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Monetary conditions and banking flows in a developing country: a balance-sheet approach

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Summary

For a small, developing and open economy, the equilibrium in terms of financial flows from private agents (e.g., banks) correlates with financial and macroeconomic soundness. Thus, Central Banks use this to implement policies aiming at stabilizing those flows for exchange rate, credit, monetary and financial objectives. Using macro-econometric tools for causal analysis and monetary policy surprises, this paper examines the effects of external monetary shocks on financial outflows from Nicaraguan private banks, from a unique dataset and following a balance-sheet approach. We show that exogenous shocks to external interest rates, which drive the international financial markets, do not have a significant effect on financial flows from Nicaraguan banks. Instead, banks react to domestic monetary conditions. Therefore, the response of Central Bank interest rates to changes in external rates (aiming to safeguard the financial flows balance) can increase the internal cost of money without fundamental reasons. A simple theoretical model is proposed to have a clearer idea of possible mechanisms.

Keywords: Nicaragua, Central Bank, Policy rate, Financial flows, Monetary surprises.
JEL Codes: B26, C58, E44, E58, G15

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1. Introduction

The Nicaraguan banking system is a small one, with a relatively deep internal financial interconnection, but to a lesser extent at an international level, particularly with financial and stock markets. However, the development of the payment system, the remittances and the trade links especially with the United States (U.S.) economy, have strengthened the bank-to-bank nexus, which also promotes and provides a favorable atmosphere for capital flows. These flows have been more evident during internal uncertainty, as observed during the sociopolitical turmoil in 2018, generating pressures on the exchange rate regime, the Central Bank reserves level and the overall internal financial intermediation.

Given the above-mentioned, this document examines the role of external monetary conditions on the private banks' financial flows, using macro-econometric strategies for causal analysis and a unique daily database at the bank level, exclusively provided by the Central Bank. The banking data includes a variety of investment indicators (proxy of flows), but this document focuses on investment in foreign instruments, which are influenced by external interest rates and monetary shocks. We focus the analysis on banking flows, because these entities are most responsive to monetary policy shocks (Villamizar-Villegas et al. 2024, p.6). We contribute to the limited literature on this topic in emerging countries.

To identify the effects of monetary shocks on bank flows, we use a high-frequency identification scheme (as in Gürkaynak et al. 2005, Gertler & Karadi 2015, Nakamura & Steinsson 2018*a*, Jarociński & Karadi 2020, Bu et al. 2021, to mention a few seminal papers). The strategy allows us to identify variations in external financial conditions, associated exclusively with monetary shocks, which are exogenous to the Nicaraguan economy. We create a variety of monetary policy shocks, based on intraday future prices (in 5-minute windows) of international financial instruments (e.g., U.S. interest rates) with different maturities, after monetary policy announcements of the U.S. Federal Reserve Bank (FED), following a similar approach to Gertler & Karadi (2015), Jarociński & Karadi (2020), Bu et al. (2021). Monetary policy surprises from Jarociński & Karadi (2020) are also considered for the estimations.

We show that exogenous shocks to external interest rates (i.e., in U.S.), following FED monetary policy announcements, do not have a significant effect on financial outflows from Nicaraguan banks. This result is robust to various sensitivity analysis and different empirical strategies. However, the evidence also indicates that private banks respond to internal monetary conditions, in particular when the Central Bank changes the interest rate for deposits (proxy of monetary policy rate). Therefore, the response of Central Bank interest rates to movements in external rates (aiming to safeguard the financial flows balance), can increase the internal cost of money to borrowers, without fundamental justification (considering bank flows conditions). We also propose a simple theoretical model for a better

understanding of the potential mechanisms in a multi-currency context.

The contribution of this paper is twofold. On the one hand, we provide strong evidence that the spillovers from external monetary shocks (e.g., from the U.S. economy) do not play a major role in a developing country (i.e., Nicaragua), when the analysis is focused on banking flows (the most common mechanism), and even in presence of economic and financial interconnections between the developed and the developing country. Thus, the document contributes to the limited literature in developing countries. Our results contrast with the findings provided by the literature in numerous emerging countries, in which a positive evidence of spillover of those monetary shocks has been documented (see: Lee & Bowdler 2020, Villamizar-Villegas et al. 2024), which provokes changes in private banks incentives and decisions that promote capital outflows, as discussed in Correa et al. (2022).

On the other hand, we develop a theoretical model for a developing country, following a balance-sheet approach for banks (a Nicaraguan-like context), in which banks face a trade-off when choosing among investment options in different currencies and instruments. This approach allows us to explain how domestic instruments denominated in foreign currency can serve as substitutes for foreign ones, allowing banks to operate with domestic financial assets, even after external monetary shocks occur. We show that the Central Bank plays an important role in this process, which is consistent with empirical evidence provided.

The rest of this paper is organized as follows. In section 2 the document includes the related literature focused on financial flows. Section 3 describes the details of the Nicaraguan banking system. In section 4 a theoretical model on bank flows (from a balance-sheet perspective) is proposed and discussed. Section 5 discusses the data and methodological issues. The results are shown in section 6, and the concluding remarks are presented in section 7.

2. Literature review

Traditional drivers of capital flows

There is a variety of studies exploring how financial flows can affect macroeconomic and financial soundness (see, e.g., Agbloyor et al. 2014, Igan et al. 2020, Ebire et al. 2021). These studies analyze the flows from private banks and their determinants (see: Buch 2003, 2005, Buch et al. 2013, Di Giovanni 2005, Papaioannou 2009, Herrmann & Mihaljek 2013, Müller & Uhde 2013, Reinhardt & Riddiough 2015, Koepke 2019, Choi & Furceri 2019, Avdjiev et al. 2022, Feldkircher & Schuberth 2023, Romero et al. 2023, to mention a few), because general capital inflows and outflows are driven *vis-à-vis* by banking flows (Avdjiev et al. 2022).

Most of the literature has been developed in a cross-country context, and the main results

indicate that private banks' financial flows are driven by multiple factors, known as *push* and *pull* factors (see: Hernandez et al. 2001, Ghosh et al. 2011, Villamizar-Villegas et al. 2024). The *push* factors, distinguished in Calvo et al. (1994) and Fernandez-Arias (1996), include, among others, global risks and economic growth. On the other hand, *pull* factors are driven by internal dynamics, such as domestic growth,[1] country risk premium, rate of return on financial assets and others (Koepke 2019, Villamizar-Villegas et al. 2024). These factors can drive portfolio investments, Foreign Direct Investment (FDI), but also banking flows (ibid).

Regarding the banking flows, Buch (2005) examines the role of geographic distance on banking connections and lending in France, Germany, Italy, United Kingdom and the U.S., where the distance remained as an important factor in explaining banking dynamics, mainly in Europe. According to Buch (2005), distance can cause the so–called *home bias* phenomenon in banks that operate with others abroad.[2] This result is consistent with Herrmann & Mihaljek (2013) and Doan et al. (2021).

Buch et al. (2013) found a similar trend to Buch (2005), for German banks before and during the IFC. Giannetti & Laeven (2012) also documented in 55 countries that, after a crisis, financial flows from banks in their home country tend to be reduced to subsidiaries located in other countries (see Giannetti & Laeven 2012, p.24).[3] This seems to be counterintuitive when compared with the *flight-to-quality* principle discussed in Bernanke et al. (1994), in which negative shocks to borrowers reduce the allocation of loans from banks. The same pattern can be found in institutional investors, who *flight to quality* when emerging markets experienced financial turmoil (see Eichengreen et al. 2001, Caballero & Krishnamurthy 2005, Calvo & Talvi 2006, Reinhart 2019).

In addition, Buch et al. (2013) mention that the decline in German banks' flows is most pronounced after crisis, in an intensive margin (international operations), but not at an extensive margin (reduction in the number of subsidiaries), which is aligned with the *home bias* hypothesis (p.2). Wildmann (2011) comes to a similar conclusion for German banks' portfolio flows, which is mostly driven by short-term indicators such as exchange rate dynamics and early warning of financial risk indicators (ibid).

Papaioannou (2009) investigated the effects of structural determinants on banking flows.[4] In contrast with Wildmann (2011)'s results, Papaioannou (2009, p.270) found that private banks' portfolio investments and flows are driven by geography,[5] politics and institutions.

[1] See Dahl & Shrieves (1999).

[2] About 25 percent of the variance in the bias across countries can be attributed to distance (Buch 2005).

[3] Wang (2018) finds a similar result under uncertainty in non-home countries of private banks, they increase the probability of *home bias*.

[4] According to Huizinga et al. (2014), taxation seems to be an important determinant of banking flows.

[5] In line with Buch (2005) and Buch et al. (2013).

This relationship was found in a bilateral fashion, from banks of 19 source countries to entities in 51 recipient countries.

In emerging countries,[6] Kim & Wu (2011) found strong evidence that the sovereign credit rating is one of the most important drivers of banking flows and lending abroad. On the other hand, geographical proximity, cultural and legal linkages are only important for ameliorating informational asymmetries[7] in riskier lending decisions to borrowers[8] from non-investment grade countries (Kim & Wu 2011, p.333). The results also show spillover effects, which indicate that improvements in one emerging market region, reduce bank flows to other regions.

In Herrmann & Mihaljek (2013), they analyze the factors behind the flows from developed-country banks to emerging markets, finding that spillover effects from private banks flows—as mentioned in Kim & Wu (2011)—are driven by global risk aversion and expected financial volatility. The spillover caused by bank flows is also precursor of crisis. Van Rijckeghem & Weder (2003, p.503) conclude that a common bank lender had an important predictive power in the Thailand and Mexican crisis, which can eventually result in contagion when flows to emerging countries are not diversified. In fact, Shirota (2015) identifies that common factors can explain between 40 and 50 percent of volatility in overall cross-border banking flows.[9] This suggests that the international propagation of shocks (spillovers) through global banks are quantitatively important (see: Shirota 2015, p.147).

Crisis and uncertainty also play an important role in cross-border banking flows. In boom periods, the growth rate of banks' foreign claims is largely driven by a global common factor (associated with economic cycles), but during and after a crisis, idiosyncratic supply and demand shocks emerge (Amiti et al. 2019, p.98). Other studies show that global crises have an asymmetric impact on the risk attitudes of banking institutions towards country-specific uncertainty: global crises make banks more risk-averse to foreign uncertainty but have no effect on their responsiveness to domestic uncertainty (Wang 2018, p.19). This result is also consistent with the *home bias* puzzle documented in Buch (2005), Giannetti & Laeven (2012) and Buch et al. (2013). Thus, bank flows are associated with improved financial stability (i.e., lower systemic risk) in the recipient country (Karolyi et al. 2023, p.1563).

Some studies have found that higher flow-recipient country uncertainty is associated with increased cross-border flows. Biswas & Zhai (2021, p.2) suggest that a 1 percent increase in the recipient-country policy uncertainty is associated with an 8.8 percent increase in cross-border

[6] Banking flows of G7 countries to a sample of 55 emerging market borrowers for the period 1995-2008.

[7] See Buch (2003) for further discussion.

[8] A similar result is found in Dinger & Te Kaat (2020, p.5).

[9] Cerutti et al. (2017, p.113) conclude that push factors of global financial conditions are best captured by U.S. monetary conditions and exchange rate dynamics, and by European bank conditions.

financial flows. On the other hand, Choi & Furceri (2019) analyze the portfolio rebalancing behavior of global banks, under higher uncertainty in the home country (measured by country-specific stock market volatility), and their findings suggest that banks reallocate their flows toward foreign borrowers, who are perceived as relatively safer (*ceteris paribus*) due to a rise in idiosyncratic uncertainty (Choi & Furceri 2019, p.262)

Monetary policy and capital flows

Monetary policy influence on capital flows has been analyzed in recent years (see e.g., Cerutti & Osorio-Buitron 2020, Albrizio et al. 2020, Correa et al. 2022, Ouerk 2023). In this sense, Correa et al. (2022) documented that domestic monetary tightening leads to an increase in cross-border lending and flows. Specifically, a one-percentage point increase in the domestic monetary policy rate leads to about 8 percent higher cross-border bank flows. Thus, domestic monetary tightening leads to stronger re-allocation of credit away from source countries with weaker financial banking sectors (see: Correa et al. 2022, pp.439-440).

However, previous results differ from that found in Albrizio et al. (2020), in which the evidence suggests that exogenous monetary policy tightening in systemically-important advanced economies (e.g., the U.S. economy), leads to an economically and statistically significant decline in cross-border bank flows (Albrizio et al. 2020, p.15). The results of Albrizio et al. (2020) are consistent with Avdjiev et al. (2018), but in this paper the effects of monetary policy shocks depend on whether the shock occurs on a global currency (or not), as in Takáts & Temesvary (2020), Lee & Bowdler (2022) and Feldkircher & Schuberth (2023).

According to Lu et al. (2022), the transmission of monetary policy shocks to banking flows depends on the exchange rate regime, given that more flexible regimes are more shock-absorbent than the rigid systems. Cerutti & Osorio-Buitron (2020) make a distinction if the monetary policy shock occurs in U.S., finding that shocks in Europe affect only emerging markets in Europe, whilst shocks in the U.S. seem to impact other emerging markets, where dollarized assets are more common (ibid). In Korea, Yun (2022, p.83) finds that financial flows from banks with high shares of loans in their balance sheets, are more sensitive to interest rate changes, particularly after monetary policy shocks.

One key aspect for identifying the financial effects of monetary policy shocks is the validity of instruments, given that the accuracy of the estimated effects depends directly on the validity of the monetary policy measure (Romer & Romer 2004, p.1055). This is an open discussion (see: Brennan et al. 2024, Nakamura & Steinsson 2018*b*, Ramey 2016), that has been developed in seminal papers such as Romer & Romer (2004), Gürkaynak et al. (2005), Gertler & Karadi (2015), Nakamura & Steinsson (2018*a*), Miranda-Agrippino & Ricco (2021), to mention a few.

In some papers, monetary shocks are proxied by the difference between what the monetary authority intended to do, and what it actually did. In Romer & Romer (2004, p.1056) they combine information on the FED expected funds rate, derived from the Weekly Report of the Manager of Open Market Operations, with detailed readings of the Federal Reserve's narrative accounts of each Federal Open Market Committee (FOMC) meeting. To address endogeneity the authors regress the intended monetary policy rate on macroeconomic forecasts of inflation and real activity, to 'exogeneize' the shock.[10] The results from Romer & Romer (2004) suggest that an exogenous monetary shock (increase in interest rate) leads to a reduction in Gross Domestic Product (GDP) of about 4 percent after two years, which is more severe than the estimate using the difference in the monetary policy rate as proxy of the shock.

Kuttner (2001) was one of the first to take advantage of the FED funds futures market to 'disentangle' anticipated from unanticipated changes of the FED funds rate (Brennan et al. 2024, p.6). Kuttner (2001) uses the financial futures to identify the market's expected monetary rate, derived from the change in futures prices around FOMC meetings, following a narrative approach as Romer & Romer (2004). In Gürkaynak et al. (2005) they go further and estimate the monetary surprises using the FED futures with intraday data. The method employs high-frequency data to identify the movements in future prices around every FOMC meeting.[11] According to their estimates, both monetary policy actions and statements have important but different effects on asset prices (Gürkaynak et al. 2005, p.55).

Most recently, Dahlhaus & Vasishtha (2020) utilize a variety of U.S. monetary policy shocks to identify their effects on capital flows from 23 emerging markets. They find that the monetary policy news shock decreases the portfolio flow significantly. On average, a 50 basis point interest rate hike, reduces the capital flows in 0.5 percent of GDP in these countries, 12 months after the shock. This effect is heterogeneous, but financial openness does not seem to be associated with differences in effects on capital flows (Dahlhaus & Vasishtha 2020).

Investigating the debt and equity flows in Brasil and Latin American countries, Fischer (2020) follows a similar approach to Gertler & Karadi (2015) and Nakamura & Steinsson (2018*a*), and his findings suggest that the flows (particularly debt) to this countries is more pronounced in local currency than in hard-currency debt (in particular for Brasil). For the rest of countries, results suggest that the FED announcements do not have a statistically significant effect on equity flows to Latin America, within the seven days before and seven days after event windows (ibid).

[10] This is done by recovering the residuals of the regression.

