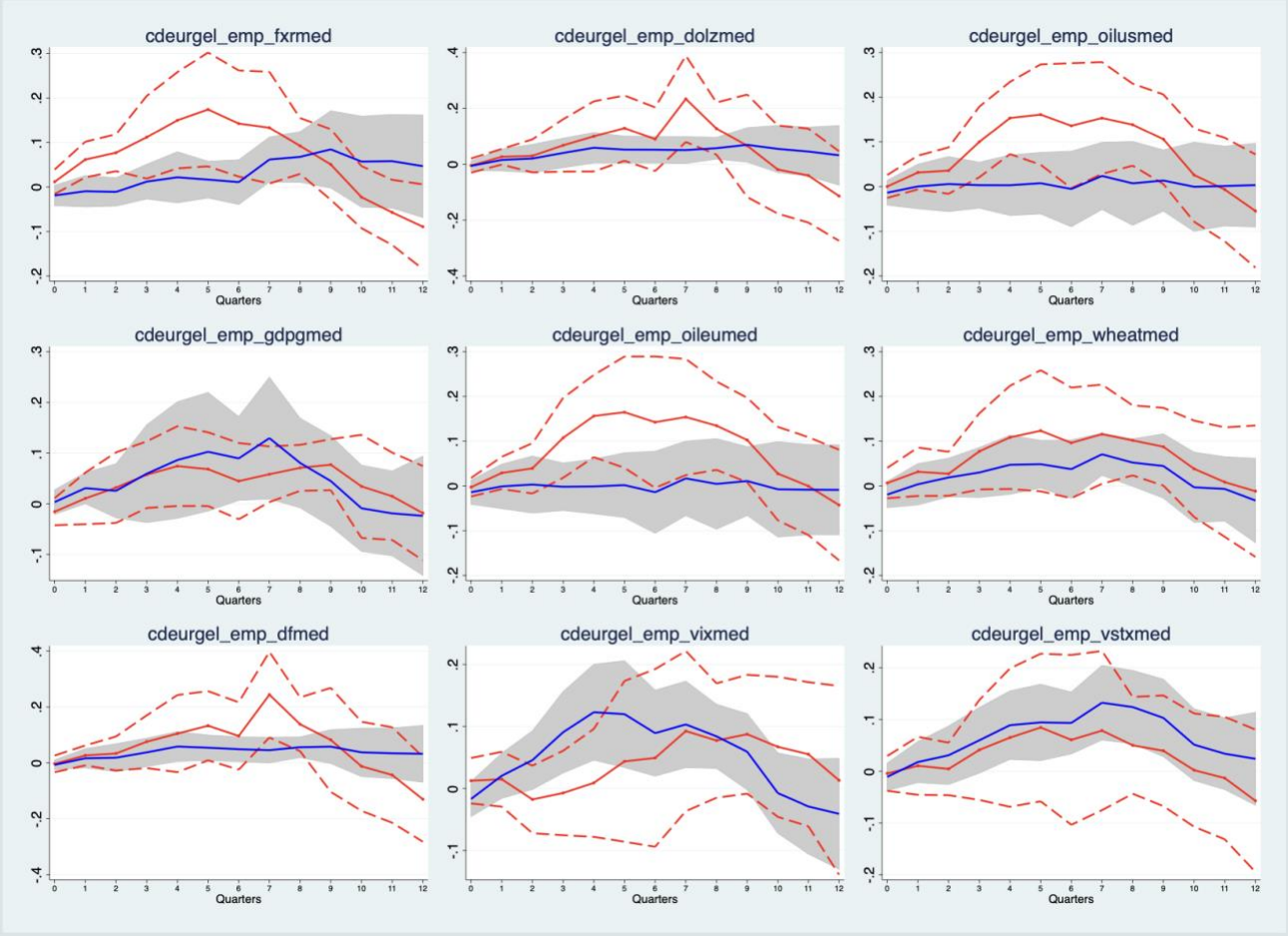


Figure 7. The effect of ECB shocks on EUR/GEL: elasticity β_h^{EMP} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{EMP} i_t^{EMP} + \beta_{R,h}^{ECBI} i_t^{ECBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{EMP} + \tau_j i_{t-j}^{ECBI}) + (1 - S_{t-1})[\beta_{X,h}^{EMP} i_t^{EMP} + \beta_{X,h}^{ECBI} i_t^{ECBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{EMP} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of MP shocks, β_h^{EMP}, when state variables have a positive impact on the economy; blue lines - the effects of MP shocks, β_h^{EMP}, when state variables have a negative impact on the economy.

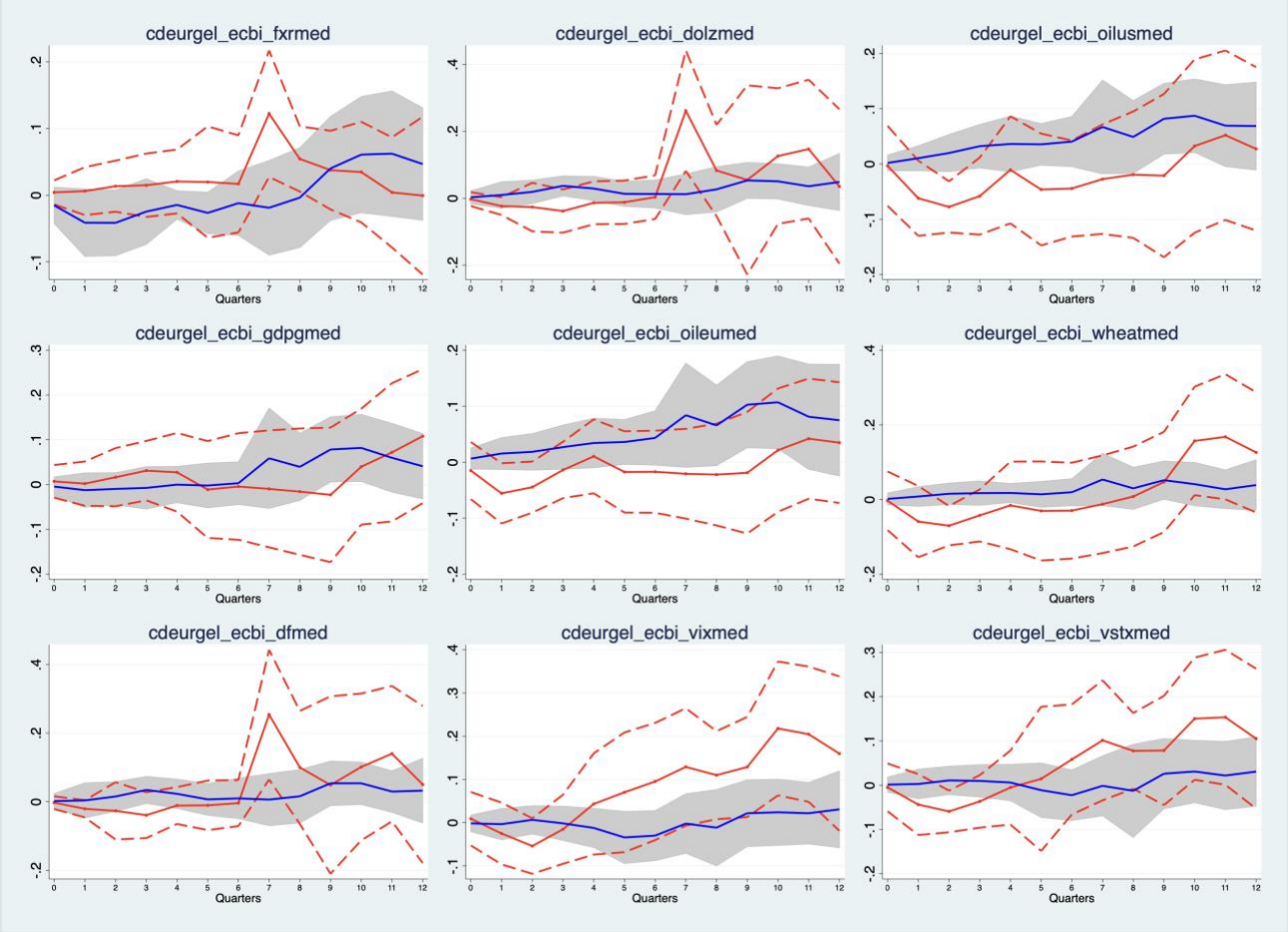


Figure 8. The effect of ECB shocks on EUR/GEL: elasticity β_h^{ECBI} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{EMP} i_t^{EMP} + \beta_{R,h}^{ECBI} i_t^{ECBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{EMP} + \tau_j i_{t-j}^{ECBI}) + (1 - S_{t-1})[\beta_{X,h}^{EMP} i_t^{EMP} + \beta_{X,h}^{ECBI} i_t^{ECBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{ECBI} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of CBI shocks, β_h^{ECBI}, when state variables have a positive impact on the economy; blue lines - the effects of CBI shocks, β_h^{ECBI}, when state variables have a negative impact on the economy.