[11] This approach has been widely used most recently (see: Nakamura & Steinsson 2018*a*, Jarociński & Karadi 2020, Miranda-Agrippino & Ricco 2021, Gertler & Karadi 2015, Swanson 2021).

Ciminelli et al. (2022) also focus the analysis on the FED monetary shocks, considering additionally the Jarociński & Karadi (2020) shocks. The main finding in this study indicates that the information shock effect differs from the effective monetary policy shock, in terms of the capital allocation in mutual funds, because U.S. investors tend to reduce the capital allocation in emerging markets bonds and equity, as well as in U.S. bonds. This contrasts with their response after an information shock, in which the increase in U.S. equity is more pronounced. The latter results suggest that investors revise upwards their belief about the state of the economy and thus increase equity investment (particularly in the U.S.) after positive information news shocks (ibid).[12]

It is important to note that Ciminelli et al. (2022) identify pure monetary and information shocks, which can generate different results (similar to Gürkaynak et al. (2005)). While an increase in interest rates due to a pure monetary policy shock generally decreases allocations of funds (particularly to emerging countries), an increase in interest rates due to expectation of higher growth (information news shocks) does not lead to outflows from emerging markets funds and may even increase allocations into some types of funds. Thus, strategies that do not distinguish pure monetary policy from information news shocks may lead to the conclusion that FED monetary policy only has small effects on fund flows (Ciminelli et al. 2022, p.9).

Lee & Bowdler (2020) also follow the standard monetary approach to investigate the macroeconomic effects of these shocks, including banking flows. They show that U.S. banks reduce their flows after exogenous monetary shocks, and at an international level, flows after a tightening of U.S. monetary policy are more pronounced in emerging markets than amongst advanced economies (Lee & Bowdler 2020, p.7), evidencing a *flight-to-quality* behavior. It is notable, because according to Villamizar-Villegas et al. (2024, p.6), banking flows are most responsive to monetary policy shocks, compared to other type of flows.[13]

Kaufmann (2023) used the Jarociński & Karadi (2020) FED monetary policy surprises, through which they found that after a FED monetary loosening (reduction of 5 basis points), the U.S. banks increase the lending (about 0.5 percent), and this behavior is also found in banks of the Euro Area, but with a smaller magnitude (0.1 percent), suggesting the presence of spillover effects after an exogenous monetary shock (consistent with Jarociński (2022)).

[12] Similar evidence was found previously in Wongswan (2009).

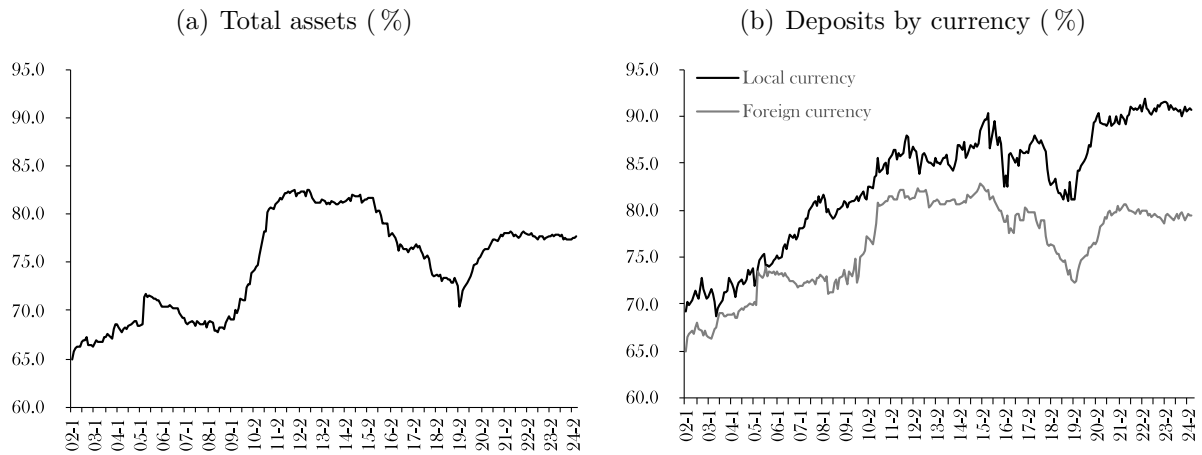
[13] Correa et al. (2022, p.440) found that banks rebalance their loan portfolios toward foreign borrowers in response to relatively tighter domestic monetary conditions.

3. The Nicaraguan banking system

The banking system in Nicaragua is relatively small and concentrated. Total deposits to GDP averaged 34.6 percent over the period 2006-2023, and the credit-to-GDP ratio was 30.2 percent during the same period (Figure A3 in the Annex). As of 2024, eight banks operated in the country (one state-owned bank), and two middle financial institutions, which have not changed much over time. At that time, all these financial institutions had 450 branches and about 10,000 employees, according to information from the Central Bank of Nicaragua (BCN for its Spanish acronym), as shown in Figure A1.

When analyzing the financial indicators of the three main banks,[14] one can observe that the financial intermediation is determined by these banks. In terms of financial assets, the three largest banks currently represent more than 77 percent of total assets, which has slightly increased over time (see panel (a) in Figure 1). However, this asset concentration was reduced between 2015 and 2019 because of the creation of a new private bank,[15] which was closed in 2019 after the socio-political turmoil that occurred in April 2018.

FIGURE 1: Assets and Deposits Concentration (2002-2024)



Note:–Percent of the assets and deposits owned by the three largest banks. Horizontal axis in months.
Source: Own elaboration. Data from BCN.

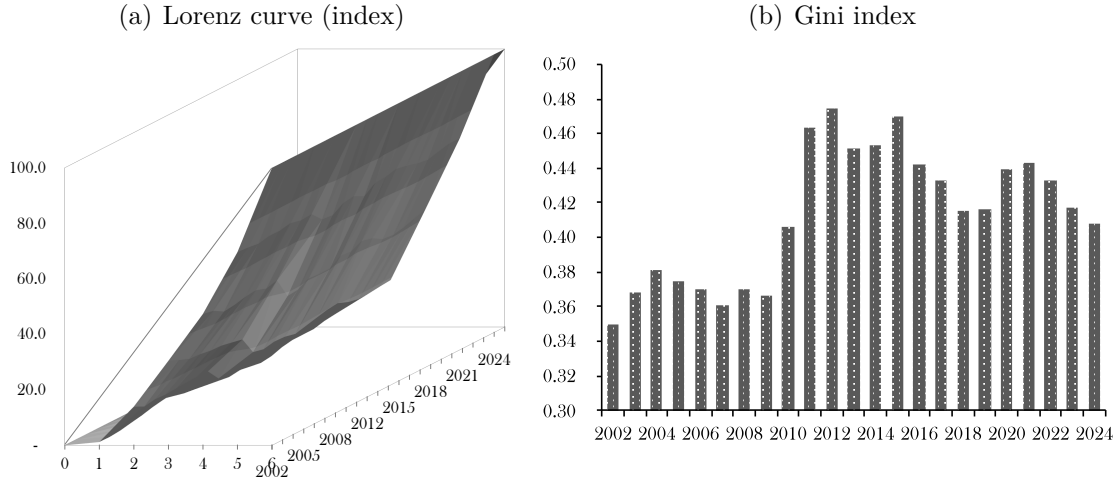
The above-mentioned is also observed in deposits. The concentration of this indicator among the three main banks is evident. In local currency, more than 90 percent of total deposits are concentrated in these three banks, with an upward trend over time. This trend is less evident in deposits denominated in foreign currency (most of which are U.S. dollars), because in this currency almost 79 percent of deposits are concentrated in the three largest banks. This means that the management of assets and deposits in foreign currencies is more

[14]Banpro, Lafise and Bac.
[15]The Bancorp bank started to operate on April 2015 until October 2019.

competitive among banks.

Inequality in asset management shows a relative upward trend, according to the Gini (1912) index (see panel (b) in Figure 2) and the Lorenz (1905) curves. The Gini index indicates a relatively concentrated assets structure in Nicaragua, which has been influenced by the dominance of the three main private banks.

FIGURE 2: Financial Assets Concentration and Inequality



Note:–Includes financial assets of private banks that operated over the period 2002-2024 (6 banks). The diagonal line of panel (a) in Figure 2 indicates the equality condition in assets position of private banks.
Source: Own elaboration. Data from BCN.

The concentration of the banking system in Nicaragua is a notable feature. However, another important aspect is the denomination of these assets (e.g., credits and deposits). When analyzing the total credit portfolio, more than 91 percent of those are denominated either in foreign currency (i.e., U.S. dollars) or in local currency indexed to the local currency devaluation rate.[16] This ratio of foreign-currency-denominated credits has increased monotonically over time, suggesting a particular interest of financial intermediaries in assets denominated in foreign currency (including the indexed ones).

In terms of deposits, the result is less 'dramatic'. However, more than 67 percent of deposits are denominated in foreign currency (U.S. dollars). The mismatch between deposits and credits reflects the presence of indexed credits. Given that most of the assets and deposits are denominated in U.S. dollars, the country exhibits a *de facto* financial 'dollarization'. However, this is a particularity of financial intermediaries, because for transactional and payment purposes, the local currency is more representative as mentioned in BCN (2021).

[16]This includes credits issued in local currency, but the payment needs to be done in foreign currency.

3.1. Financial interconnection and monetary policy

The financial depth depends substantially on the banking system's interconnection. The Nicaraguan banking system has a relatively deep internal interconnection, but to a lesser extent at an international level, especially to financial and stock markets. In Nicaragua, the private banks operate in a private repo market,[17] which allows them to obtain funding from each other when liquidity issues arise (either in local or foreign currency). However, the banks also have access to the repo market with the Central Bank, which played a major role after the social turmoil in 2018 when interbank operations dropped, as can be seen in Figure A4.

The interbank operations define the interbank interest rate, which is a key indicator for monetary policy purposes of Central Banks. In Nicaragua, this interest rate is also considered for operative monetary decisions; however, the monetary policy rate in Nicaragua (the so-called Tasa de Referencia Monetaria, TRM) is more influenced by external factors. The Central Bank in Nicaragua textually defines that the TRM "is set in correspondence with external rates and internal monetary conditions, focused on the Central Bank fundamental objectives of preserving the local currency and payment system stability, but also safeguard the liquidity of the financial system, to preserve the financial intermediation". The TRM is also a communicative tool for the Central Bank, which is used to (potentially) guide the private agents' decisions and expectations.

The Central Bank interest rate (i.e., TRM) influences the cost of money for private banks (see Torres 2023), when these banks get the liquidity that the Central Bank provides through its active operations, such as repos. This reflects the traditional mechanism of monetary policy, through which the Central Bank drives, either directly or indirectly, the private banks' interest rates, thereby generating an impact on the cost of money to borrowers (at least in local currency).

The Central Bank interest rate is mainly driven by exogenous factors, such as international interest rates. For instance, there is a significant correlation (94 percent) between the TRM and the Federal Funds Rate (FED funds) as shown in Figure A5, due to the influence of the U.S. economy on the global economy and the financial environment. This means that monetary decisions made for the North American economy, eventually affect the path of monetary conditions in Nicaragua, through the BCN reaction to exogenous monetary events.

[17] A re-purchase agreement in which a bank gets funding collateralized with private or public instruments.

4. Model (in progress)

4.1. Introduction and assumptions

In this model, we consider a representative bank of a small economy, in an internal and internationally interconnected financial system. The bank has a balance-sheet constraint as shown in equation (1), similar to constraints discussed in Dhal (2010) and Torres (2023). In this paper a new approach is proposed to increase the model's flexibility, allowing banks to operate in a multi-currency dimension, without exchange rate rigidities. For instance, banks can invest and lend money in different currencies, and we include a foreign constraint that allows us to distinguish the trade-off between domestic and foreign assets in foreign currency. We also provide insights on the role of the Central Bank in this model, which is helpful for explaining the dynamics on investment.

As a starting point, the bank constraint implies that sources and uses of money are equal. In this context, the total deposits the bank holds (D_t) plus the financial capital requirements (K_t) and the interbank lending resources (P_t), define the bank's sources of funds. Conversely, the uses of these funds include: the total lending (L_t), the financial investment (I_t) and the reserve requirement (R_t) that the private bank must hold at the Central Bank, which ultimately depends on the levels of deposits (D_t) and other liabilities.

$$D_t + K_t + P_t - L_t - I_t - R_t = 0 \tag{1}$$

The regulatory capital K_t is directly correlated with the amount of risky assets (i.e., risky L_t). This means that the more risk the bank undertakes, the more capital is required to report to the regulatory authority. Another regulatory aspect is the reserve requirement, which is primarily based on deposits held by the bank. Thus, one of the assumptions involves that R_t is a fraction of D_t.

For the sake of simplicity, the balance-sheet constraint is defined in local currency, although the bank holds assets in both local and foreign currencies. In this model, foreign indicators are converted (into local currency) using the exchange rate E_t of the period. For ease of analysis, the exchange rate evolves at a fixed annual rate α^E. For instance, the total amount of deposits D_t includes both the local currency proportion and the foreign deposits converted using E_t.

The total deposits D_t consist of a proportion δ of local currency deposits, and a proportion δ^* of deposits denominated in foreign currency. The parameters meet the conditions that $0 < \delta \leq 1$; $0 < \delta^* \leq 1$ and $\delta + \delta^* = 1$. Then, we have:

$$D_t = \delta D_t + \delta^* D_t^* E_t \tag{2}$$

For K_t, we assume that this indicator reflects a portion of the risky credits L_t^R, but the risky credits represent a proportion ω of the total lending portfolio L_t. Therefore, $K_t = \omega L_t$, and the foreign currency capital is defined as $K_t^* = \omega^* L_t^* E_t$. In the model, ω^* and ω are both positive and may or may not take the same value. These parameters also imply that $\kappa\omega + \kappa^*\omega^* = 1$. Thus, K_t is defined as:

$$K_t = \kappa\omega L_t + \kappa^*\omega^* L_t^* E_t \tag{3}$$

where κ and κ^* are positive values and reflect the portion of local and foreign currency capital, respectively.

Conversely, as P_t represents the sources coming from interbank activity (e.g., repos and/or financial options), in the model these sources can be allocated in lending L_t, L_t^* and/or investments I_t, I_t^*. Thus, the equation of P_t is defined as:

$$P_t = \phi I_t + (1-\phi)L_t + \phi^* I_t^* E_t + (1-\phi^*)L_t^* E_t \tag{4}$$

In equation (4), ϕ reflects the proportion of P_t the bank allocates for investing in local currency assets, and ϕ^* is the fraction for foreign currency investments. Since $1-\phi$ indicates the fraction of financial resources the bank uses for lending, as ϕ tends to zero, lending is more representative. The same applies for $1-\phi^*$. The model explicitly assumes that the bank gets funding from interbank market in both currencies.

The uses of financial resources are defined in (5), (6) and (7), following the same approach described previously.

$$L_t = \lambda L_t + \lambda^* L_t^* E_t \tag{5}$$

$$I_t = \gamma I_t + \gamma^* I_t^* E_t \tag{6}$$

$$R_t = \rho D_t + \rho^* D_t^* E_t \tag{7}$$

In equation (5), the parameters λ and λ^* are positive and represent the portion of credits in local and foreign currency relative to the total (subject to $\lambda + \lambda^* = 1$). From equation (6), γ and γ^* define the proportions of investment in domestic assets denominated in both local and foreign currency, respectively. These parameters are also positive and meet the condition that $\gamma + \gamma^* = 1$. It is important to note that in equation (7) the reserves that the bank holds at the Central Bank (R_t) depend on the levels of deposits in both currencies, defined by ρ and ρ^*, which in sum meet that $\rho + \rho^* = 1$. However, the bank's funds reserved at the Central Bank do not accrue any interest (i.e., they are not financially compensated). The latter condition affects directly the profit function.