In some states, MP shocks are generally insignificant, Figure 7, but one should bear in mind that in these models the small sample issue affects standard deviations and also that the effect on EUR/GEL was statistically insignificant in a linear model. In conditions where certain state-defining variables should theoretically weigh down on the economy, the impact of the MP shock tends to be minimal. This may create a situation where even in what might appear to be "recessionary" states, the negative effect of a one standard deviation MP shock is cushioned. Interestingly, it is the more beneficial states that allow for the exchange rate to depreciate sufficiently, acting as a shock absorber in the expenditure-switching channel. This depreciation enables Georgia to establish a stronger foothold in the trade market, as was described above.

Particularly important is the effect of oil prices. When oil prices are lower than the median, the GEL depreciates against the EUR. It could be that low oil prices when there is a contractionary monetary

policy in EA, reflect bad economic states in the global economies and this negative effect is stronger on Georgia than was the benefits stemming from lower oil prices, such as lower import expenditures.

In the context of CBI shocks, Figure 8, illustrates that the impact on the EUR/GEL exchange rate is generally negligible in most scenarios. However, upon closer examination of oil prices, the effects align with expectations from existing literature. Specifically, the positive spillover effect of a CBI shock is magnified when oil prices are at lower levels.

Exports



Figure 9. The effect of ECB shocks on exports: elasticity β_h^{EMP} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{EMP} i_t^{EMP} + \beta_{R,h}^{ECBI} i_t^{ECBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{EMP} + \tau_j i_{t-j}^{ECBI}) + (1 - S_{t-1})[\beta_{X,h}^{EMP} i_t^{EMP} + \beta_{X,h}^{ECBI} i_t^{ECBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{EMP} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of MP shocks, β_h^{EMP}, when state variables have a positive impact on the economy; blue lines - the effects of MP shocks, β_h^{EMP}, when state variables have a negative impact on the economy.

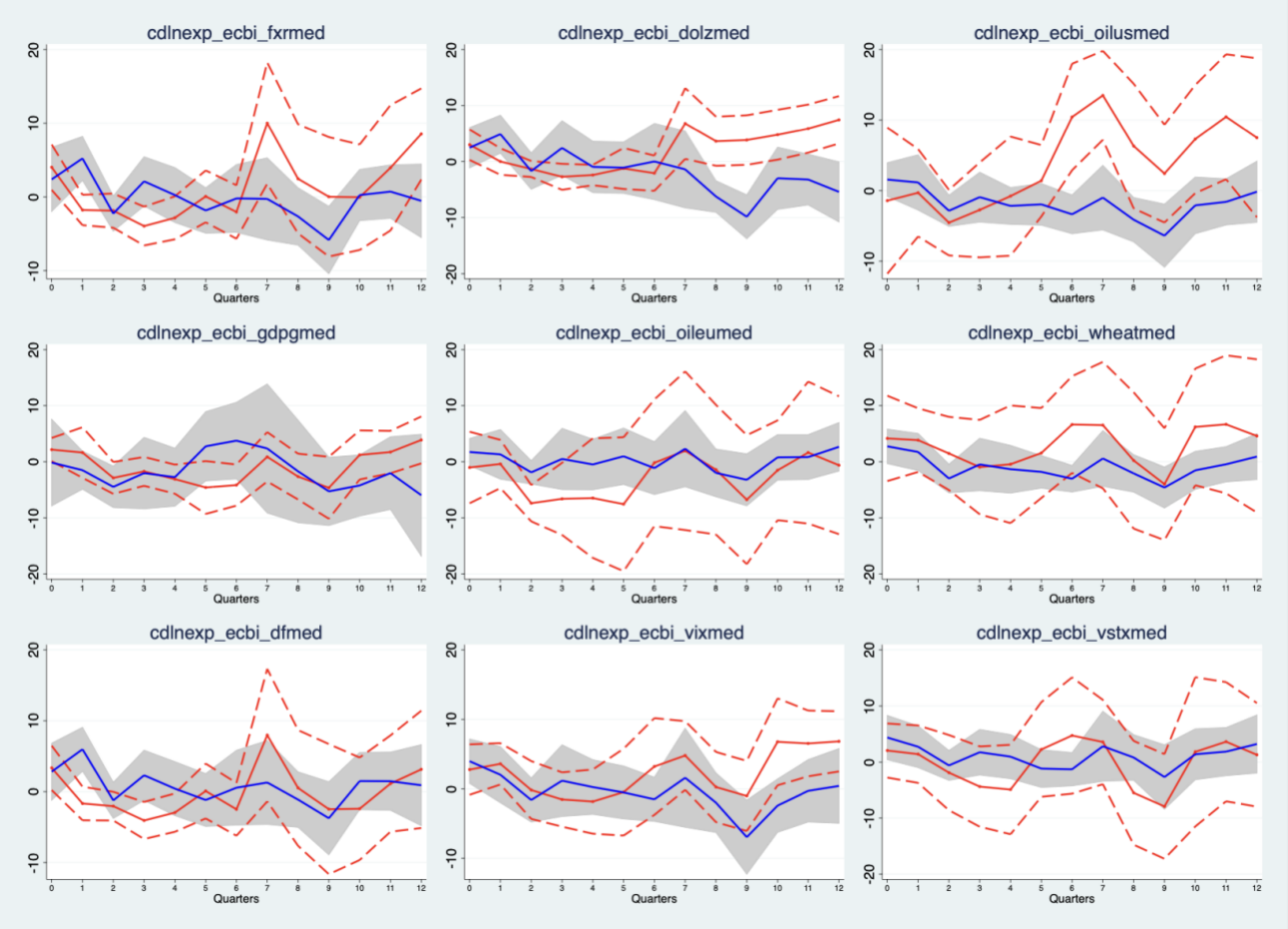


Figure 10. The effect of ECB shocks on exports: elasticity β_h^{ECBI} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{EMP} i_t^{EMP} + \beta_{R,h}^{ECBI} i_t^{ECBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{EMP} + \tau_j i_{t-j}^{ECBI}) + (1 - S_{t-1})[\beta_{X,h}^{EMP} i_t^{EMP} + \beta_{X,h}^{ECBI} i_t^{ECBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{ECBI} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of CBI shocks, β_h^{ECBI}, when state variables have a positive impact on the economy; blue lines - the effects of CBI shocks, β_h^{ECBI}, when state variables have a negative impact on the economy.

For the case of exports as well, Figure 9, in the majority of cases, it becomes evident that the effects of "expansionary" and "recessionary" states lead to contrasting impacts on MP spillovers. The influence of an MP shock is prominently felt across various states. These results align with existing literature, indicating that the negative repercussions of spillovers are mitigated in positive economic climates but exacerbated during downturns.

Furthermore, low global volatility, characterized by the VIX index, and reduced volatility in Europe, represented by the VSTXX, positively influence exports, which aligns with economic reasoning. A low GDP gap further amplifies the beneficial spillover from the MP shock. Interestingly, oil prices do not significantly affect exports when they are above a medium threshold; however, when they dip below this level, the impact of an MP shock leads to a statistically significant decrease in exports.

As mentioned above, it could be that oil prices went down because of a global turmoil, the affect of which was graver on Georgia than the benefits from oil price decline. Moreover, when the Eurozone conducts a contractionary monetary policy, thereby reducing their aggregate demand, countries that are major oil exporters experience lower demand for their oil as EA is one of the major oil importers. Consequently, a decelerating economy in the Eurozone tends to drive down oil prices, creating an environment where lower oil prices are anticipated during periods of contractionary monetary policy, therefore the linear model captured this effect. A more straightforward explanation would be that some of the biggest Georgia's trade partners, Russia, and Azerbaijan, are heavily dependent on oil exports and if oil prices go down, they afford lower imports.

As was the case in a linear model, in Figure 10, it is evident that the impact of CBI shock on exports is largely insignificant. However, the effects of positive and negative states are consistent with the literature, especially statically significantly in case of high and low dollarization rate in Georgia and low oil prices in the US.

FOMC spillovers

USD/GEL

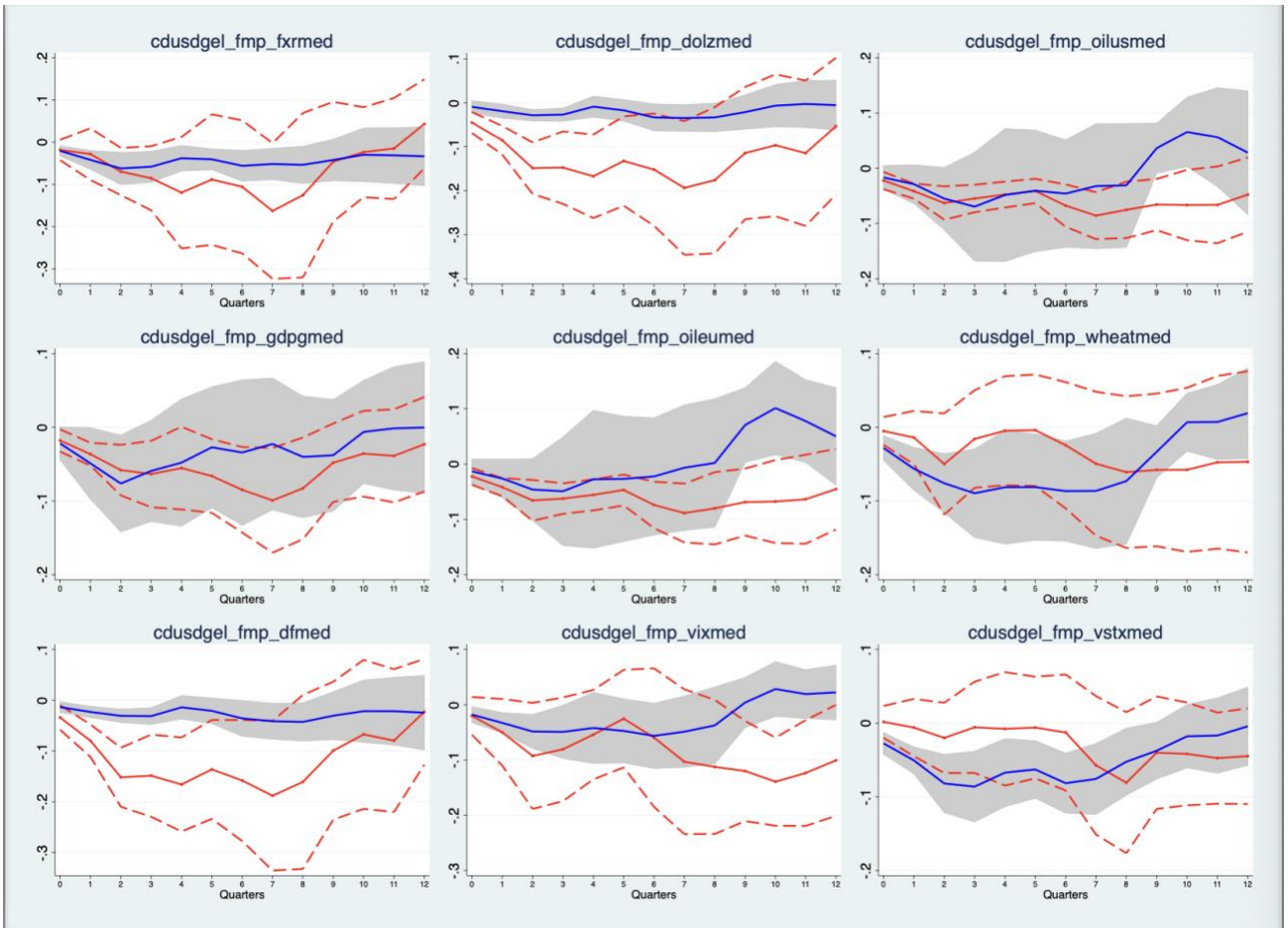


Figure 11. The effect of Fed shocks on USD/GEL: elasticity β_h^{FMP} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + (1 - S_{t-1})[\beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FMP} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of MP shocks, β_h^{FMP}, when state variables have a positive impact on the economy; blue lines - the effects of MP shocks, β_h^{FMP}, when state variables have a negative impact on the economy.

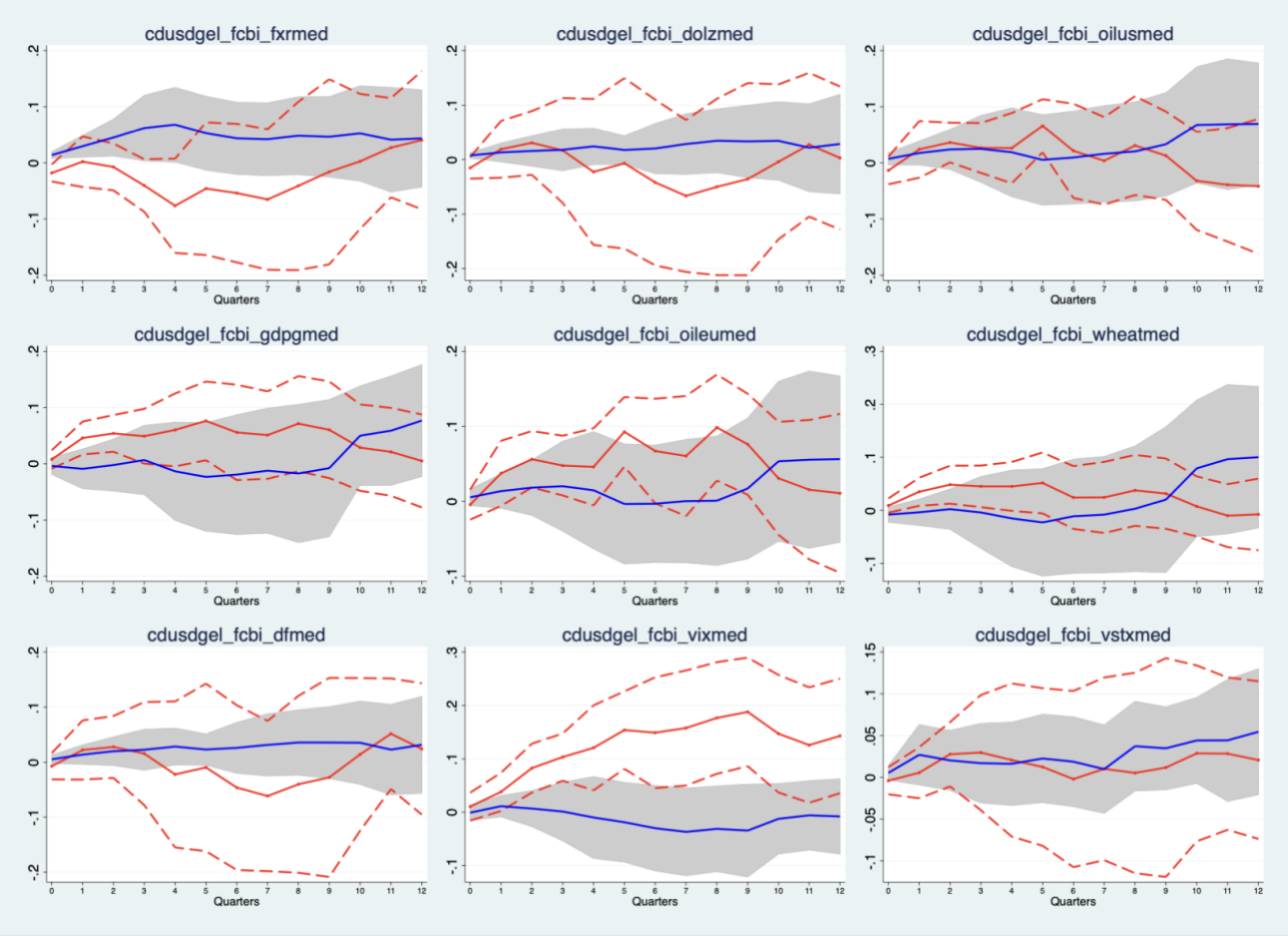


Figure 12. The effect of Fed shocks on USD/GEL: elasticity β_h^{FCBI} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + (1 - S_{t-1})[\beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FCBI} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of CBI shocks, β_h^{FCBI}, when state variables have a positive impact on the economy; blue lines - the effects of CBI shocks, β_h^{FCBI}, when state variables have a negative impact on the economy.