After operating equations (2), (5) and (6) we get $D_t = \frac{\delta^* D_t^* E_t}{1-\delta}$, $L_t = \frac{\lambda^* L_t^* E_t}{1-\lambda}$ and $I_t = \frac{\gamma^* I_t^* E_t}{1-\gamma}$, respectively. These expressions indicate that if δ, λ and γ are all equal to zero, the balance-sheet identity will be driven by the indicators denominated in foreign currency, and the exchange rate will play a role. It is worth noting that I_t^* refers to domestic assets in foreign currency (e.g., Government bonds in U.S. dollars), however the dynamics of foreign instruments denominated in foreign currency differ (e.g., U.S. Government bonds), because of risk premiums and transactional costs, and other internal and external factors. This distinction is important because the bank can invest in domestic and external assets in foreign currency. We will elaborate more on that later.

4.2. Optimization

With the proposed expressions, we can operate (1) and define the identity in terms of the endogenous variables that the bank controls (i.e., L_t^* and I_t^*). By substituting (3), (4) and (7) in equation (1), equation (8) can be obtained. This identity is derived and explained in more detail in Appendix A.1.

$$D_t = \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right] - (\kappa\omega - \phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] - (1 - \phi^* + \kappa^*\omega^*)L_t^* E_t - \phi^* I_t^* E_t\right] \tag{8}$$

Given that the bank derives profits from active operations, after accounting for the cost of financial resources (i.e., funds), the profit function can be expressed as follows:

$$\Pi_t = (1-\epsilon)(r_L - \tau_{r_L})L_t + (1-\epsilon^*)(r_L^* - \tau_{r_L^*})L_t^* E_t + (r_I - \tau_{r_I})I_t + (r_I^* - \tau_{r_I^*})I_t^* E_t - r_D D_t - r_P P_t \tag{9}$$

In equation (9), the parameters ϵ and ϵ^* represent the risk-return component for lending in local and foreign currency, respectively. This implies that as either ϵ or ϵ^* tend to one, then the benefits from L_t and L_t^* decrease due to the risk level the bank assumes, then $0 \leq \epsilon, \epsilon^* \leq 1$. Additionally, r_L, r_I, r_D and r_P define the active and passive interest rates, which can take positive values. Finally, τ_{r_L} and $\tau_{r_L^*}$ represent the taxes or charges the bank pays on financial returns that come from lending activities in both currencies. Without loss of generality, this tax or charge can be extended to investment.

Substituting P_t in (9), we get:

$$\begin{aligned}\max_{I_t^*, L_t^*}(\Pi_t) = &\left[(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)\right]L_t + \left[(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*)\right]L_t^* E_t \\ &+ \left[(r_I - \tau_{r_I}) - r_P\phi\right]I_t + \left[(r_I^* - \tau_{r_I^*}) - r_P\phi^*\right]I_t^* E_t - r_D D_t\end{aligned} \tag{10}$$

Once D_t, L_t and I_t are included, equation (11) is obtained (see details in Appendix A.1):

$$\begin{aligned}\max_{I_t^*, L_t^*}(\Pi_t) = &[(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)]\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] + [(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*)]L_t^* E_t \\ &+ [(r_I - \tau_{r_I}) - r_P\phi]\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right] + [(r_I^* - \tau_{r_I^*}) - r_P\phi^*]I_t^* E_t \\ -r_D\left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)&\left[(1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right] - (\kappa\omega - \phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] - (1 - \phi^* + \kappa^*\omega^*)L_t^* E_t - \phi^* I_t^* E_t\right]\end{aligned} \tag{11}$$

Taking the First Order Conditions (FOC) with respect to the variables under bank's control (i.e., I_t^* and L_t^*), expression (12) can be obtained (see further details in Appendix A.1).

$$\begin{aligned}\frac{\partial \Pi_t}{\partial I_t^*} \to r_I^* = (1 + \xi_{r^*}^{I^*})^{-1}&\left\{\left(\frac{r_D\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^*}{1-\gamma}\right] - \phi^*\right]\right\} \\ &+ (1 + \xi_{r^*}^{I^*})^{-1}\left\{(\tau_{r_I} + r_P\phi)\left[\frac{\gamma^*}{1-\gamma}\right] + (\tau_{r_I^*} + r_P\phi^*) - r_I(1 + \xi_r^{I^*})\left[\frac{\gamma^*}{1-\gamma}\right]\right\}\end{aligned} \tag{12}$$

The expression (12) indicates that the optimum interest rate for domestic investment denominated in foreign currency is positively driven by the passive interest rate of deposits (r_D), this suggests that the higher cost of money is, the higher interest rate of assets the bank needs to compensate that cost. This effect is mediated by δ^*, indicating that as the share of deposits in foreign currency tends to one, then the implicit pass-through of passive interest rate to the rate the bank needs for its assets tends to be one-to-one.

Conversely, if $\delta^* \to 0$, then D_t is primarily defined by deposits in local currency, thus there is not an indirect effect of the interest rate that the bank pays for those deposits and the optimal interest rate needed for investments in foreign currency. Without deposits in foreign currency it is not possible to allocate resources to I_t^*, then, this investment would depend on the financial resources from P_t, in which a share ϕ^* is supposed to be used for I_t^*.

The result previously discussed is driven by $r_P\phi^*$, indicating that as the financial cost of interbank operations in foreign currency increases, the interest rate of I_t^* needs to increase, but this will be moderated by ϕ^*, thus, as $\phi^* \to 0$, then this effect of r_P over r_I^* tends to diminish (closer to zero). This result aligns with the expected profit of the representative bank, because as the cost of passive operations increases, the active operations need to compensate for this by means of higher interest rates.

It is important to note that regulatory parameters are not 'innocuous', particularly regarding the reserve requirements, given that this regulation affects the deposits in both currencies,

which is 'translated' into a reduction of the available resources for investments and lending. Given that $\delta^* > \rho^*$, then, as the bank faces a higher reserve requirement in foreign currency, the higher r_I^* is needed to compensate this cost, which is mediated by the cost that the bank pays for those resources ($r_D^* D_t^*$) held by the Central Bank without any financial compensation. On the other hand, taxes/charges on investment earnings are also associated with higher interest rates needed to compensate for the financial cost and the opportunity cost related to invest (rather than lending), because the taxes/charges for lending are not necessarily equal to those applied to investments earnings.

In this model, the inverse elasticity of interest rates to investment level defines the equilibrium interest rate r_I^*, that maximizes the bank's profit function. Given the interaction between investments in assets denominated in local and foreign currency, the bank has a trade-off and the model's mechanism indicates that, as the investments in local currency become more profitable (higher r_I), under the plausible assumption that elasticities are approximately the same ($\xi_r^{I^*} \approx \xi_{r^*}^{I^*}$),[18] the trade-off of interest rates in (12) is driven by $\left[\frac{\gamma^*}{1-\gamma}\right]$, which can 'neutralize' the last result because as r_I increases, I_t tends to increase in total investment reducing at the same time the weight of I_t^*, and in this scenario $\gamma^* \to 0$. However, a primary result of the model reveals a trade-off in interest rates for domestic investments in both local and foreign currencies, which appears counter-intuitive if we ignore the role of $\left[\frac{\gamma^*}{1-\gamma}\right]$.

However, the mechanism described can be rationally explained by the fact that, if a bank increases investments in local instruments (such as bonds) denominated in local currency (because the bank has no exchange rate constraints), then, under the trade-off, the bank can reduce investments denominated in foreign currency and this reduction implies that the instrument price will decrease, increasing interest rate of these instruments (r_I^*) and those in local currency will face a higher price, lowering the rate of return (r_I), and *vice versa*.

4.3. The foreign-to-domestic assets link

The context of the model involves a bank that operates with both local and foreign currency assets. Additionally, the bank also has the alternative to invest abroad. In this scenario, the previous solution is significant because it is reasonable to assume that a link between external and domestic assets exists. The existence of this link implies that domestic rates serve as benchmark against external rates, due to the size of the local economy.

Since the previous interest rate reflects the returns on investment in domestic assets denominated in foreign currency (I_t^*), the investments in foreign assets are assumed to be

[18] Under the assumption that $\xi_r^{I^*} \approx \xi_{r^*}^{I^*}$, then $\frac{1+\xi_r^{I^*}}{1+\xi_{r^*}^{I^*}} \approx 1$.

represented as I_t^{*F}.

If we consider that financial resources in foreign currency can be allocated on investments in local and foreign assets (denominated in foreign currency), this implies that the investments' constraint can be extended as in equation (13) and equation (14), in which the shares of investments in local and external instruments (both in foreign currency) are constrained such that $\phi^* + \phi^{*F} \leq 1$.

$$I_t = \gamma I_t + \gamma^* I_t^* E_t + (1 - \gamma - \gamma^*) I_t^{*F} E_t \tag{13}$$

The equation for P_t also incorporates the new constraint, as the bank faces the trade-off of investing the resources from interbank operations in foreign currency, either in local or in global instruments,

$$P_t = \phi I_t + (1 - \phi) L_t + \phi^* I_t^* E_t + \phi^{*F} I_t^{*F} E_t + (1 - \phi^* - \phi^{*F}) L_t^* E_t \tag{14}$$

With the newly proposed identities, the equation for D_t that incorporates the main constraints is presented in equation (15). More details can be found in Appendix A.2.

$$D_t = \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)} \right) \left[L_t(\phi - \kappa\omega) + I_t(1-\phi) - (1 - \phi^* + \kappa^*\omega^* - \phi^{*F}) L_t^* E_t - \phi^* I_t^* E_t - \phi^{*F} I_t^{*F} E_t \right] \tag{15}$$

The new benefits function resembles the one proposed in (10), but this version incorporates the profits from I_t^{*F}. Once we include (14) and simplify the profit function:

$$\begin{aligned} \max_{I_t, I_t^*, L_t, L_t^*} (\Pi_t) = {} & [(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)] L_t + [(1-\epsilon^*)[(r_L^* - \tau_{r_L^*}) - r_P(1 - \phi^* - \phi^{*F})] L_t^* E_t \\ & + (r_I - \tau_{r_I} - r_P\phi) I_t + (r_I^* - \tau_{r_I^*} - r_P\phi^*) I_t^* E_t + [(r_I^{*F} - \tau_{r_I^{*F}}) - r_P\phi^{*F}] I_t^{*F} E_t - r_D D_t \end{aligned} \tag{16}$$

Substituting the equivalencies for L_t and I_t, we get:

$$\begin{aligned} \max_{I_t^*, I_t^{*F}, L_t^*} (\Pi_t) = {} & [(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)] \left[\frac{\lambda^* L_t^* E_t}{1-\lambda} \right] + [(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1 - \phi^* - \phi^{*F})] L_t^* E_t \\ & + [(r_I - \tau_{r_I}) - r_P\phi] \left[\frac{\gamma^* I_t^* E_t + (1 - \gamma - \gamma^*) I_t^{*F} E_t}{1-\gamma} \right] + [(r_I^* - \tau_{r_I^*}) - r_P\phi^*] I_t^* E_t + [(r_I^{*F} - \tau_{r_I^{*F}}) - r_P\phi^{*F}] I_t^{*F} E_t \\ & - r_D \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)} \right) \left\{ (1-\phi) \left[\frac{\gamma^* I_t^* E_t + (1 - \gamma - \gamma^*) I_t^{*F} E_t}{1-\gamma} \right] - (\kappa\omega - \phi) \left[\frac{\lambda^* L_t^* E_t}{1-\lambda} \right] \right\} \\ & + r_D \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)} \right) \{ (1 - \phi^* + \kappa^*\omega^* - \phi^{*F}) L_t^* E_t + \phi^* I_t^* E_t + \phi^{*F} I_t^{*F} E_t \} \end{aligned} \tag{17}$$

Operating the new profit function that includes I_t^{*F}, we get the results shown in equation (18). Further details on the derivation of this expression can be found in Appendix A.2.

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \rightarrow r_I = \left(\frac{r_D \delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi) - \frac{\phi^{*F}(1-\gamma)}{(1-\gamma-\gamma^*)}\right] + r_P\phi + \tau_{r_I} + \left(\frac{1-\gamma}{1-\gamma-\gamma^*}\right)\left[r_P\phi^{*F} + \tau_{r^{*F}} - r_I^{*F}(1+\xi_{r^{*F}}^{I^{*F}})\right] \quad (18)$$

The key point to emphasize in equation (18) is the one concerning the link between r_I^{*F} and r_I^*, which is not directly reflected in the partial result, because of the link between r_I^{*F} is explicitly mediated by r_I, considering the endogeneity in the bank's decisions. With this assumption in mind, if we take the implicit change of rates, after changes in r_I^{*F}, we get the following: $\frac{\partial r_I^*}{\partial r_I^{*F}} = \frac{\partial r_I^*}{\partial r_I}\frac{\partial r_I}{\partial r_I^{*F}} = -(1+\xi_{r^{*F}}^{I^{*F}})\frac{(1-\gamma)}{(1-\gamma-\gamma^*)}\frac{\partial r_I^*}{\partial r_I}$.

Since local economy is assumed to be a small and open economy, the local interest rate should not have a significant impact on external rates. Therefore, the change in external rates after changes in investment (I_t^{*F}) in this small economy should tend to zero. In that particular case, $\xi_{r^{*F}}^{I^{*F}} \rightarrow 0$, because this elasticity recovers the changes in $r_{I^*}^{*F}$ caused by changes in I_t^{*F} from the local economy. Therefore, $\frac{\partial r_I}{\partial r_I^{*F}} \approx -\frac{(1-\gamma)}{(1-\gamma-\gamma^*)}$ and under the assumption of implicit relationship in local instruments interest rates (r_I, r_I^*), then, $\frac{\partial r_I^*}{\partial r_I^{*F}} \approx \frac{(1-\gamma)}{(1-\gamma-\gamma^*)}$ given the negative relationship between r_I and r_I^*, it is rational to think that $\frac{\partial r_I^*}{\partial r_I} \rightarrow -1$.

The previous results indicate that the influence of external rates on the bank's profit function is defined by the importance of resources, since the bank allocates funds to investments in foreign instruments, rather than to local ones denominated either in local or foreign currency. For example, as $(1-\gamma-\gamma^*) \rightarrow 1$, it means that the bank uses almost all the resources to invest abroad, and in this particular case, the relationship between r_I^{*F} and r_I^* tends to be equal to 1, indicating that the passthrough of external rates to domestic rates should be higher compared to the cases in which $(1-\gamma-\gamma^*) \rightarrow 0$, because $\gamma \rightarrow 1$ and $\gamma^* \rightarrow 0$ (see equation (13)) where resources are invested domestically. These results are consistent and depending on the size of the economy, as well as the propensity of the bank to invest abroad.

4.4. The Central Bank

In this model, the Central Bank is responsible for the monetary policy through interest rate management (endogenously defined), with the aim of maintaining monetary equilibrium as a final goal (rather than focusing solely on inflation), targeting private interest rates. The Central Bank interest rate 'emerges' from active monetary operations with private banks (affecting monetary aggregates), operating with the traditional mechanism to intervene the

financial market in a small economy.

Considering the point mentioned above, the Central Bank offers financial instruments (i.e., bills, deposits or repos) paying an interest rate r_{CB} in domestic currency, but also offers instruments in foreign currency with a compensation rate r^*_{CB}. The equivalence between rates is as follows:

$$r_{CB} = \mu + \eta r_P + \epsilon^{r_{CB}} \tag{19}$$

$$r^*_{CB} = \pi r_{CB} - \alpha_E + \epsilon^{r^*_{CB}} \tag{20}$$

In equation (19) $\mu > 0$ indicates the unconditional mean for r_{CB}, and $0 < \eta \leq 1$ reflects the influence of the interbank rate on the domestic Central Bank's monetary policy decisions, because r_P is the most common reference rate to target.