Figure 11 highlights the notable impacts observed in the context of Fed's MP shock spillovers at times of low dollarization and a reduced share of foreign-currency denominated debt (FD). The IRFs depict an interesting trend, whereby high levels of dollarization and FD result in an insignificance in

the spillover effects of the Federal Reserve's MP shock. Conversely, in instances where dollarization and FD are low, it appears as if a noticeable GEL appreciation occurs.

From a safe-haven perspective, this implies that a scenario where Georgia exhibits low dollarization, and the Federal Reserve implements an expansionary monetary policy leads to GEL depreciation. The lowered Fed rate signals a tendency for investors, the government, and individuals to swiftly convert their GEL holdings into dollars, considering the latter as a safe haven during pending global crises. In contrast, elevated levels of dollarization eliminate the necessity for conversion, rendering the impact void.

Moreover, the states of oil prices move the impact in opposite directions, but it becomes both economically and statistically significant about 9 quarters after the shock.

The scenario where during states of lower wheat prices and decreased volatility in the EA, a USD tightening suggests a likelihood of GEL depreciation, aligns with the notion of a safe haven, indicating that when the EA market faces minimal threats and food prices are stable, the demand for the dollar as a safe haven currency diminishes. Consequently, in a stable economic environment, the effects of US's contractionary and expansionary monetary policies on Georgia tend to follow conventional patterns without the need for drastic adjustments.

Figure 12 reinforces the safe-haven logic by showcasing that in circumstances where the VIX index is minimal, and the US financial market remains stable, a negative news shock within the US— represented by a negative CBI shock — can lead to GEL appreciation. This appreciation is attributed to the situation where Fed rate increases less than anticipated, signaling a potential weakness in the US economy compared to initial expectations. Consequently, investors exhibit caution and withdraw, contributing to the GEL's appreciation in response to the negative news shock in the US.

Exports

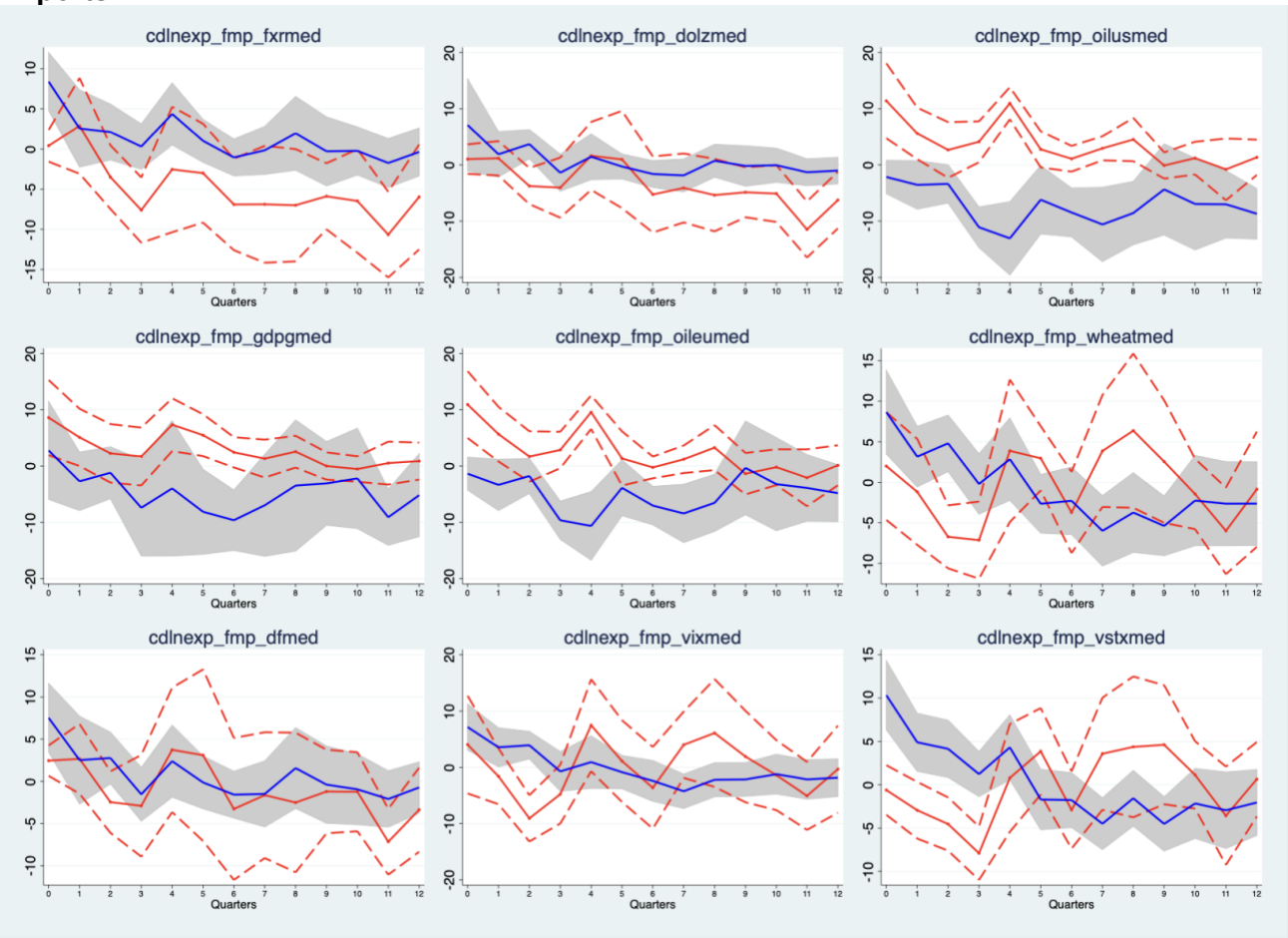


Figure 13. The effect of Fed shocks on exports: elasticity β_h^{FMP} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + (1 - S_{t-1})[\beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FMP} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of MP shocks, β_h^{FMP}, when state variables have a positive impact on the economy; blue lines - the effects of MP shocks, β_h^{FMP}, when state variables have a negative impact on the economy.

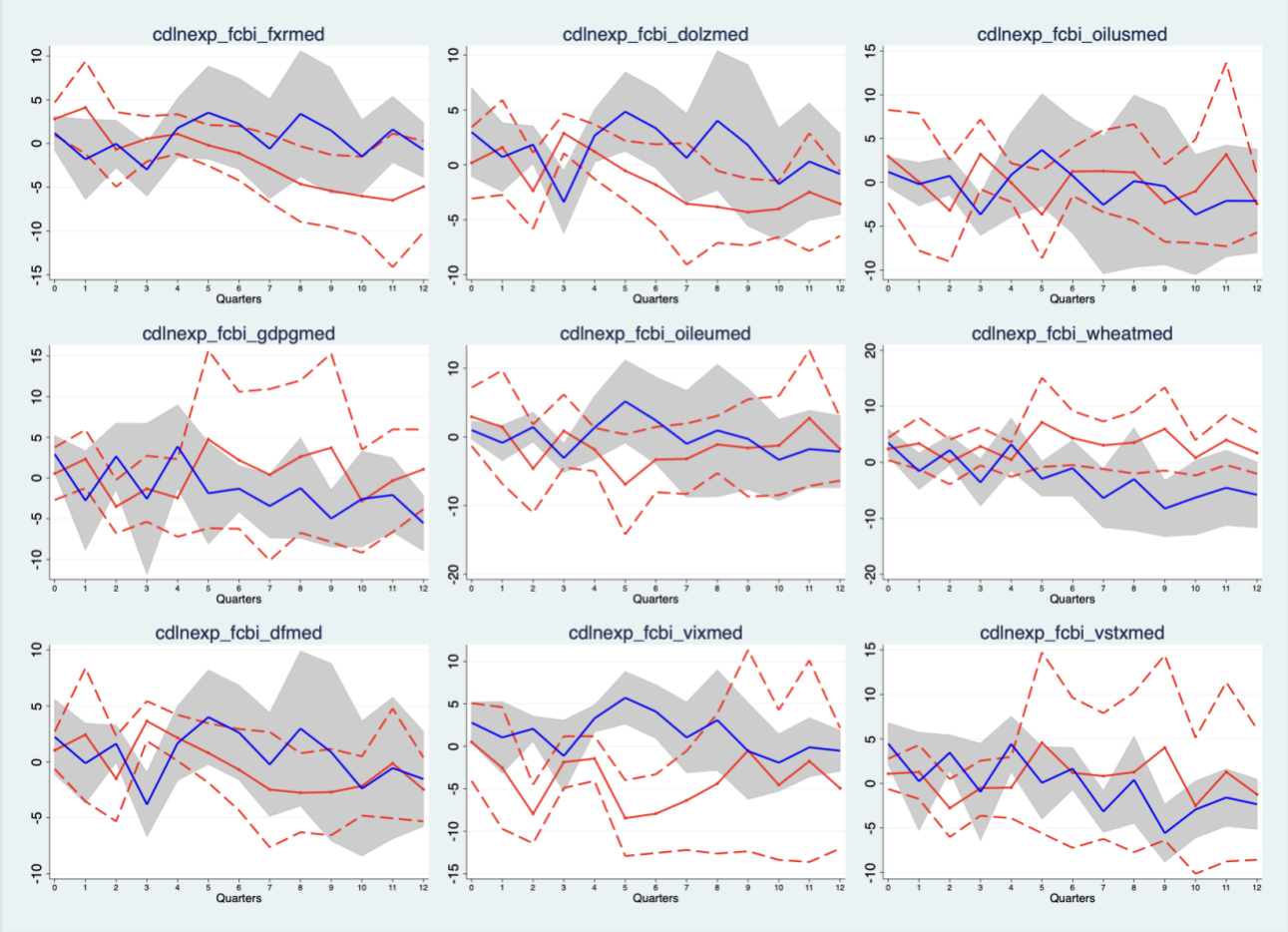


Figure 14. The effect of Fed shocks on USD/GEL: elasticity β_h^{FCBI} from local projections:

$$y_{t+h} = \alpha_h + S_{t-1}[\beta_{R,h}^{FMP} i_t^{FMP} + \beta_{R,h}^{FCBI} i_t^{FCBI}] + \sum_{j=1}^{4} \gamma_j y_{t-j} + \sum_{j=1}^{4} (\delta_j i_{t-j}^{FMP} + \tau_j i_{t-j}^{FCBI}) + (1 - S_{t-1})[\beta_{X,h}^{FMP} i_t^{FMP} + \beta_{X,h}^{FCBI} i_t^{FCBI}] + \epsilon_{t+h}$$

Note: The solid lines show the median OLS estimates of β_h^{FCBI} at different horizons h. The shaded areas show 90% confidence interval, HAC-corrected standard deviations. Red lines show the effects of CBI shocks, β_h^{FCBI}, when state variables have a positive impact on the economy; blue lines - the effects of CBI shocks, β_h^{FCBI}, when state variables have a negative impact on the economy.

In Figure 13, it is evident that GDP gap and oil prices have contrasting effects on FOMC's MP spillovers depending on whether the states are positive or negative. The rationale behind the GDP gap effect is straightforward. Concerning oil prices, when the US implements an expansionary monetary policy to combat economic challenges, it reduces oil demand. Consequently, when oil prices are low, the USD serves as a safe haven currency during economic turmoil, leading to decreased Georgian exports, as described in the linear model. This reasoning would hold, if oil prices were lower not only because US lowered demand but the rest of the world too, in the face of an impending crises, which is usually what happens. Moreover, as above, low oil prices mean lower demand for imports by Georgian main trading partners.

Likewise, as shown in Figure 14, the impact of the CBI shock is most significant when considering the VIX index. It results in export movements in the exact opposite direction of the MP shock, aligning with existing literature and the rationale presented in this paper.

In summary, when evaluating and managing monetary policy spillovers from the US, crucial variables to factor in include oil prices, the VIX index, and most significantly, the level of deposit dollarization in Georgia. And as different states lead to opposite results this would mean that linear LPs captured underestimated spillovers.

Georgian Monetary Policy Rate Response to FOMC and ECB Shocks

Linear LP

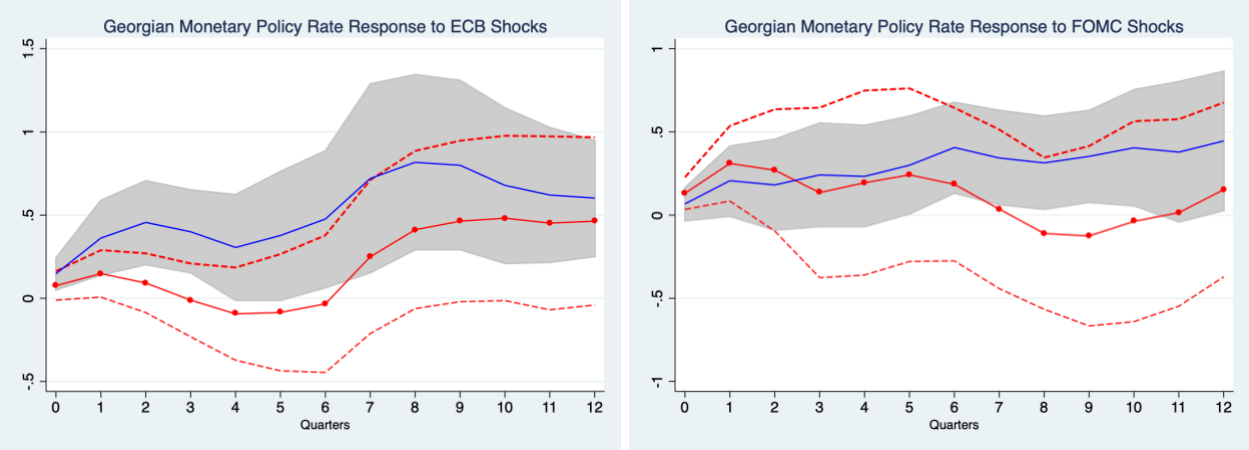


Figure 15. Reaction of Georgian monetary policy rate to MP and CBI shocks; Red - MP, Blue - CBI.

The findings suggest that at a 10% significance level, the MP shocks from the ECB and the FOMC do not noticeably affect Georgia's monetary policy rate (GMP). In contrast, the impact of CBI shocks, originating from both the FOMC and ECB, is statistically significant. Compared to the shocks stemming from the ECB, the impact from FOMC's MP shock is notable but less relevant for GMP, as confidence bands are too wide. The impact of FOMC's CBI shock starts rather late as well. This implies that GMP responds more significantly to ECB. The IRF's capture that following the ECB's unexpected monetary policy rate hike Georgia reacts by implementing a similar monetary policy at first but the opposing policy after several quarters, this relationship could be because Georgia is reacting to the spillovers from the ECB policy change that was captured in this paper. There is a policy hike in Georgia 7 quarters after the MP shock, but it is statistically insignificant.

The strong association between CBI shocks and GMP, more pronounced than the response to MP shocks, could elucidate why the impact of CBI shocks appears minimal and insignificant in the models above. It could be that as CBI shocks reflect positive news in the policy-making economy, the National Bank of Georgia also captures that there are prospects for improved economic conditions in the EA and it will have positive spillovers on Georgia both directly and through its trading partners and therefore by contractionary monetary policy it captures the potential spike in inflation.

Robustness Checks

Robust to crises periods

As part of the robustness check, I estimated the Impulse Response Functions (IRFs) while excluding specific outlier periods:

• The **2008 financial crisis**, marked by rate cuts from both the ECB and the Fed, and the war in Georgia (2008Q4, 2009Q4).

• The **COVID-19 period** (2020Q1–2022Q4), characterized by interest rate hikes from both central banks and a global economic slowdown.

• The **post-COVID period** (2022Q1–2023Q3), which saw significant rate hikes and notable inflows from Russia to Georgia.

Each period was excluded individually due to sample size constraints. These periods were chosen to prevent outliers from distorting the analysis, a common practice in econometric studies to reduce bias and isolate spillover effects. They also align with the periods identified earlier when discussing spillovers from FOMC announcements.

The results were in line with expectations. Excluding these periods had little effect on ECB spillovers, as they tend to be more direct. However, it rendered spillovers from FOMC announcements insignificant, reinforcing the idea that the transmission channels are stifled, and the IRFs mainly captured crisis-driven rate changes rather than direct monetary policy transmission from the US to Georgia.

Models with the broader set of controls.