On the other hand, r^*_{CB} has a relationship with r_{CB} defined by π, with $-1 \leq \pi \leq 1$. This relationship arises because there is a trade-off between the instruments offered by the Central Bank, considering that the model does not have constraints on the exchange market. Finally, α_E is the exchange rate depreciation/devaluation rate, and $\epsilon^{r_{CB}}$ and $\epsilon^{r^*_{CB}}$ represent the unexpected shocks to r_{CB} and r^*_{CB}, respectively (with $\mathbb{E}[r_{CB}, r^*_{CB}] = 0$). Including the two previous equations in (18), as $r_P = \frac{1}{\eta\pi}[r^*_{CB} + \alpha_E - (\mu\pi + \pi\epsilon^{r_{CB}} + \epsilon^{r^*_{CB}})]$, we get:

$$\begin{aligned} r_I = &\left(\frac{r_D\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi) - \frac{\phi^{*F}(1-\gamma)}{(1-\gamma-\gamma^*)}\right] + \frac{\phi}{\eta\pi}[r^*_{CB} + \alpha_E - (\mu\pi + \pi\epsilon^{r_{CB}} + \epsilon^{r^*_{CB}})] \\ &+ \tau_{r_I} + \left(\frac{1-\gamma}{1-\gamma-\gamma^*}\right)\left[\frac{\phi^{*F}}{\eta\pi}[r^*_{CB} + \alpha_E - (\mu\pi + \pi\epsilon^{r_{CB}} + \epsilon^{r^*_{CB}})] + \tau_{r^{*F}} - r^{*F}_I(1 + \xi^{I^{*F}}_{r^{*F}})\right] \end{aligned} \tag{21}$$

Due to the Central Bank defines endogenously r_{CB} and r^*_{CB}, then $\frac{\partial r_I}{\partial r_{CB}} = \frac{\partial r_I}{\partial r^*_{CB}}\frac{\partial r^*_{CB}}{\partial r_{CB}}$. Then, the result is straightforward:

$$\eta\pi\frac{\partial r_I}{\partial r_{CB}} = \frac{\phi(1-\gamma-\gamma^*) + \phi^{*F}(1-\gamma)}{(1-\gamma-\gamma^*)} \tag{22}$$

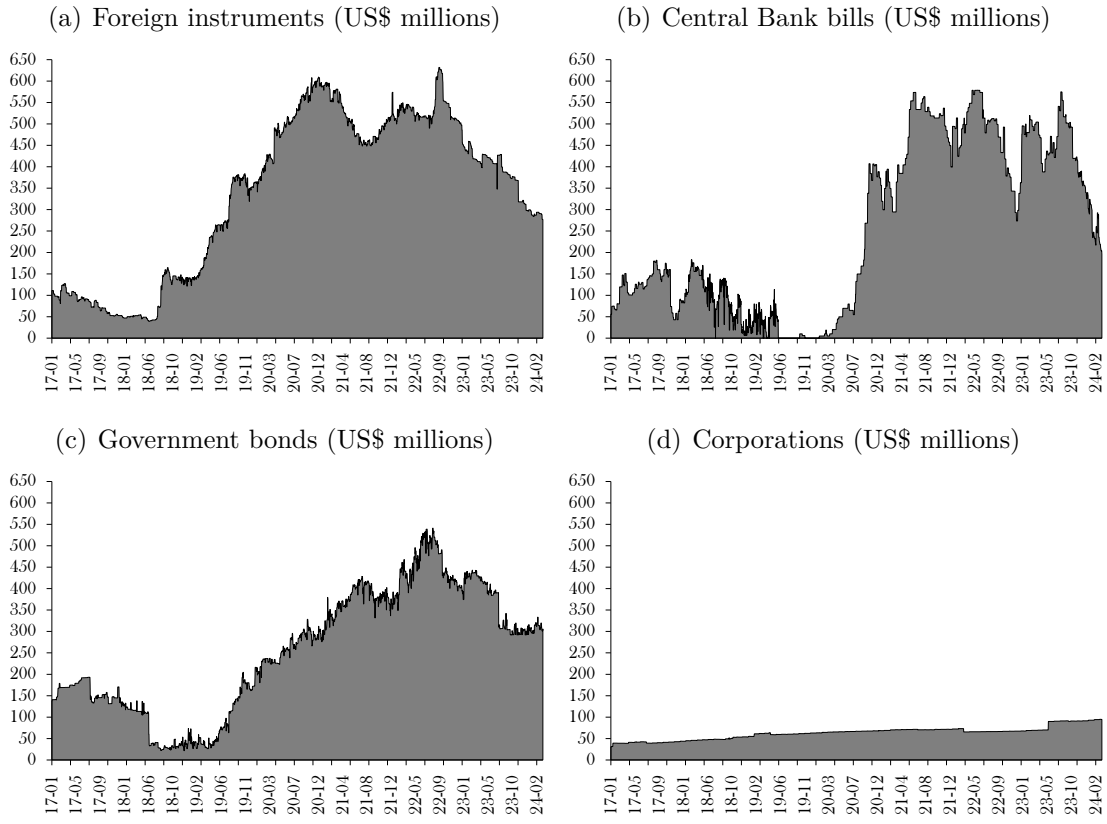
Equation (22) indicates that the sensitivity of investment's interest rates, is driven by the degree of response of the Central Bank to deviations in r_P, but also by the correlation between rates in different currencies. For simplicity, if we assume a high sensitivity of the response of Central Bank to r_P (this is $\eta \to 1$), and a high positive correlation between r_{CB} and r^*_{CB} (this is $\pi \to 1$), the sensitivity of investments interest rate will depend on how the private bank allocates the available money either for lending or investing, but precisely the money coming from P_t. Thus, equation (22) 'condenses' the ways in which the private bank will react and take decisions on I_t, I^*_t and I^{*F}_t, depending on endogenous components.

5. Methodological aspects

5.1. Data

In this document, we use a novel and not publicly available database that includes all the balance-sheet indicators of the Nicaraguan private banks in a daily frequency, covering the period from January 2017 to March 2024.[19] The primary database is exclusively provided by the Central Bank (under a FOIA-like mechanism), which contains information about assets, credits, deposits, obligations, investments and other financial indicators. The investment indicator is available in five main categories: 1) foreign financial instruments (proxy for financial flows), 2) Central Bank bonds, 3) Central Bank bills, 4) Government bonds and 5) other investments in private corporations. These categories will be considered in the analysis, as shown in Figure 3.

FIGURE 3: Investment Categories of Private Banks



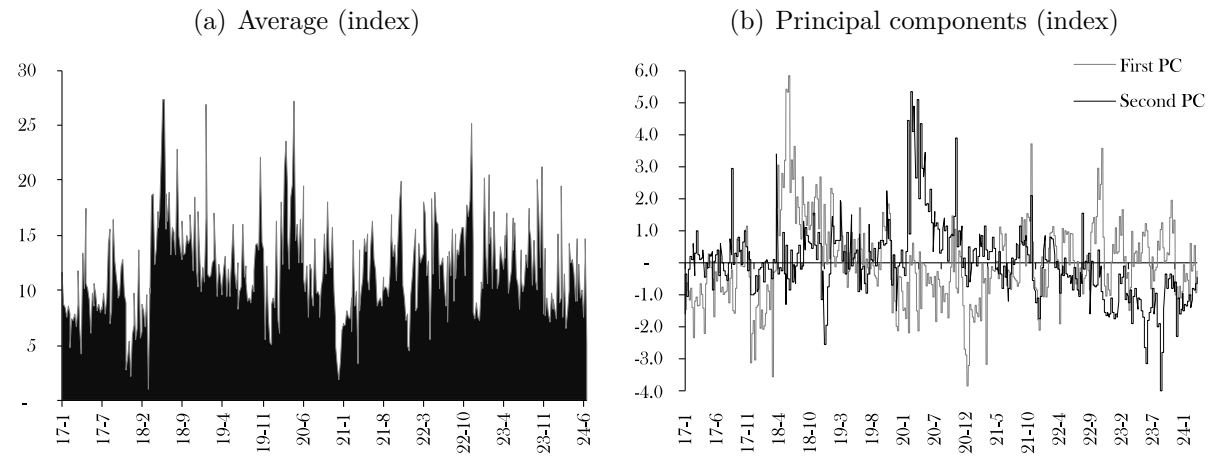
Note:–Millions of U.S. dollars. Cumulative amount in both, local and foreign currency. The investment in Central Banks instruments does not include BCN bonds. Bills are financial instruments with a shorter maturity period than bonds, commonly up to 1 year. Figure 3 includes information of: Banpro, Lafise, Bac and Ficohsa bank.
Source: Own elaboration. Data from BCN.

[19] All private banks and other financial institutions that incur financial obligations, must report information requested by the Central Bank for a reserve requirement purpose.

The database also includes information regarding the interest rates of Central Bank financial instruments (i.e., bills, repos, deposits), Government bills and other rates. Although the database includes information of all financial intermediaries that incur obligations, this study focuses exclusively on private banks, because of their financial interconnection with other foreign banks and the magnitude of their operations. The data include operations in both local and foreign currency, which are converted using the exchange rate of each day.

To measure internal instability and potential risk, we created an uncertainty index (Figure 4). As in Castelnuovo & Tran (2017), we develop an index based on 15 keywords from Google Trends (similar to the words used in Largaespada (2021)). This index reflects economic and political uncertainty.[20] We used weekly data from 2017 to 2024, of a 0-100 scaled index. Since weekly data are only available for a 5-year interval, the data were overlapped to create a continuous series for the full sample. To keep the consistency in terms of scale, we divide the two series in the overlapped period, and we create a scalar for re-scaling the most recent data. Once the series are completed, we divide them by the maximum value of each variable to preserve the original 0-100 scale.[21] Due to the high number of indices, we employed the Principal Component Analysis (PCA) method to capture the main variation explained in these data, as can be seen in Figure 4, in which the two main PC are plotted.[22]

FIGURE 4: Uncertainty Index for Nicaragua



Note:–Panel (a) reflects an arithmetic-average index from the 15 keyword sub-indices (excludes "crisis" and "disaster" keywords because of seasonality). Horizontal axis in days, from 2017 to 2024.
Source: Own elaboration with Google Trends data.

[20]We include the words: "crisis", "debt", "risk", "arrears", "bankruptcy", "devaluation", "government", "corruption", "sanctions", "reforms", "unstable", "uncertainty", "migration", "pandemic", "disaster".

[21]Weekly data are assigned to the corresponding day of a particular week, to use these data in a daily periodicity.

[22]The first PC in Figure 4 correlates mainly with the 2018 sociopolitical crisis, and the second PC correlates with the COVID-19 pandemic shock.

We also consider external information regarding interest rates, uncertainty, economic trends, and other indicators. The effective Federal Funds (FED funds) interest rate is the primary foreign financial indicator about external conditions, but we also consider the S&P500 index. Additionally, we take into account the Treasury bill rate from the St. Louis FRED data portal. Given that we use Local Projections and other identification strategies (see section 5.3) that rely on external and exogenous variables, we create a variety of financial shocks, which are described in section 5.1.1.

5.1.1. Monetary shocks(surprises)

In this document, we follow a common framework to identify exogenous variations in the context of high-frequency data (see Gürkaynak et al. 2005, Nakamura & Steinsson 2018*a*, Brennan et al. 2024). We refer to financial asset price changes around FOMC monetary policy announcements as "surprises". If we assume that prices reflect expectations, they only change to the extent the announcement surprises the markets (Jarociński & Karadi 2020, p.6). We utilize information about the futures market from the Chicago Mercantile Exchange (CME).[23] In this case, intraday data are used for identifying movements in interest rates associated to announcements and monetary policy rate decisions from the FOMC of the Federal Reserve. These data include operations conducted in a 5-minute interval.

When the period of time is short enough (i.e., minutes), we can argue that changes in prices of those financial instruments around a particular event (e.g., FED announcement) could be exogenous and attributable to that event (see Gürkaynak et al. 2005, Nakamura & Steinsson 2018*a*, Brennan et al. 2024). Therefore, this paper uses the same approach to include those variations around FOMC announcements, as monetary policy "surprises", and we evaluate the effects of these shocks on the financial flows from Nicaraguan private banks.

We include every FOMC meeting and statement to identify variations in interest rates. During the period (2017–2024), 67 meetings are considered, in which the FED has increased the interest rate 18 times and reduced it 5 times. The average increase of the monetary policy rate has been 6.3 basis points, with the highest increases experienced in 2022 and 2023, after the inflationary pressures observed over 2021 and 2022. The most significant reduction of the FED's main interest rate was observed during the COVID-19 pandemic, with a minimum of 100 basis points, as the negative outlook caused by the pandemic and lockdowns started to emerge (see Table 1).

[23] We use the Barchart tool to access to these statistics.

TABLE 1: Federal Funds Rate Changes

Year	Meetings	Mean	SD	Max.	Min.
2017	8	9.4	12.9	25.0	0.0
2018	8	12.5	13.4	25.0	0.0
2019	10	-7.5	12.1	0.0	-25.0
2020	13	-11.5	30.0	0.0	-100.0
2021	8	0.0	0.0	0.0	0.0
2022	8	46.9	28.1	75.0	0.0
2023	8	12.5	13.4	25.0	0.0
2024	4	0.0	0.0	0.0	0.0

Note:–Data from January 2017 to June 2024. SD standard deviation.
Source: Own elaboration, data from FED.

The shock (surprise) s_t is defined as the change in futures (prices) measured on interest rates, 10 minutes before and 20 minutes after each meeting. Given that the CME statistics indicate futures prices, the implicit interest rates are estimated as $i_t = 100 - p_t$, where, p_t is the price of the instrument. Therefore, the shock s_t is defined as $s_t = (100 - p_{t+\Delta_1}) - (100 - p_{t-\Delta_0}) = i_{t+\Delta_1} - i_{t-\Delta_0}$, where Δ_1 and Δ_0 represent the +20 and -10 minutes window, respectively.

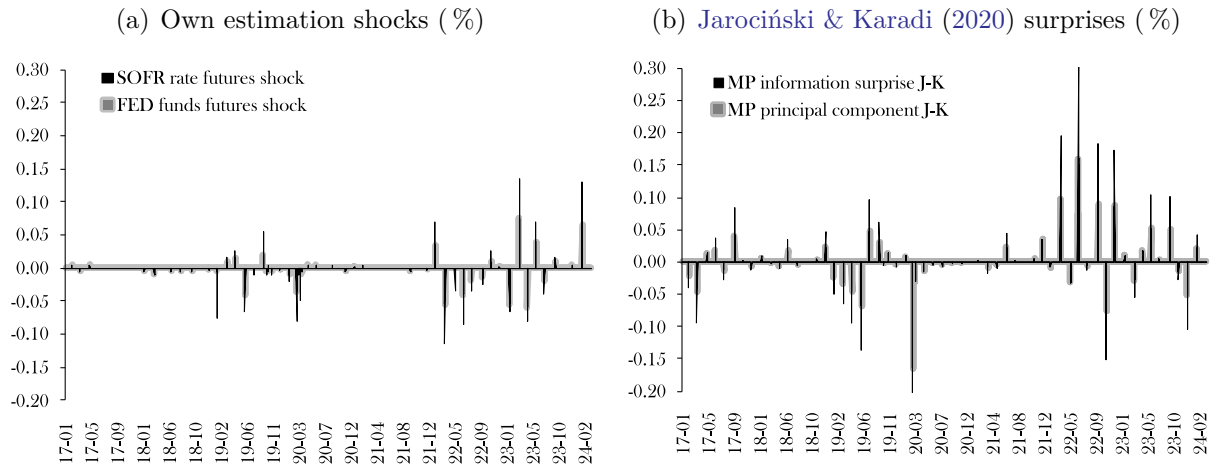
In this document, futures on three different financial instruments are included, as in other studies (see e.g., Nakamura & Steinsson 2018*a*, Jarociński & Karadi 2020, Brennan et al. 2024). The first instrument is the 30-day FED futures from CME. This variable proxies the agents' expectations, given the changes in actual interest rates. The second financial instrument is the 90-day Secured Overnight Financing Rate (SOFR), which is used as proxy of 90-day FED funds rate futures, because Gertler & Karadi (2015) find that the three-month ahead FED funds futures, performs better as an external instrument in a Vector Auto-regression (VAR) analysis, compared to other policy "surprise" measures (Brennan et al. 2024, p.10), but also Jarociński & Karadi (2020, p.6) argue that changes in these futures combine surprises about actual rate setting and near-term forward guidance, and they are insensitive to "timing surprises" because of the three-month period. Finally, we use the S&P500 futures to proxy the change in private activity after a monetary policy announcement.

In order to compare the baseline results, different instruments are included. The basic results are derived from the shocks created and described above. However, we also use a database of monetary surprises provided by Jarociński & Karadi (2020).[24] This database includes information about FED funds' futures for different maturities, futures on Treasury bills and also futures on the S&P500, as we describe in Table A1.