As anticipated, for both ECB and FOMC, the outcomes of the model incorporating a more comprehensive range of controls align precisely with the model with only longer lags of a dependent variable and the shocks. Notably, the IRFs exhibit consistent patterns, albeit with narrower confidence intervals, underscoring the exogeneity of the shocks. Detailed graphical representations of these results will be provided in the online appendix for enhanced clarity and comprehensive understanding of the model's findings.

VAR

The VAR specification yielded outcomes that aligned exceptionally well with those obtained from linear local projections, as evident in the following observations. Across the IRFs generated by the VAR model, the directional trends mirrored those derived from the linear LP analysis. Nonetheless, the challenge of wide confidence intervals persisted and is more severe with VARs. To enhance clarity, this section will present the IRFs, and variance decompositions specifically related to real

GDP. All other dependent variables showed consistent results with LP results, comprehensive details for additional variables will be provided upon request.

ECB

As stated above, the VAR IRFs are consistent with the linear LP IRFs. However here one can also observe that up to 3.5% of the variability of real GDP is explained by the EHFI shock, over 4% by ECBI shock, and over 8% by EMP shock, Figure 16. These results posit that spillovers from ECB are notable.

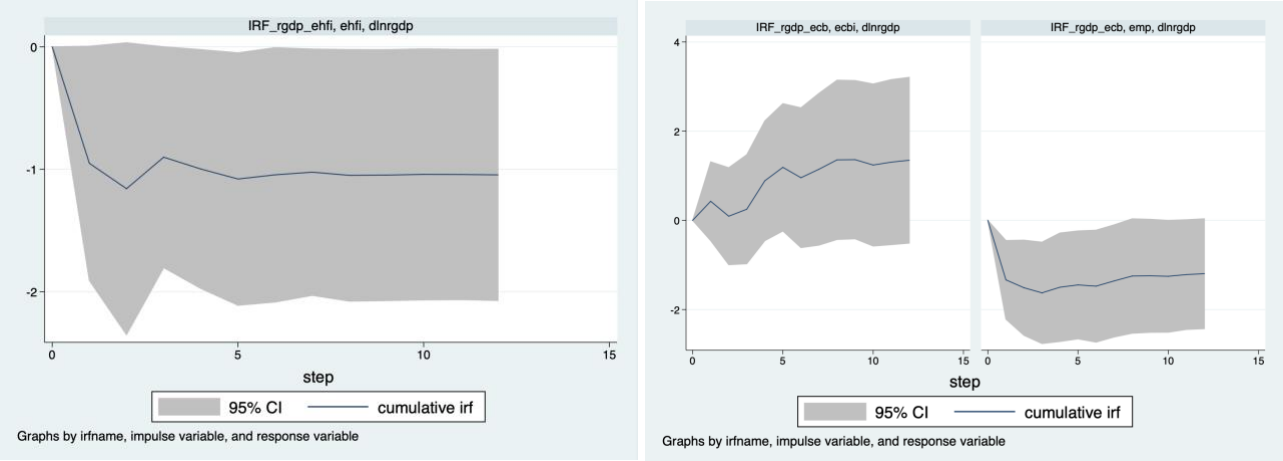


Figure 16. IRFs of Real GDP's Response to EHFI, and EMP, ECBI shocks.

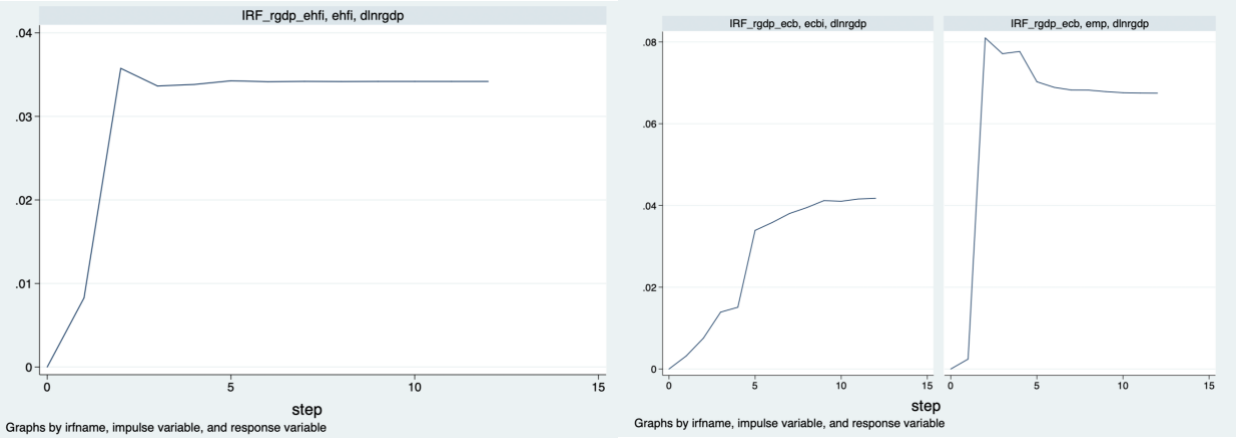


Figure 17. FEVD of Real GDP's Response to EHFI, and EMP, ECBI shocks.

Fed

Fed effects are also in line with the LP results. As for variance decomposition, FHFI explains up to 8% of real GDPs variation; FMP – up to 15%; FCBI – up to 8%, Figure 18.

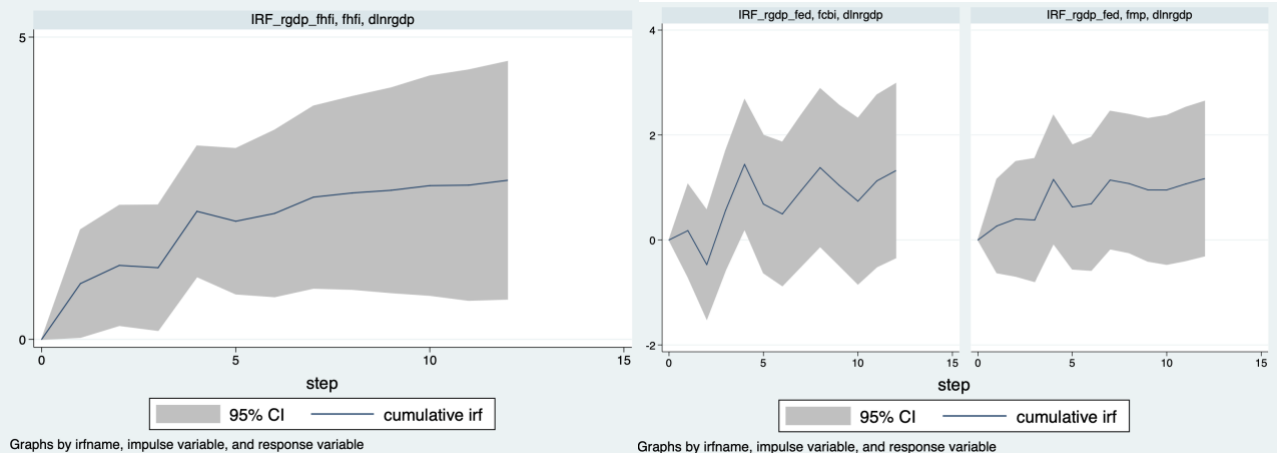


Figure 18. IRFs of Real GDP's Response to FHFI, and FMP, FCBI shocks.

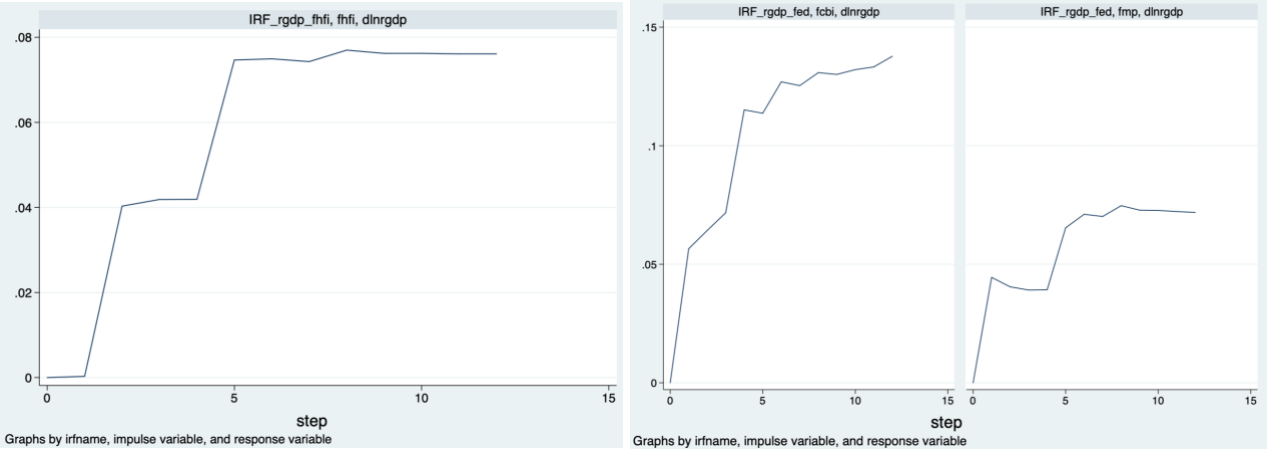


Figure 19. FEVD of Real GDP's Response to FHFI, and FMP, FCBI shocks.

The VAR specification was robust to reordering MP and CBI shocks, and to running orthogonalized VARs pointing to their orthogonality.

Conclusion

In conclusion, the announcements by both the FOMC and the ECB significantly impact Georgia's real variables according to the main specification, and these findings remain robust across different specifications.

Given the close trade, financial, and geographic ties between Georgia and the EA, the spillovers from the ECB's announcement, whether direct or indirect through Georgia's trading partners, align with expected economic reasoning and literature, as transmission channels are less obstructed. These spillovers are noticeable in terms of currency and trade effects, which in turn affect real GDP, CPI, government expenditures and revenues. It is to be noted, that when disaggregating the shocks from high-frequency identification (HFI) into central bank information (CBI) and pure monetary policy (MP) shocks, the effects of these shocks are opposite of one another, MP shocks lead to typical global impacts, such as a recession, a currency depreciation, lower exports and imports, lower government expenditure and revenue. Conversely, a CBI shock results in economic growth, an appreciation of the exchange rate, and increase in export and import, higher government expenditure and revenue. As predicted, when accounting for both shocks, impact of ECB's monetary policy spillovers on Georgia was higher. Furthermore, the transmission of policy spillovers is contingent on certain variables that significantly impact Georgia's economy, as well as key global stability indicators.

On the other hand, the relationship between Georgia and the FOMC presents a more intricate dynamic due to US's weaker linkages with both Georgia and its main trade partners. Nonetheless, once major changes in US monetary policy were observed, while also considered the safe-haven status of the USD, the spillovers from FOMC meetings became clearer. Factors such as the VIX index and the level of dollarization in Georgia's economy played key roles on the size and the direction of spillovers.

Moreover, the study has room for improvement, the findings in this paper can be challenged or supported. Particularly in providing precise policy recommendations, conducting a thorough analysis on spillover channels—such as through a **Balance of Payments framework** or identifying **household channels**—could enhance the model dramatically. This study concentrates exclusively on the effects on real variables, a similar study could investigate Georgia's **financial variables**, although it may pose challenges specific to Georgia. Moreover, analyzing **business and economic cycles** would be beneficial in comprehending spillovers from the Fed. Additionally, incorporating higher-frequency macroeconomic variables may offer better insights into the impacts of monetary policy spillovers. According to Nakamura & Steinsson (2018), frequency mismatch results in a **"power problem."** This suggests that the signal to noise ratio might be too small to accurately measure the effects of monetary policy on macroeconomic variables like output and inflation which are at lower frequencies and are influenced by various structural shocks.

A key policy implication is the need to distinguish between MP and CBI shocks when assessing spillovers. For an emerging oil-importing economy with flexible exchange rates, like Georgia, MP shocks from an economy with strong trade and financial ties—here, the ECB—warrant closer attention, particularly in relation to oil prices, the GDP gap, and dollarization. In the absence of such close linkages, as in the case of FOMC spillovers, a more nuanced approach is required, accounting for global risk sentiment and Georgia's economic cycle. Responding to FOMC decisions is markedly less straightforward than responding to ECB decisions. However, without a clearer understanding of transmission channels, policy responses remain constrained.

Understanding monetary policy spillovers is crucial in an era of deepening global integration, where policy decisions in major economies shape economic stability worldwide. This is especially relevant

when considering secondary spillovers—where initial effects on trade partners feed back into the policy-making economy, amplifying global transmission channels.

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Appendix A

Table A.1 State variables in the literature

Source	State variables
IMF (2024)	o FX reserves o External debt o Public debt o Global environment indicators: VIX index and oil prices US$ per barrel
Pragyan (2023)	o Business cycle proxied by output gap o Uncertainty o CB transparency o Financial development
IMF (2022)	o Public debt o FX reserves o VIX o Oil prices
Ahmed et al. (2021)	o Balance sheet vulnerabilities
Adedeji, et al. (2019)	o Oil prices
Ahmed et al. (2015)	o FX reserves o Public debt o External debt o Exchange rate regime

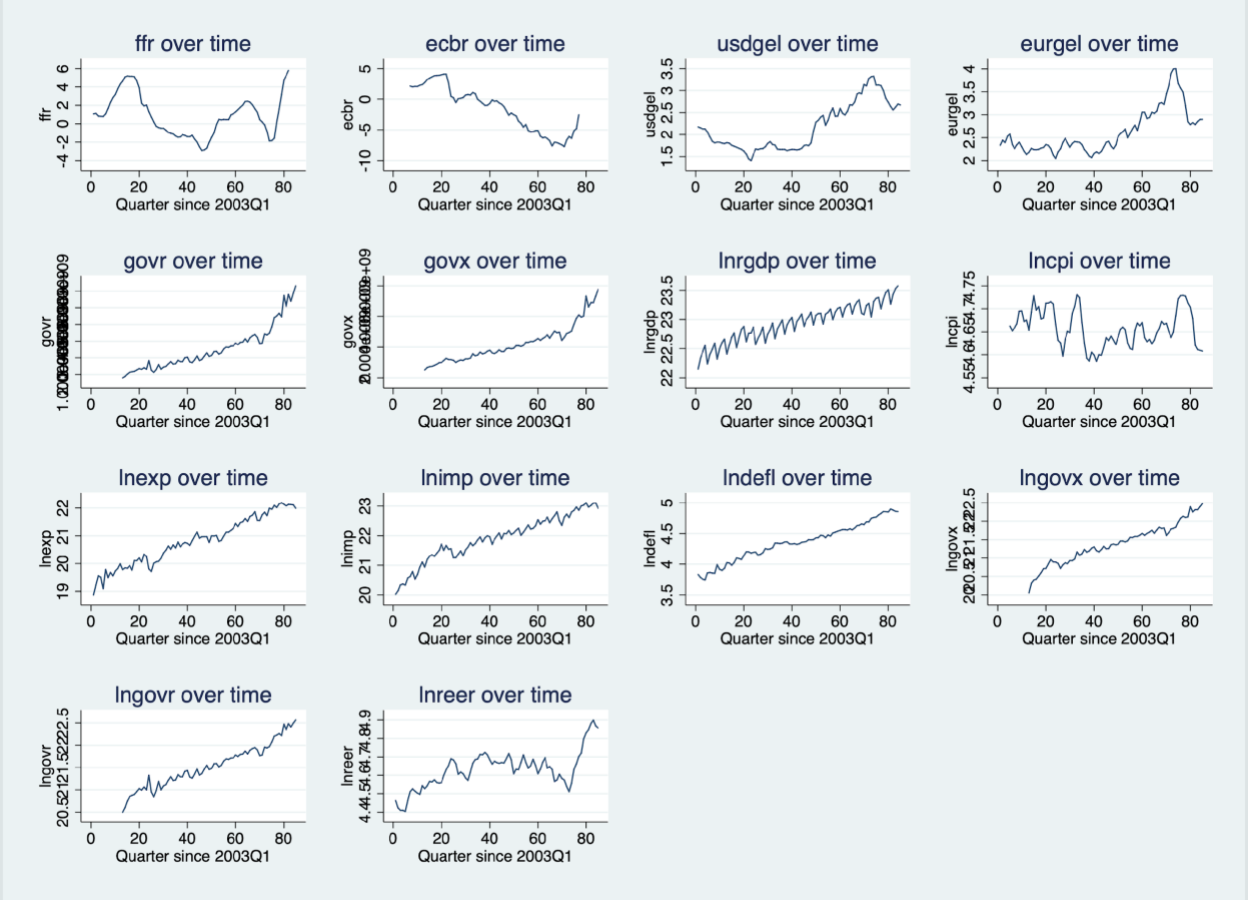
	o	Current account deficits
Eichengreen and Gupta (2014)	o o o	Fiscal deficit Public debt FX reserves
Mishra et al. (2014)	o o	Fiscal deficit FX reserves
Aizenman et al. (2014)	o o	External debt FX reserves
Ramey and Zubairy (2014)	o o o	Unemployment rate Capacity utilization Output gap
Bowman et al. (2014)	o o o	Public debt Financial openness Exchange rate regime