[24]See Marek Jarociński's webpage for further details on Jarociński & Karadi (2020) surprises.

Jarociński & Karadi (2020) evaluate different measures of the shock, considering various maturities of financial instruments. However, they 'condense' these measures into four main categories. The first category is derived from principal component scheme (PCA) of the FED funds futures in four different horizons, which also includes the Eurodollar futures. The second category includes the surprises for the S&P500 futures. The third category reflects the Monetary Policy and Central Bank Information shocks obtained using simple ("Poor Man's") sign restrictions. The final category represents the information shocks obtained with the median rotation that implements the sign restrictions (Jarociński & Karadi 2020), as we describe in Table A1. The comparison between the own-estimated shocks and the Jarociński & Karadi (2020) data is shown in Figure 5.

FIGURE 5: Monetary Policy Shocks(Surprises)



Note:–Vertical axis indicates basis points. See Table A1 for further details on the variables. Estimations with intraday data, and a 30-minute window. Panel (a) shows the 30-day FED funds futures interest rate change, and the 90-day SOFR futures interest rate change. J-K: Jarociński & Karadi (2020). MP: monetary policy.
Source: Own elaboration and Jarociński & Karadi (2020).

Despite the series shown in Figure 5 represent different instruments, they share a certain correlation (in general). As can be seen in Table A2, the own-estimated shocks and the surprises from Jarociński & Karadi (2020) have a low correlation coefficient, but statistically different from zero in almost all cases. Among the surprises provided by Jarociński & Karadi (2020), the coefficient tends to be small as well (highlighted in Brennan et al. 2024), reflecting the nature of each instrument and their sensitivity to FED announcements.

5.2. Descriptive statistics and correlations

When analyzing the investment structure of private banks in Nicaragua, it is evident that investment in foreign financial instruments is the most influential component, which had a

monotonic and upward trend during the period 2018-2021, and its behavior was similar to that of investments in government bonds (see Figure 3). This recent trend is mostly explained by the internal socio-political turmoil that began in 2018. The second most significant investment category is in Central Bank bills, which increased in the 'aftermath' of the COVID-19 pandemic.

TABLE 2: Descriptive Statistics of Main Variables

Variable	Obs.	Mean	Std. Dev.	Max.	Min.
Foreign instruments investment (US$ millions)	2634	339.2	186.9	632.1	39.4
Central bank bills investment (US$ millions)	2427	273.9	192.9	578.6	5.0
Government bonds investment (US$ millions)	2634	255.3	143.5	541.1	21.6
Participation in businesses (US$ millions)	2634	63.1	14.5	94.9	30.8
Total investment (US$ millions)	2634	909.9	493.4	1,693.4	133.3
Foreign instruments investment (growth rate)	2269	57.5	117.7	569.9	- 61.4
Central bank bills investment (growth rate)	1856	339.9	1,267.4	8,002.0	- 96.4
Government bonds investment (growth rate)	2269	70.7	174.0	784.0	- 85.1
Participation in businesses (growth rate)	2269	13.9	13.8	39.5	- 7.9
Effective FED funds rate (percent)	2634	1.8	1.7	5.3	0.0
Treasury bills rate (percent)	2634	1.9	1.7	5.4	- 0.1
S&P500 growth rate (percent)	2634	12.0	14.3	76.1	- 21.1
Economic Policy Uncertainty (index)	2634	144.3	106.1	1,026.4	4.1
Nicaraguan uncertainty index (1^{st} PC)	2634	-	1.3	5.8	- 3.8
Nicaraguan uncertainty index (2^{nd} PC)	2634	-	1.2	5.3	- 4.0
OE shock 30-day FED funds futures (b.p)†	2634	-0.0	0.3	7.5	- 6.0
OE shock 90-day SOFR rate futures (b.p)†	2634	-0.0	0.3	6.5	- 7.0
OE shock S&P500 futures (b.p)†	2634	- 0.3	11.9	87.8	- 486.9
CB monetary policy surprise SR-PM J-K (b.p)$^{\diamond}$	2634	0.0	0.7	16.0	- 16.4
CB information surprise SR-PM J-K (b.p)$^{\diamond}$	2634	0.0	0.1	3.5	- 3.2
CB monetary policy surprise SR-MR J-K (b.p)$^{\diamond}$	2634	0.0	0.6	12.6	- 12.1
CB information surprise SR-MR J-K (b.p)$^{\diamond}$	2634	0.0	0.3	5.4	-4.4
Surprise on S&P500 futures J-K (b.p)$^{\diamond}$	2634	0.0	6.3	77.4	- 135.2

Note:–Daily data from January 2017 to March 2024. † see section 5.1.1 for further details about the shock. $^{\diamond}$ J-K data from Jarociński & Karadi (2020). See Table A1 for further details on the variables. Bills are financial instruments with a shorter maturity period than bonds, commonly up to 1 year. Zero investment values are treated as missing values, because of the indeterminate result when dividing by zero. If no FOMC announcement occurred during the period, a value of zero is imputed. (b.p): basis points. FED: Federal Reserve Bank. SOFR: Secured Overnight Financing Rate. SR-PM: Poor Man's sign restriction. SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020). OE: own estimations. PC: principal component.
Source: Own elaboration.

The aforementioned seems to indicate that both, internal and external shocks are associated with the investment dynamics of private banks. Despite this fact, the investment dynamic in these three main categories shows a relatively high and statistically significant correlation (see Table A2). The growth rate of bank's investment in foreign financial instruments is positively correlated with investments in Government bonds, indicating that entities allocate resources in domestic and external instruments similarly. However, we must consider that

investments in Government bonds are usually carried out in domestic currency. Thus, that positive correlation may not necessarily indicate complementarity in terms of banks' investment decisions.

In Table 2 it can be observed that the descriptive statistics of the own-estimated monetary shocks and those from Jarociński & Karadi (2020) are similar. In general, the mean of the shocks(surprises) is zero, and the dispersion is similar, although the magnitude differs once we compare the Jarociński & Karadi (2020) surprises using their Poor Man's assumption under a sign restriction scheme. Another notable result is that these shocks generally share a significant correlation, as shown in Table A2 of the Annex, since the shocks are identified (only) during specific events (i.e., FOMC announcement), as we describe in Table A1.

5.3. Method

In this document, two different empirical strategies will be used to identify the effect of monetary shocks on bank flows, primarily through Impulse Response Functions (IRF). Since the Sims (1980) contribution, VAR models have been part of the 'toolkit' in empirical macroeconomics. Thus, the baseline strategy is the Structural Vector Auto-regression (SVAR), given that this model remains the most popular empirical approach to impulse-response estimation (Plagborg-Møller & Wolf 2021, p.955). The Local Projection approach is also implemented to provide validity to baseline results.

5.3.1. SVAR model

Following Enders (2008) notation, the SVAR structure is defined as in equation (23),[25]

$$BX_t = \Gamma + \Phi X_{t-1} + e_t \tag{23}$$

where X_t is the vector of variables of interest, primarily including the bank's investment in foreign financial instruments and the monetary shock (surprise) as an exogenous factor, along with additional control variables (exogenous and endogenous) such as crisis indicators, regulations, credit, deposits and other financial indicators that could endogenously affect the flows. B reflects a matrix of contemporaneous relationships between variables. Γ is a vector of constant terms, and Φ is a matrix of the lagged dynamic of the variables. Finally, e_t is a vector of correlated errors, with mean of zero and variance-covariance matrix $\Sigma_e = e_t^T e_t$.

If equation (23) is pre-multiplied by B^{-1}, the contemporaneous dynamic of the variables is expressed as equation in (24), with $A_0 = B^{-1}\Gamma$, $A_1 = B^{-1}\Phi$ and $u_t = B^{-1}e_t$. In this case, u_t represents the vector of error terms, which follows $u_t \sim N(0, I)$, where I

[25] SVAR(1) for simplicity.

represents the variance-covariance matrix, in which disturbances are uncorrelated under certain assumptions.

$$X_t = A_0 + A_1 X_{t-1} + u_t \tag{24}$$

It can be shown that $\Sigma_u = B^{-1} e_t e_t^T (B^{-1})^T$, as in equation (25), because,

$$\Sigma_u = u_t^T u_t = B^{-1} e_t (B^{-1} e_t)^T = B^{-1} e_t e_t^T (B^{-1})^T \tag{25}$$

According to Enders (2008), if we take the expected value of (25):

$$\mathbb{E}(\Sigma_u) = \mathbb{E}(B^{-1} e_t e_t^T (B^{-1})^T) = B^{-1}\,\mathbb{E}(e_t e_t^T)(B^{-1})^T = B^{-1}\Sigma_e (B^{-1})^T \tag{26}$$

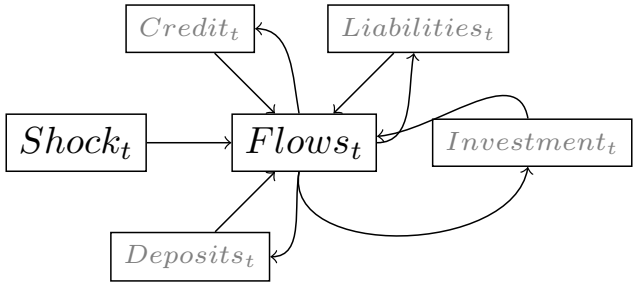
In matrix B we explicitly include restrictions on contemporaneous and lagged dynamics, to avoid direct and lagged relationships between the main variable (i.e., investments of private banks) and the external and exogenous monetary shocks(surprises). This approach is based on the reasonable assumption that internal variables do not affect the external ones, given that Nicaragua is an open but small economy. The approach allows us to "exogenize" the shock s_t, so that, we can get a pure response:

$$\frac{\partial y_{t+h}}{\partial s_t} = 0 \quad \forall \quad h \geq 0 \tag{27}$$

where y_{t+h} is the projection matrix h steps ahead of the endogenous variable of interest y_t, conditioned on the shock s_t that occurs in period t.

We consider the following structure of the system,

FIGURE 6: Exogenous and Endogenous Relationships



Note:–The system includes exogenous indicators to control the 2018 sociopolitical crisis, the Covid-19 pandemic and investment limits implemented in November 2022. We control the contemporaneous and lagged relationship of the variables. Each arrow indicates the 'causality path'.
Source: Own elaboration.

In this system, we manage the endogeneity explicitly constraining the variance-covariance matrix driven by B^{-1}, allowing us to define a 'causality path' from external to internal

variables, but not in the opposite direction.

5.3.2. Local Projections

According to Jordà (2023), if we consider a vector of random and stationary variables, such that $W_t = \{w_{1t}, w_{2t}, w_{jt}, ..., w_{kt}\}'$, for $j = 1, 2, ..., k$. This vector follows a simple VAR(1) structure for simplicity; the result is as follows (demeaned).

$$(W_t - \mu) = A(W_{t-1} - \mu) + \varepsilon_t \tag{28}$$

where ε_t exhibits a normal distribution (for simplicity) with mean and variance as $\varepsilon_t \sim N(0, \Omega)$. Here, Ω is the variance-covariance matrix, which is commonly and serially correlated due to the 'inertia' imposed to the model.

If we iterate equation (28),

$$\begin{aligned}
(W_{t+1} - \mu) &= A(W_t - \mu) + \varepsilon_{t+1} \\
(W_{t+1} - \mu) &= A^2(W_{t-1} - \mu) + A\varepsilon_t + \varepsilon_{t+1} \\
&\vdots \\
(W_{t+h} - \mu) &= A^{h+1}(W_{t-1} - \mu) + A^h\varepsilon_t + ..., + A^0\varepsilon_{t+h}
\end{aligned}$$

where $A^0 = I$, the identity matrix. Analogously to the previous equation, if we take the w_{jt+h} variable from W_t, and we estimate the regression with respect to W_{t-1}:[26]

$$w_{jt+h} = \beta_{jh+1} W_{t-1} + \phi_{jt+h} \tag{29}$$

In equation (29) β_{jh+1} is the vector of estimated coefficients for every variable in W_{t-1}. Given the recursive process implicit in the model, ϕ_{jt+h} can be expressed as a vector as follows $\varphi_{t+h} = B_h\varepsilon_t + ... + B_0\varepsilon_{t+h}$.

According to Jordà (2005) and Jordà (2023), IRFs of the Local Projections approach can be estimated as the expected value of w_{jt+h} conditioned on changes in ε_t evaluated at time t.[27] This is a straightforward method for obtaining IRFs from individual regressions, where β_{jh} indicates the dynamic 'effect' of W_{t-1} on w_{jt+h}.

In equation (29), the right-hand side variable (in W_{t-1}) needs to be exogenous, which provides more flexibility to this method, but it relies on independence assumptions as other

[26] The constant term is excluded, because with centered data (from mean) the Least Squared estimator equals the one with constant and non-zero mean.

[27] $IRF_{ij}(h) = \mathbb{E}[w_{jt+h}|\varepsilon_t = \delta_i; W_{t-1}] - \mathbb{E}[w_{jt+h}|\varepsilon_t = 0; W_{t-1}]$.

methods, such as Instrumental Variables. Given that β_{jh} reflects a direct estimate of the impulse-response, standard errors do not require the delta method or simulation-based methods, though they require adjusting for the serial correlation in the residuals or lag augmentation (Jordà 2023, p.610).

Jordà (2005, p.162) argues that the advantages of local projections are numerous: 1) the method can be estimated using simple least squares; 2) the method provides appropriate inference (individual or joint) that does not require asymptotic delta-method approximations or numerical techniques for calculation; 3) this method is robust to misspecification of the data-generating process, and 4) it can easily accommodate experimentation with highly nonlinear specifications that are often impractical or infeasible in a multivariate context (e.g., VAR models). However, Plagborg-Møller & Wolf (2021, p.956) find that linear Local Projections and VARs in fact estimate the exact same impulse responses in population, because these are not conceptually different methods; instead, they are simply two particular linear projection techniques that share the same estimand but differ in their finite-sample properties (ibid).

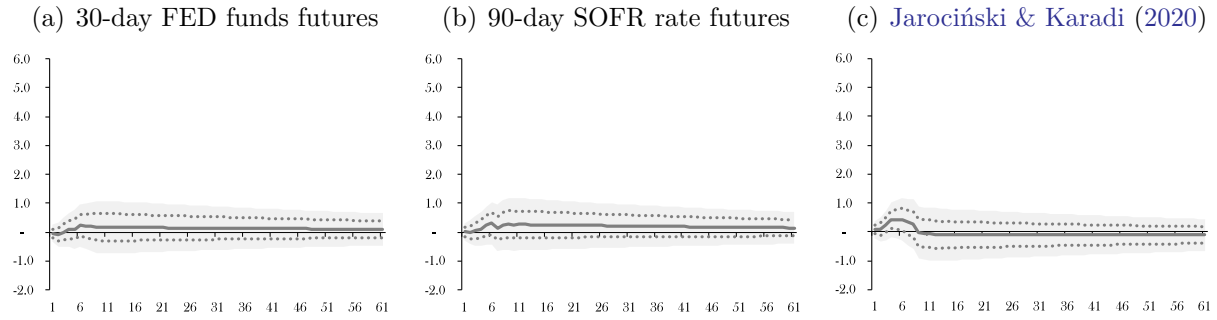
6. Results

The results of the SVAR model are shown in Figure 7. From panel (a) to panel (c), results use the own-estimated monetary policy shocks as the main exogenous variable. The SVAR models include up to 18 lags (see Table A3) and multiple constraints allowing us to limit the influence of internal variables to the external ones. These constraints are included for contemporaneous and lagged dynamics of variables. It is notable to mention that in the baseline results, three categorical variables are included as exogenous controls: one for the socio-political turmoil after April 2018, another for the COVID-19 pandemic and the last one as an indicator of external investment limits defined since November 2022 by the regulatory authority.[28]

Baseline results indicate that a 1 standard deviation shock to external monetary conditions, slightly increases foreign-instrument investments of the Nicaraguan private banks, however, the evidence is not conclusive enough, as the confidence intervals suggest that these responses are not significantly different from zero, when we consider a ± 1.96 standard error interval from the point estimate (i.e., 95 percent confidence level), and even these responses are not significant under a 68 percent confidence level. This behavior remains consistent even when considering the Jarociński & Karadi (2020) surprises for the same FOMC announcements.

[28] See CD-SIBOIF-1345-1-NOV17-2022 resolution.

FIGURE 7: Response of Financial Flows to a Monetary Shock (SVAR)



Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details on the variables. Shock simulated equivalent to an increase of 1 basis point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. In Jarociński & Karadi (2020) the Poor Man's sign restriction strategy on Central Bank information shock is considered.
Source: Own elaboration.

We observe a slight increase in financial flows from private banks following a monetary shock, however the magnitude of this response is small. The Jarociński & Karadi (2020) shock considered is the first principal component of the FED funds interest rate futures (and Euro-Dollar futures) for different maturities (ranging from 1 month to 1 year), but results remain if we consider other shocks measures, as shown in Figure A6 of the Annex. Additionally, the results also hold when analyzing the data at the bank level.

This preliminary evidence is unexpected given the trade and financial links between Nicaragua and the U.S. economy, which could suggest that shocks to the U.S. economy should impact on the Nicaraguan economy, and therefore, on the domestic banking system. If we observe the trade dynamics between the countries, more than 35 percent (on average) of merchandise exports from Nicaragua go to the U.S., and about 24 percent of the total Nicaraguan merchandise imports come from the U.S. (Figure 9). On the other hand, more than 80 percent of total remittances to Nicaragua are originated in the U.S. economy, which has strengthened the bank interconnection between countries in recent years, given that the bank channel is the most influential for remittances inflows (see: Torres & Aráuz 2023).

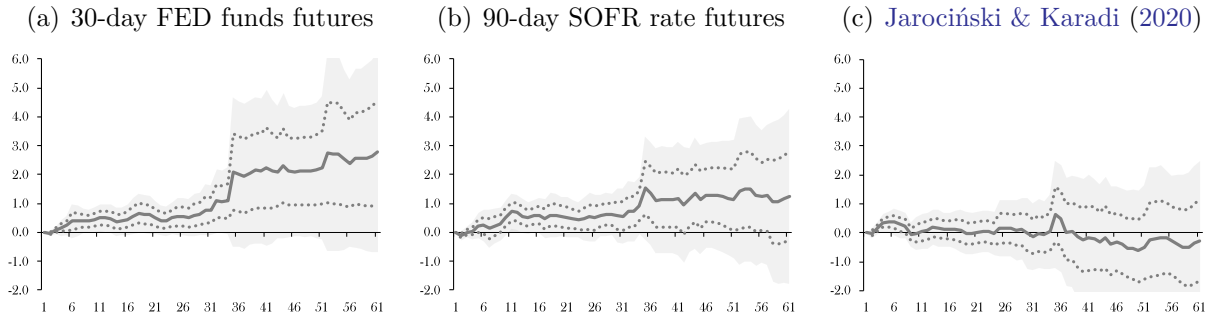
Despite the point mentioned above, the evidence found suggests that monetary shocks in the U.S. economy do not play a significant role in the investment decisions of Nicaraguan banks (i.e., flows). However, this finding is notable due to the importance of the U.S. monetary policy on the Nicaraguan monetary policy. As discussed in section 3.1, in Nicaragua the Central Bank defines the relevant interest rates (e.g., TRM) considering the external ones (primarily FED funds rates), and the internal monetary conditions as the Central Bank mentions in several press releases.

With these elements in mind, benchmark results suggest that after monetary shocks in the U.S. economy, the Central Bank in Nicaragua should act cautiously, because increases of the U.S. monetary policy rate are not directly related to financial outflows from Nicaraguan private banks. This is notable if the internal monetary policy stance is based on the external monetary policy, and particularly when the Central Bank aims at stabilizing internal monetary conditions.

The results of the Local Projections approach are shown in Figure 8. These results are similar to those discussed previously (Figure 7). The IRFs indicate that an increase of 1 basis point in any monetary shock (surprise) is associated with an increase in foreign instruments investment (i.e., flows) from Nicaraguan private banks. However, the results are not statistically different from zero as well as the SVAR evidence.

We include the three main shocks, and the most notable response is observed after the shock to the 30-day FED funds futures. In this scenario, the response of investment is positive and statistically different from zero in the very short term (i.e., less than 30 days). This relationship indicates a positive 2.5 percent response in private banks flows after the shock. While some results are statistically significant when we use the surprises provided by Jarociński & Karadi (2020), the magnitude is negligible as shown in panel (c) of Figure A8 in the Annex, because the shock magnitude is the same in all cases and the response is standardized. However, we also show the results after 1 standard deviation shock.

FIGURE 8: Response of Financial Flows to a Monetary Shock (Local Projections)



Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details on the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes two indicative variables for exogenous shocks: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. In Jarociński & Karadi (2020) the Poor Man's sign restriction strategy on Central Bank information shock is considered.
Source: Own elaboration.

As shown in Figure A6, in Figure A8 results indicate that the impact of external monetary shocks on financial flows from Nicaraguan private banks is not significantly different from zero, supporting the previous discussion and suggests that external monetary shocks seem to have no real effects on the financial dynamics in Nicaragua. However, the dynamics observed

when estimating Local Projections are primarily driven by the second-largest bank (after the bank-by-bank estimations) in terms of assets in Nicaragua (Lafise Bank),[29] because this bank is the most internationally integrated (see the results in Figure A10).

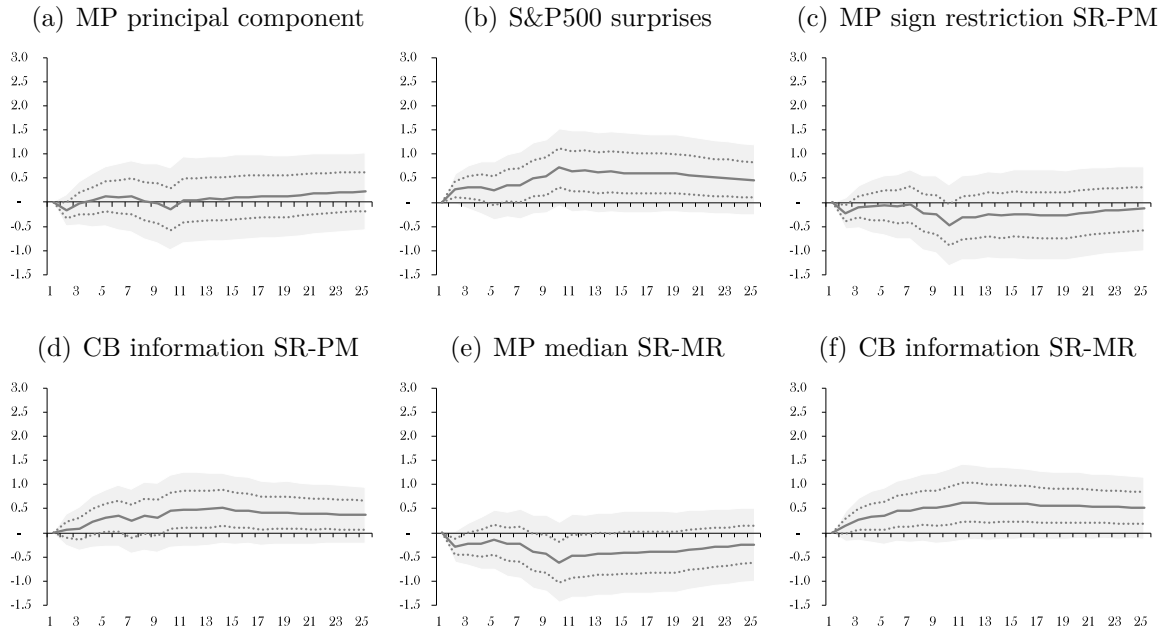
6.1. Sensitivity analysis

The previous results hold once we analyze a longer time period, because for sensitivity analysis, we estimate the same model using Local Projections with monthly data ranging from January 2002 to April 2024. As shown in Figure 9, we do not find a response that is statistically different from zero after a random monetary shock of 1 standard deviation in six of the monthly monetary shocks proposed by Jarociński & Karadi (2020). Overall, the results are mixed and statistically equal to zero.

The results described previously could be explained by the relatively low financial interconnection and depth of the Nicaraguan financial system, especially with global stock and bond markets, and in particular, with the U.S. financial system, because the trade interconnection between the two countries is high (see Figure A14), as well as the remittance flows (see e.g., Torres & Aráuz 2023).

[29] Latin American Financial Services.

FIGURE 9: Influence of Monetary Shocks on Investment Ratio (monthly)

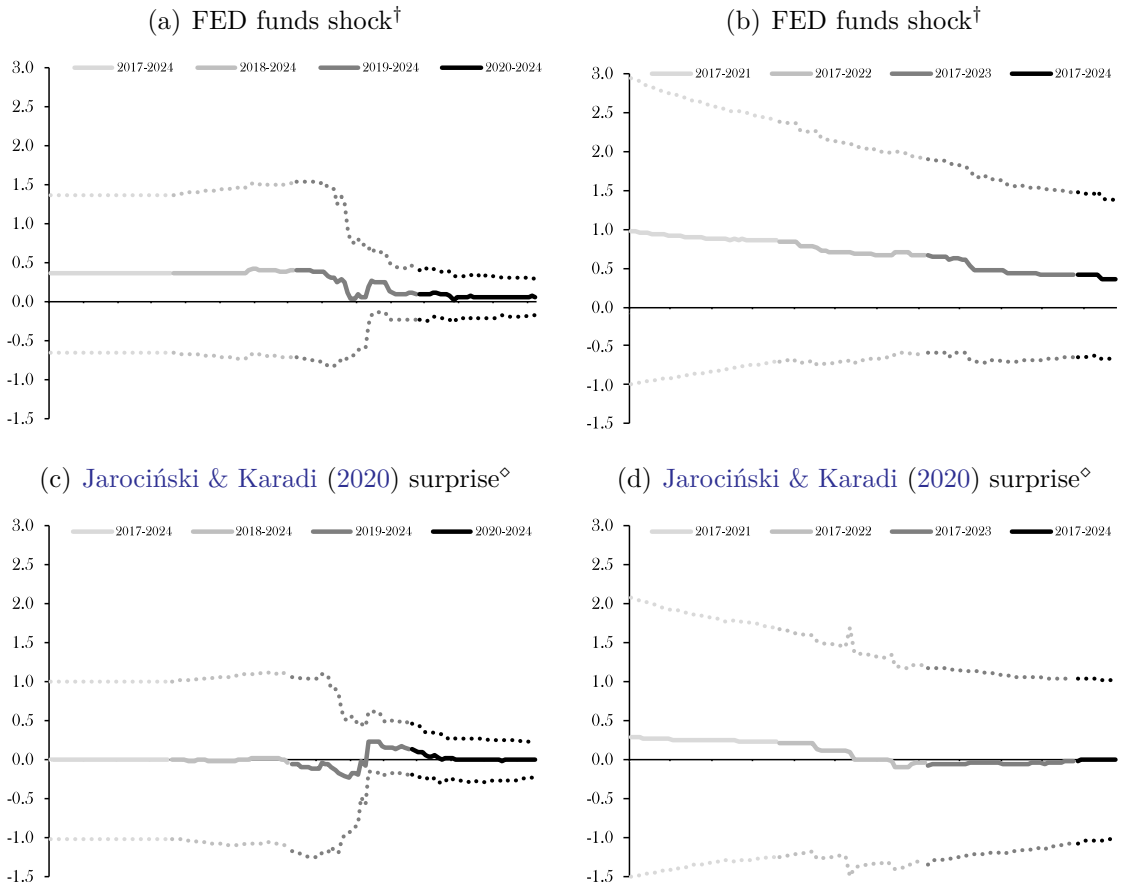


Note:–Vertical axis in percentage points (p.p). Horizontal axis in months. The shaded area indicates a 95 percent confidence interval (±1.96 standard error band), and the dotted lines reflect a 68 percent confidence interval. See Table A1 for further details on the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other one for the COVID-19 pandemic. MP: monetary policy. CB: central bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

As an alternative sensitivity analysis, we estimate the same initial model using the different instruments in different sub-periods. The model is estimated either including (panel (b) of Figure (10)) or excluding (panel (a) of Figure (10)) 10 days of data (35 estimations per year). Once every IRF is estimated, we compute the simple average response during 60 days, and the average of every confidence band.

The results of the previous sensitivity exercise are plotted in Figure 10, in which the key aspect to highlight is that almost every point estimate is positive, however, all the confidence intervals estimated include zero (with ±1,96 standard error bands). The same result is obtained when we use one of the Jarociński & Karadi (2020) surprises (on interest rates derivatives), finding a similar behavior of individual estimators during every sub-period. Thus, the 'extreme bounds analysis' *à la* Leamer & Leonard (1983) conducted, reinforces the initial results we described previously.

FIGURE 10: Monetary Shocks and Bank Flows in Sub-periods (SVAR, 10-day span)



Note:–Average estimation of individual IRFs in each sub-period with a 10-day step. Vertical axis in percentage points (p.p). The dotted lines indicate a 95 percent confidence interval (±1.96 standard error). † shock estimated with futures of the 30-day FED funds rate. ◇ The Jarociński & Karadi (2020) surprise is the first principal component of the policy indicator, as we describe in Table A1. Each model is estimated with up to 10 lags. The shock simulated is equivalent to an increase of 1 standard deviation of the shock. The system includes two indicative variables for exogenous indicators: for the 2018 socio-political turmoil and the COVID-19 pandemic.
Source: Own elaboration.

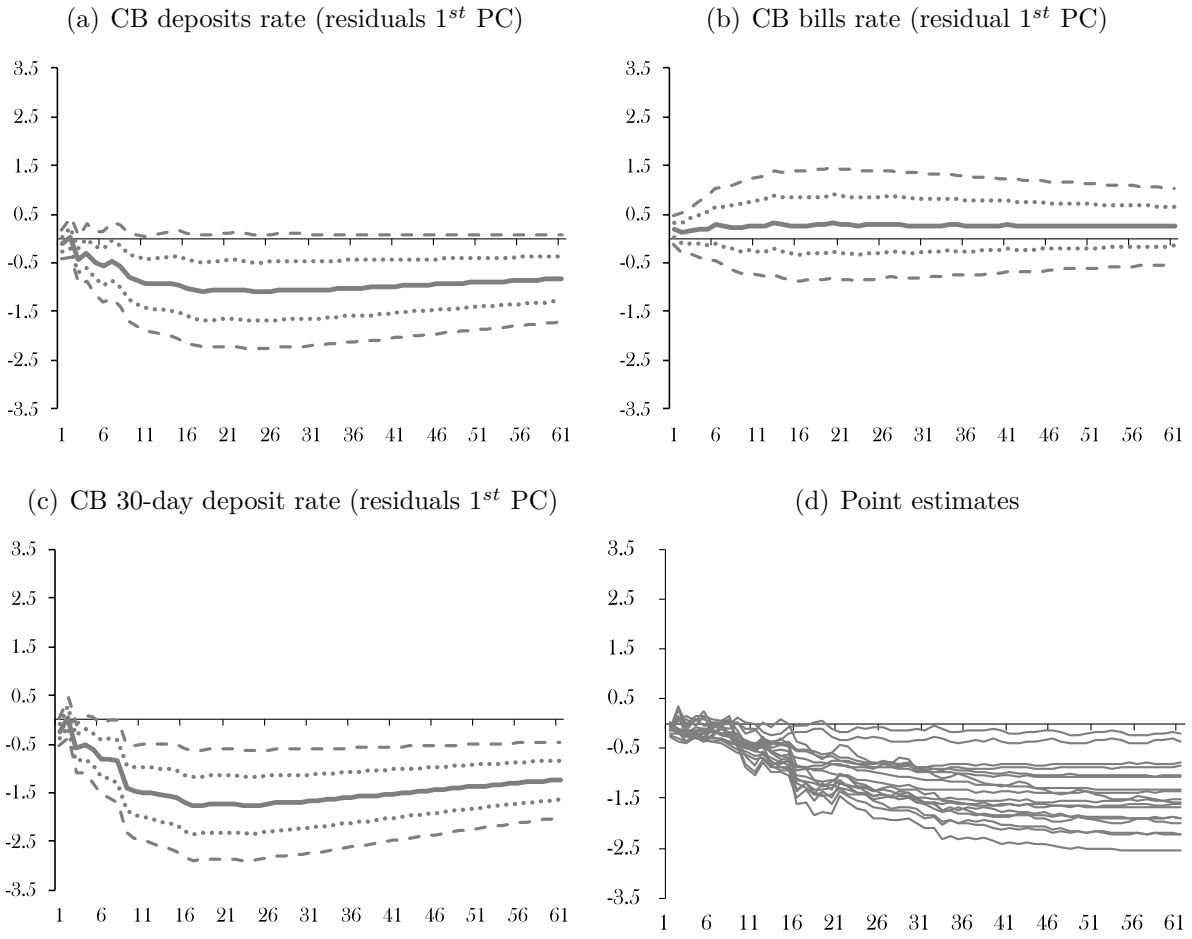
Given the trade-off between investment and lending discussed in the model proposed (see Section 4), we use the exogenous shocks proposed in Jarociński & Karadi (2020) and our own estimated surprises, to assess the potential reaction of internal credit denominated in foreign currency (i.e., U.S. dollars), after an external monetary shock. Results are shown in Figure A11 and Figure A12 of the Annex, in which no significant results are found, aligning with previous findings and studies such as Degasperi et al. (2020), who found that developed countries seem to have a lesser exposure to world monetary fluctuations because of their low external banking interconnection, but also given the capital controls usually implemented.