Appendix B

Data characteristics

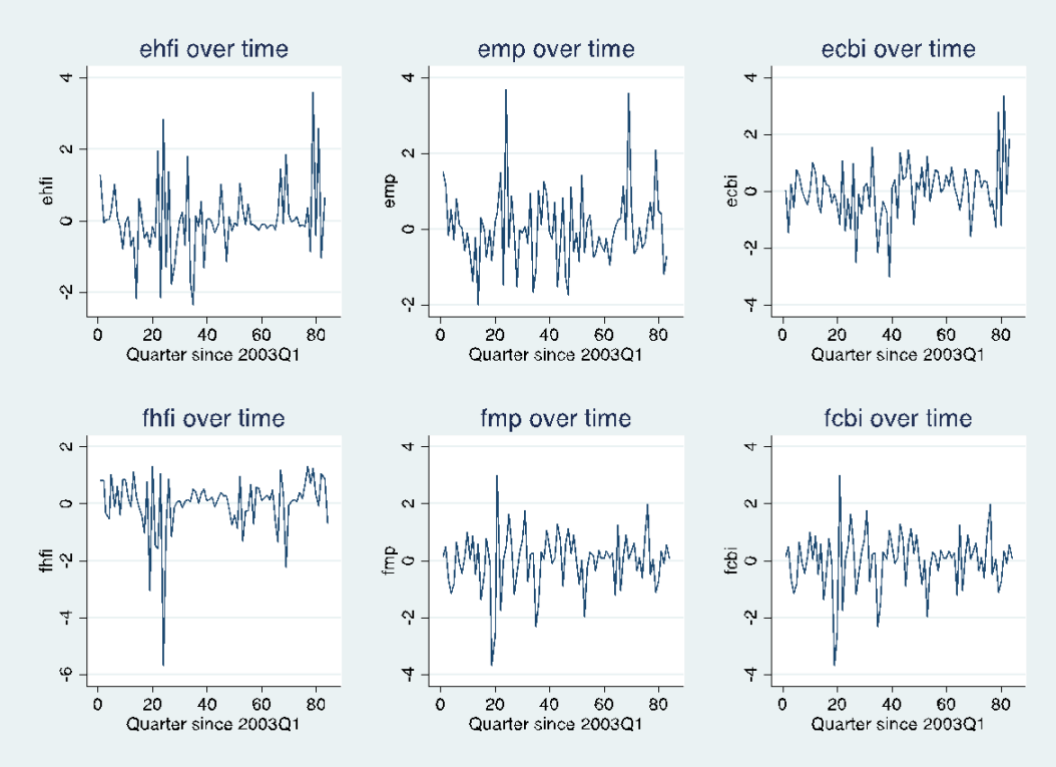
This section will provide a brief discussion of the data utilized in the econometric analysis. The dataset contains quarterly data, with the longest series spanning from 2003 Q1 to 2024 Q1.

Figure 1 Time series plots of dependent variables and lnreer



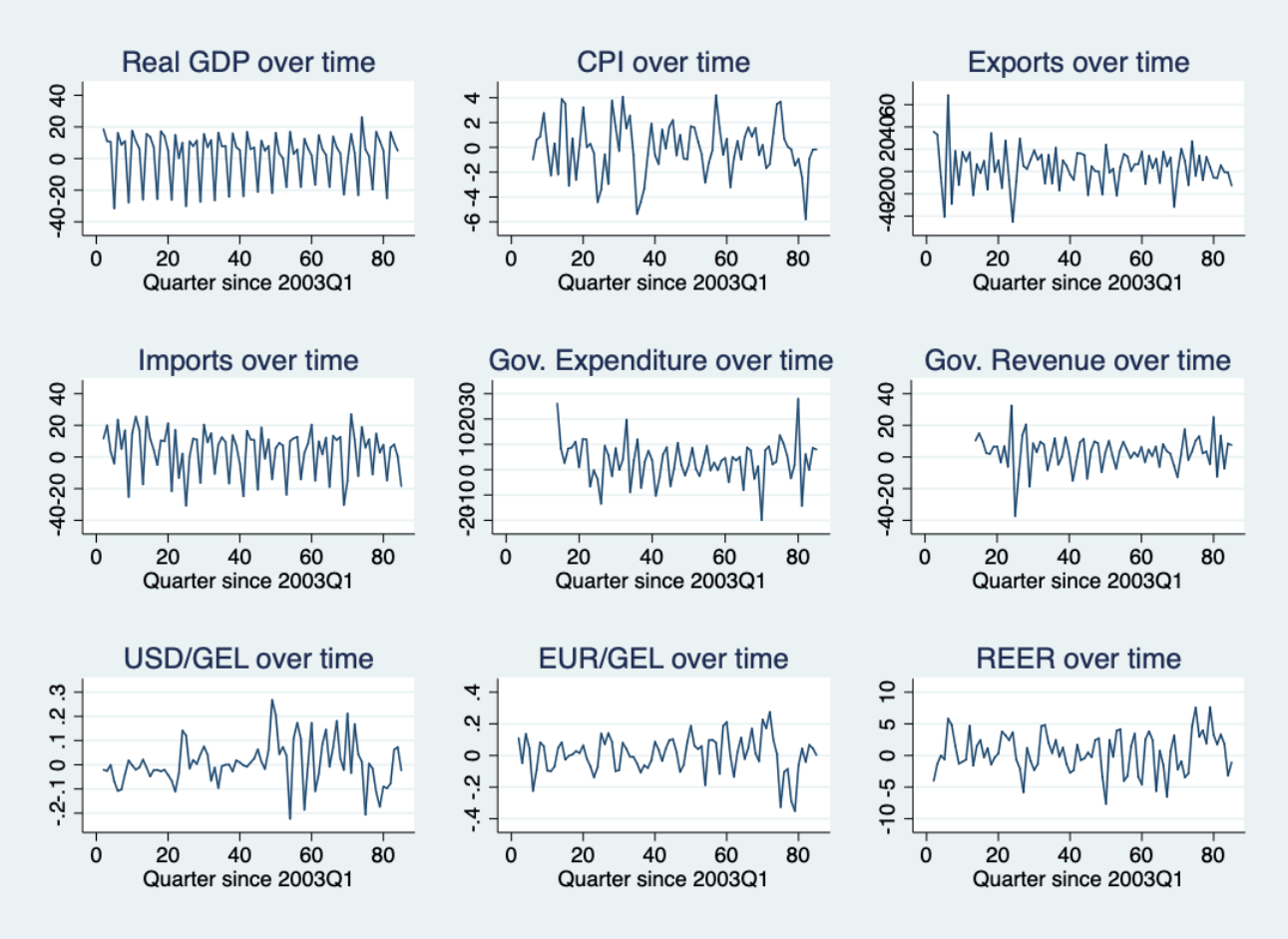
All the variables plotted above exhibit a first-order unit root when tested with the Augmented Dickey-Fuller test. However, this unit root disappears when the series are first-differenced, rendering them stationary. Despite this, it would contradict economic reasoning to consider monetary policy rates as non-stationary. Literature suggests that, for example, the Fed Funds rate, although ordinary tests may indicate a unit root, is in fact a stationary process with two structural breaks—events that significantly altered its level and trend (Bassil, 2008). Consequently, all variables plotted above will be first-differenced, except for the Fed Funds shadow rate (ffr) and the ECB shadow rate (ecbr).

Figure 2 Time series plots for monetary policy shocks



The shocks pose no issues with either non-stationarity or seasonality.

Figure 3 Time series plots of first differenced dependent variables and lnreer



When plotting after first differencing the issue of seasonality that was evident in the first graph still exists at first glance. Moreover, when checking by regressing on quarters, for the vast majority of variables, there exists seasonality. This issue was resolved by conducting time series deconstructing and then removing seasonality from the variables, using the moving average methodology over 4 periods. This methodology assumes an additive model that assumes that a variable is comprised of trend, seasonal and error components at time t.

Figure 4 Time series plots of first differenced and deseasonalised *dependent* variables and lnreer