However, the previous result contrasts with Avdjiev & Hale (2019), who evidenced that U.S. monetary policy shocks affect bank lending, particularly in 'internationally active banks',

suggesting that the more integrated the banks are, the more they can respond to external monetary shocks, which is consistent with Banerjee et al. (2021) results for India.

Given that external monetary shocks do not explain the volatility in bank flows and credit, we estimate the relationship between flows and internal interest rates (foreign currency operations). We consider the Central Bank's deposits and bills rates for different maturities (less than 1 year), using the PCA strategy to capture the combined variability of those variables.

FIGURE 11: CB Instruments Rates and Bank Flows (SVAR)



Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 95 percent confidence interval (±1.96 standard error band), and the dotted lines represent a 68 percent confidence interval. See Table A1 for further details on the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes endogenous variables (e.g., deposits, credits, liabilities domestic investment) and three indicative variables for exogenous indicators: one for the 2018 socio-political turmoil, one for the COVID-19 pandemic and a dummy variable for the 2022 external investment limits. See more details in Figure A13. CB: Central Bank. PC: Principal Component.
Source: Own elaboration.

We orthogonalize the interest rate variable with respect to the foreign investment variable,

using the residuals of the regression between these two variables (controlling for the FED funds rate),[30] as well as employing the Golub & Van Loan (2013) method. The results indicate that an increase of 1 standard deviation of the Central Bank deposit rate (principal component), reduces the propensity of banks to invest abroad by 2 to 3 percentage points (p.p). The results are statistically different from zero after approximately 30 days. However, the Central Bank bills interest rates do not cause significant movements of flows. Although the point estimate is negative (as in the previous case), the reduction observed in banks' investment decisions is statistically zero. This suggests that Central Bank deposit rates are more effective for deterring outflows from private banks.

The longer term the rates have, the greater their influence is on private banks' investment decisions. As can be seen in Figure A13, the 30-day deposit rate drives changes in bank investments. This result is consistent with the fact that the bank investments are oriented toward longer maturities, and in that case, the Central Bank deposit rate serves as a substitute for external rates of foreign instruments. The same result is observed when we estimate the effect of this rate on bank credit (see Figure A15). These results also align with the theoretical approach proposed in section 4.

Based on the discussions above, we can infer that the Central Bank should respond cautiously to external monetary shocks, if the objective is deterring financial outflows from private banks, because these banks do not react to those shocks. For instance, if the Central Bank increases its policy rate (and other indexed rates) after an external monetary shock, this may cause internal financial inefficiencies, because higher Central Bank rates have a direct pass-through towards lending rates (see: Torres 2023), increasing the cost of borrowing to borrowers, if private banks access to the liquidity provided by the Central Bank through its active financial operations (e.g., through repos). If private banks do not get funding through these mechanisms provided by the Central Bank, the pass-through of rates can be smaller.

7. Concluding remarks

For a small, developing and open economies, the equilibrium in terms of financial flows from private agents (e.g., banks) is fundamental when Central Banks aim to safeguard the monetary and exchange markets soundness. Given this context, the financial flows issue has been part of the economic research agenda during decades, with a specific focus on emerging and developed countries, but to a lesser extent in developing economies. Thus, this document provides insights on how a developing economy navigates external forces that can affect internal monetary conditions, offering also theoretical fundamentals.

[30] In order to control for the variation of the internal Central Bank rates due to external financial conditions.

This document examines the effects of external monetary policy shocks on private banks outflows in Nicaragua. The focus is on the U.S. economy, given the trade and financial links between the two countries. To this end, we have utilized a unique and not publicly available dataset that includes daily financial balance-sheet indicators of Nicaraguan private banks, as well as external monetary shocks derived in this study from intraday financial-futures data. In addition, we have considered the shocks from Jarociński & Karadi (2020) which has been used to validate our benchmark results.

The main results of this study indicate that external and exogenous monetary shocks have no direct impact on banking flows from Nicaraguan private banks, and these results are robust across different empirical strategies and shocks(surprises) analyzed. The finding could be explained by the fact that Nicaragua has a strong economic relationship with the U.S. economy in terms of trade and remittances, but the Nicaraguan banking system lacks depth and its interconnection with U.S. banks is primarily to payment purposes, instead of channeling resources to stock and bond markets, in which the transmission of monetary policy shocks is almost immediate.

Despite the results, we find that the behavior of private banks is primarily driven by Central Bank interest rates. These rates create incentives for banks to invest in local instruments denominated in foreign currency, aiming to compensate for the risk of foreign currency outflows that can impact the internal monetary conditions. Thus, we conclude that the trade-off between investment and lending applies to Nicaraguan banks when the Central Bank adjusts interest rates. The findings suggest that the Central Bank deposit rates influence banks' investment decisions abroad, due to these rates serve as substitutes for external rates, given that the Central Bank allows private banks to invest in local instruments denominated in foreign currency. Despite the domestic risk premium, banks respond to internal monetary conditions.

The general results suggest that the Central Bank should not respond to external monetary shocks, if the objective is deterring private banks financial outflows, as private banks do not react to these shocks. If the Central Bank increases its monetary policy rate (and other indexed rates) after an external monetary shock, this may cause internal financial inefficiencies, due to the rise of these monetary rates has a pass-through to banks' active rates, increasing the cost of borrowing to borrowers, if private banks get funding from the Central Bank (i.e., through repos) and this channel is strengthened.

This study has limitations. Despite the high frequency of the database, the time period covered is relatively short. This situation affects the precision of the estimations and implies that the results are valid only in the most recent period. However, this issue can be addressed in future studies with more extended and granular statistics. Moreover, analyzing

this phenomenon using cross-country or panel approaches can provide valuable insights for extrapolating the findings to other developing countries, where this type of literature is extremely limited.

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A. Appendix

A.1. The general context

Taking equation (1), and replacing (3), (4) and (7), we get:

$$D_t+\kappa\omega L_t+\kappa^*\omega^* L_t^* E_t+\phi I_t+(1-\phi)L_t+\phi^* I_t^* E_t+(1-\phi^*)L_t^* E_t = L_t+I_t+\rho D_t+\rho^* D_t^* E_t \quad \text{(A.1)}$$

After operating the expression:

$$D_t-\rho D_t-\rho^* D_t^* E_t = L_t+I_t-\kappa\omega L_t-\kappa^*\omega^* L_t^* E_t-\phi I_t-(1-\phi)L_t-\phi^* I_t^* E_t-(1-\phi^*)L_t^* E_t \quad \text{(A.2)}$$

Simplifying,

$$(1-\rho)D_t-\rho^* D_t^* E_t = (1-\phi)I_t-(\kappa\omega-\phi)L_t-[\kappa^*\omega^*+(1-\phi^*)]L_t^* E_t-\phi^* I_t^* E_t \quad \text{(A.3)}$$

Replacing the endogenous variables L_t and I_t:

$$(1-\rho)D_t-\rho^* D_t^* E_t = (1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right]-(\kappa\omega-\phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right]-[\kappa^*\omega^*+(1-\phi^*)]L_t^* E_t-\phi^* I_t^* E_t \quad \text{(A.4)}$$

Replacing $D_t^* E_t$ from equation (2) and simplifying,

$$\left[\frac{\delta^*(1-\rho)-\rho^*(1-\delta)}{\delta^*}\right]D_t = (1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right]-(\kappa\omega-\phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right]-[1-\phi^*+\kappa^*\omega^*]L_t^* E_t-\phi^* I_t^* E_t \quad \text{(A.5)}$$

Thus, the solution for D_t is:

$$D_t = \left(\frac{\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right]-(\kappa\omega-\phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right]-[1-\phi^*+\kappa^*\omega^*]L_t^* E_t-\phi^* I_t^* E_t\right] \quad \text{(A.6)}$$

The maximization problem for the bank's control variables is as follows:

$$\max_{I_t, I_t^*, L_t, L_t^*}(\Pi_t) = (1-\epsilon)(r_L-\tau_{r_L})L_t+(1-\epsilon^*)(r_L^*-\tau_{r_L^*})L_t^* E_t+(r_I-\tau_{r_I})I_t+(r_I^*-\tau_{r_I^*})I_t^* E_t-r_D D_t-r_P P_t \quad \text{(A.7)}$$

Given the solution for D_t and including P_t, the profit function can be operated as:

$$\max_{I_t, I_t^*, L_t, L_t^*}(\Pi_t) = (1-\epsilon)(r_L - \tau_{r_L})L_t + (1-\epsilon^*)(r_L^* - \tau_{r_L^*})L_t^* E_t + (r_I - \tau_{r_I})I_t + (r_I^* - \tau_{r_I^*})I_t^* E_t - r_D D_t$$
$$- r_P\left[\phi I_t + (1-\phi)L_t + \phi^* I_t^* E_t + (1-\phi^*)L_t^* E_t\right] \quad \text{(A.8)}$$

Rearranging terms,

$$\max_{I_t^*, L_t^*}(\Pi_t) = \left[(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)\right] L_t + \left[(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*)\right] L_t^* E_t$$
$$+ \left[(r_I - \tau_{r_I}) - r_P\phi\right] I_t + \left[(r_I^* - \tau_{r_I^*}) - r_P\phi^*\right] I_t^* E_t - r_D D_t \quad \text{(A.9)}$$

Replacing D_t, L_t and I_t:

$$\max_{I_t^*, L_t^*}(\Pi_t) = \left[(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)\right]\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] + \left[(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*)\right] L_t^* E_t$$
$$+ \left[(r_I - \tau_{r_I}) - r_P\phi\right]\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right] + \left[(r_I^* - \tau_{r_I^*}) - r_P\phi^*\right] I_t^* E_t$$
$$- r_D\left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right] - (\kappa\omega - \phi)\left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] - \left[1 - \phi^* + \kappa^*\omega^*\right] L_t^* E_t - \phi^* I_t^* E_t\right] \quad \text{(A.10)}$$

Taking the FOC with respect to I_t^*, the optimum needs the condition:

$$\frac{\partial \Pi_t}{\partial I_t^*} = \frac{\partial \Pi_t}{\partial r_I^*}\frac{\partial r_I^*}{\partial I_t^*} = 0$$

Thus, operating equation (A.10):

$$\frac{\partial \Pi_t}{\partial I_t^*} \to \left[(r_I - \tau_{r_I}) - r_P\phi\right]\left[\frac{\gamma^* E_t}{1-\gamma}\right] + \left[\frac{\gamma^* I_t^* E_t}{1-\gamma}\right]\frac{\partial r_I}{\partial I_t^*} + \left[(r_I^* - \tau_{r_I^*}) - r_P\phi^*\right] E_t + I_t^* E_t \frac{\partial r_I^*}{\partial I_t^*}$$
$$- r_D\left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^* E_t}{1-\gamma}\right] - \phi^* E_t\right] = 0 \quad \text{(A.11)}$$

Defining $\frac{I_t^* \partial r_I}{r_I \partial I_t^*} = \xi_r^{I^*}$ as the inverse elasticity of investment in (domestic) assets denominated in foreign currency to changes in domestic assets (in local currency) interest rate; and $\frac{I_t^* \partial r_I^*}{r_I^* \partial I_t^*} = \xi_{r^*}^{I^*}$ as the inverse elasticity of investment in domestic assets denominated in foreign currency, relative to changes of the respective interest rate, then, equation (A.11) can be simplified to:

$$\frac{\partial \Pi_t}{\partial I_t^*} \rightarrow [(r_I - \tau_{r_I}) - r_P\phi] \left[\frac{\gamma^* E_t}{1-\gamma}\right] + \left[\frac{\gamma^* E_t}{1-\gamma}\right] r_I \xi_r^{I^*} + [(r_I^* - \tau_{r_I^*}) - r_P\phi^*]E_t + E_t r_I^* \xi_{r^*}^{I^*} - r_D \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) \left[(1-\phi)\left[\frac{\gamma^* E_t}{1-\gamma}\right] - \phi^* E_t\right] = 0 \quad \text{(A.12)}$$

$$\frac{\partial \Pi_t}{\partial I_t^*} \rightarrow r_I \left[\frac{\gamma^* E_t}{1-\gamma}\right](1+\xi_r^{I^*}) + r_I^*(1+\xi_{r^*}^{I^*})E_t = \left(\frac{r_D\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) \left[(1-\phi)\left[\frac{\gamma^* E_t}{1-\gamma}\right] - \phi^* E_t\right] + (\tau_{r_I} + r_P\phi)\left[\frac{\gamma^* E_t}{1-\gamma}\right] + (\tau_{r_I^*} + r_P\phi^*)E_t \quad \text{(A.13)}$$

Dividing by E_t, and multiplying by $\left[\frac{1-\gamma}{\gamma^*}\right]$,

$$\frac{\partial \Pi_t}{\partial I_t^*} \rightarrow r_I(1+\xi_r^{I^*}) + r_I^*(1+\xi_{r^*}^{I^*})\left[\frac{1-\gamma}{\gamma^*}\right] = \left(\frac{r_D\delta^*(1-\phi-\phi^*)}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) + (\tau_{r_I} + r_P\phi) + (\tau_{r_I^*} + r_P\phi^*)\left[\frac{1-\gamma}{\gamma^*}\right] \quad \text{(A.14)}$$

The solution for r_I can be derived.

$$\frac{\partial \Pi_t}{\partial I_t^*} \rightarrow r_I = (1+\xi_r^{I^*})^{-1}\left\{\left(\frac{r_D\delta^*(1-\phi-\phi^*)}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) + (\tau_{r_I} + r_P\phi)\right\} + (1+\xi_r^{I^*})^{-1}\left\{(\tau_{r_I^*} + r_P\phi^*)\left[\frac{1-\gamma}{\gamma^*}\right] - r_I^*(1+\xi_{r^*}^{I^*})\left[\frac{1-\gamma}{\gamma^*}\right]\right\} \quad \text{(A.15)}$$

Analogously, the solution for r_I^* is:

$$\frac{\partial \Pi_t}{\partial I_t^*} \rightarrow r_I^* = (1+\xi_{r^*}^{I^*})^{-1}\left\{\left(\frac{r_D\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{\gamma^*}{1-\gamma}\right] - \phi^*\right]\right\} + (1+\xi_{r^*}^{I^*})^{-1}\left\{(\tau_{r_I} + r_P\phi)\left[\frac{\gamma^*}{1-\gamma}\right] + (\tau_{r_I^*} + r_P\phi^*) - r_I(1+\xi_r^{I^*})\left[\frac{\gamma^*}{1-\gamma}\right]\right\} \quad \text{(A.16)}$$

A.2. The foreign-to-domestic assets link

Taking equations (13) and (14),

$$I_t = \left[\frac{\gamma^* I_t^* E_t + (1-\gamma-\gamma^*) I_t^{*F} E_t}{1-\gamma}\right] \tag{A.17}$$

$$P_t = \phi I_t + (1-\phi) L_t + \phi^* I_t^* E_t + \phi^{*F} I_t^{*F} E_t + (1-\phi^*-\phi^{*F}) L_t^* E_t \tag{A.18}$$

Plugging the previous expression into the balance-sheet identity,

$$D_t + \kappa\omega L_t + \kappa^*\omega^* L_t^* E_t + \phi I_t + (1-\phi) L_t + \phi^* I_t^* E_t + \phi^{*F} I_t^* E_t + (1-\phi^*-\phi^{*F}) L_t^* E_t = L_t + I_t + \rho D_t + \rho^* D_t^* E_t \tag{A.19}$$

Operating and factorizing:

$$D_t - \rho D_t - \rho^* D_t^* E_t = L_t + I_t - \kappa\omega L_t - \kappa^*\omega^* L_t^* E_t - \phi I_t - (1-\phi) L_t - \phi^* I_t^* E_t - \phi^{*F} I_t^* E_t - (1-\phi^*-\phi^{*F}) L_t^* E_t \tag{A.20}$$

Substituting $D_t^* E_t$ and factorizing,

$$D_t = \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) \left[L_t(\phi - \kappa\omega) + I_t(1-\phi) - (1-\phi^* + \kappa^*\omega^* - \phi^{*F}) L_t^* E_t - \phi^* I_t^* E_t - \phi^{*F} I_t^{*F} E_t\right] \tag{A.21}$$

The new profit function that includes I_t^{*F} is defined as:

$$\begin{aligned} \max_{I_t, I_t^*, L_t, L_t^*} (\Pi_t) = {} & [(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)] L_t + \\ & [(1-\epsilon^*)[(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*-\phi^{*F})] L_t^* E_t + [r_I - \tau_{r_I} - r_P\phi] I_t + (r_I^* - \tau_{r_I^*} - r_P\phi^*) I_t^* E_t \\ & [(r_I^{*F} - \tau_{r_I^{*F}}) - r_P\phi^{*F}] I_t^{*F} E_t - r_D D_t \end{aligned} \tag{A.22}$$

When substituting L_t and I_t, the profit function depends on L_t^*, I_t^* and I_t^{*F}, as follows:

$$\begin{aligned} \max_{I_t^*, I_t^{*F}, L_t^*} (\Pi_t) = {} & [(1-\epsilon)(r_L - \tau_{r_L}) - r_P(1-\phi)] \left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right] + [(1-\epsilon^*)(r_L^* - \tau_{r_L^*}) - r_P(1-\phi^*-\phi^{*F})] L_t^* E_t \\ & + [(r_I - \tau_{r_I}) - r_P\phi] \left[\frac{\gamma^* I_t^* E_t + (1-\gamma-\gamma^*) I_t^{*F} E_t}{1-\gamma}\right] + [(r_I^* - \tau_{r_I^*}) - r_P\phi^*] I_t^* E_t + [(r_I^{*F} - \tau_{r_I^{*F}}) - r_P\phi^{*F}] I_t^{*F} E_t \\ & - r_D \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) \left\{(1-\phi) \left[\frac{\gamma^* I_t^* E_t + (1-\gamma-\gamma^*) I_t^{*F} E_t}{1-\gamma}\right] - (\kappa\omega - \phi) \left[\frac{\lambda^* L_t^* E_t}{1-\lambda}\right]\right\} \\ & + r_D \left(\frac{\delta^*}{\delta^*(1-\rho) - \rho^*(1-\delta)}\right) \{(1-\phi^* + \kappa^*\omega^* - \phi^{*F}) L_t^* E_t + \phi^* I_t^* E_t + \phi^{*F} I_t^{*F} E_t\} \end{aligned} \tag{A.23}$$

Considering that in a small economy $\frac{\partial r_I}{\partial I_t^*} \neq 0$ and $\frac{\partial r_I^*}{\partial r_I} \to 0$:

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \to [(r_I - \tau_{r_I}) - r_P\phi]\left[\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right] + [r_I^{*F} - \tau_{r^{*F}} - r_P\phi^{*F}]E_t + I_t^{*F}E_t\frac{\partial r_I^{*F}}{\partial I_t^{*F}} - r_D\left(\frac{\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right] - \phi^{*F}E_t\right] = 0 \quad \text{(A.24)}$$

Operating the previous expression:

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \to [r_I^{*F} - \tau_{r^{*F}} - r_P\phi^{*F}]E_t + I_t^{*F}E_t\frac{\partial r_I^{*F}}{\partial I_t^{*F}} = r_D\left(\frac{\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[(1-\phi)\left[\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right] - \phi^{*F}E_t\right] + [r_P\phi - (r_I - \tau_{r_I})]\left[\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right] \quad \text{(A.25)}$$

Defining the elasticities for r_I^{*F} and I_t^{*F}:

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \to [r_I^{*F} - \tau_{r^{*F}} - r_P\phi^{*F}]E_t + r_I^{*F}\xi_{r^{*F}}^{I^{*F}}E_t = r_D\left(\frac{\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[(1-\phi)\left(\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right) - \phi^{*F}E_t\right] + [r_P\phi - (r_I - \tau_{r_I})]\left[\frac{(1-\gamma-\gamma^*)E_t}{1-\gamma}\right] \quad \text{(A.26)}$$

Operating and simplifying:

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \to r_I^{*F} = (1+\xi_{r^{*F}}^{I^{*F}})^{-1}\left\{\left(\frac{r_D\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[\frac{(1-\phi)(1-\gamma-\gamma^*)}{(1-\gamma)} - \phi^{*F}\right]\right\} + (1+\xi_{r^{*F}}^{I^{*F}})^{-1}\left\{[r_P\phi - r_I + \tau_{r_I}]\frac{(1-\gamma-\gamma^*)}{(1-\gamma)} + r_P\phi^{*F} + \tau_{r^{*F}}\right\} \quad \text{(A.27)}$$

Then, r_I in terms of r_I^{*F} is defined as:

$$\frac{\partial \Pi_t}{\partial I_t^{*F}} \to r_I = \left(\frac{r_D\delta^*}{\delta^*(1-\rho)-\rho^*(1-\delta)}\right)\left[(1-\phi) - \frac{\phi^{*F}(1-\gamma)}{(1-\gamma-\gamma^*)}\right] + r_P\phi + \tau_{r_I} + \left(\frac{1-\gamma}{(1-\gamma-\gamma^*)}\right)\left[r_P\phi^{*F} + \tau_{r^{*F}} - r_I^{*F}(1+\xi_{r^{*F}}^{I^{*F}})\right] \quad \text{(A.28)}$$

B. Annex

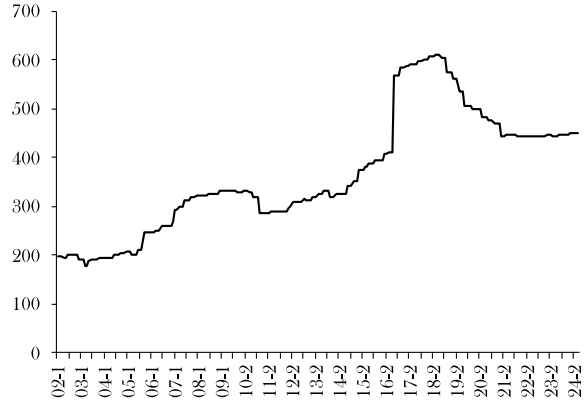
TABLE A1: Description of Variables

Variable	Description	Data source
30-day FED funds	30-day futures of the Federal Reserve Funds interest rate.	CME/Barchart
90-day SOFR rate	90-day futures of the SOFR interest rate.	CME/Barchart
S&P500 index	Futures of the S&P500 index	CME/Barchart
30-day FED funds shock	Difference before and after FED announcements ($t-10$ and $t+20$ minute window) of the 30-day FED funds futures.	Own elaboration, CME
90-day SOFR rate shock	Difference before and after FED announcements ($t-10$ and $t+20$ minute window) of the 90-day SOFR rate futures.	Own elaboration, CME
S&P500 index shock	Difference before and after FED announcements ($t-10$ and $t+20$ minute window) of the S&P500 index futures.	Own elaboration, CME
Policy indicator PC surprise	The first PC of the surprises ($t-10$ and $t+20$ minute window) in interest rate derivatives with maturities from 1 month to 1 year. It includes FED funds and euro-dollar futures.	Jarociński & Karadi (2020)
S&P500 index surprise	Difference before and after FED announcements ($t-10$ and $t+20$ minute window) on futures of the S&P500 index.	Jarociński & Karadi (2020)
CB monetary policy surprise SR-PM	Monetary Policy Information surprise obtained with simple ("Poor Man's") sign restrictions.	Jarociński & Karadi (2020)
CB information surprise SR-PM	Central Bank Information surprise obtained with simple ("Poor Man's") sign restrictions.	Jarociński & Karadi (2020)
CB monetary policy surprise SR-MR	Monetary Policy Information surprise obtained with the median rotation that implements the sign restrictions.	Jarociński & Karadi (2020)
CB information surprise SR-MR	Central Bank Information surprise obtained with the median rotation that implements the sign restrictions.	Jarociński & Karadi (2020)
Bank flows	Private banks investments in foreign instruments (U.S. dollars).	Central Bank.
Bank flows growth	Annual growth of private banks investments in foreign instruments (U.S. dollars).	Central Bank.
Bank lending	Private banks domestic credit in foreign currency.	Central Bank.
Bank lending growth	Annual growth of private banks domestic credit in foreign currency.	Central Bank.
Uncertainty index	Principal component of Google Trends keywords (up to 15 keywords).	Own elaboration.
Central Bank bills rate	Interest rate of Central Bank bills (in foreign currency) with different maturities.	Central Bank.
Central bank deposits rate	Interest rate of private banks deposits (in foreign currency) at the Central Bank.	Central Bank.
COVID-19 pandemic variable	"COVID-19" keyword search in Nicaragua.	Google Trends.
2018 socio-political crisis variable	"Protests" keyword search in Nicaragua.	Google Trends.

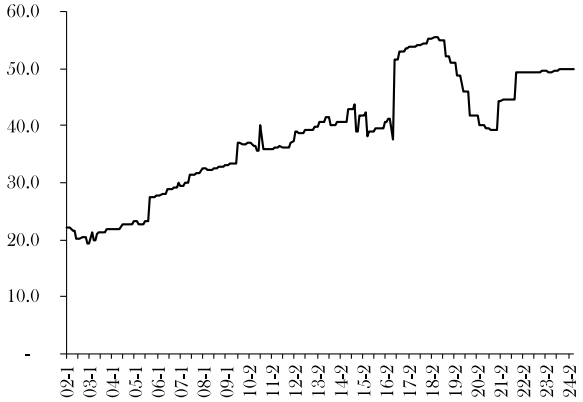
Note:–FED: Federal Reserve. S&P500: Standard & Poor's 500. SOFR: Secured Overnight Financing Rate. CME: Chicago Mercantile Exchange. MP: Monetary Policy. SR: Sign Restriction. SR-PM: Sign Restriction and Poor Man's method. SR-MR: Sign Restriction and Median Rotation method. Visit Marek Jarociński's webpage for further details on Jarociński & Karadi (2020) surprises.
Source: Own elaboration.

FIGURE A1: Number of Branches in Nicaraguan Banking System

(a) Total branches (#)



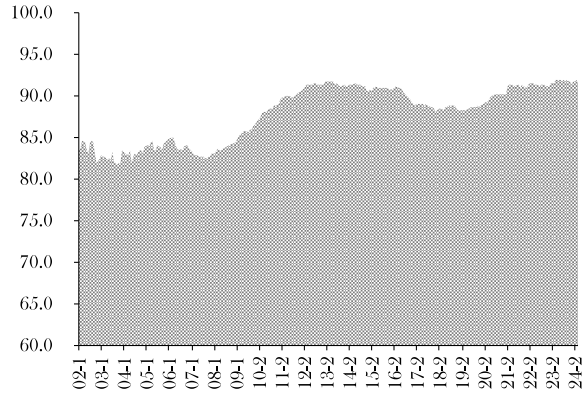
(b) Branches per institution (#)



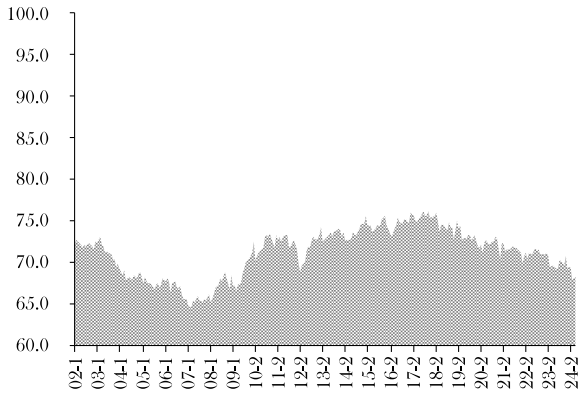
Note:–Horizontal axis in months, from 2002 to 2024.
Source: Own elaboration. Data from BCN.

FIGURE A2: Credits and Deposits 'Dollarization'

(a) Total credits (%)



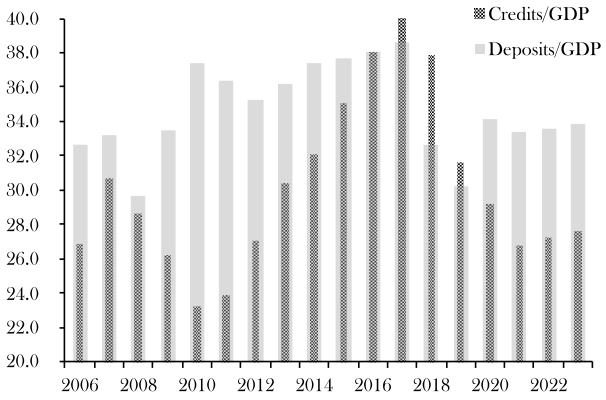
(b) Total deposits (%)



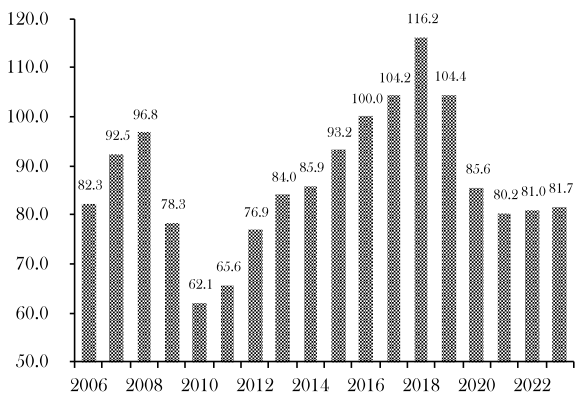
Note:–Percent total credits issued either in foreign currency, or in local currency but indexed by the local currency devaluation. Horizontal axis in months, from 2002 to 2024.
Source: Own elaboration. Data from BCN.

Figure A3: Ratio of Deposits and Credits Over GDP

(a) Credits and deposits over GDP (%)



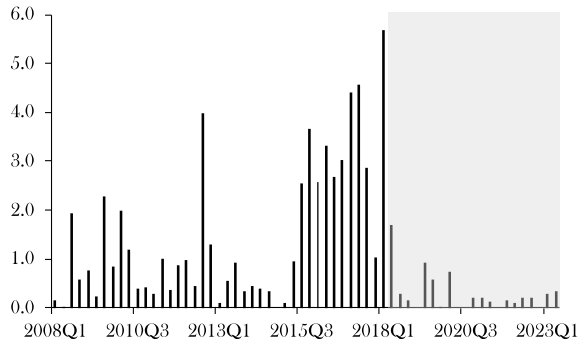
(b) Ratio credits and deposits (%)



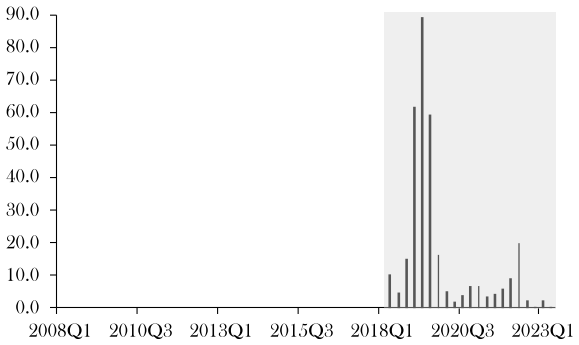
Note:–Percent. Annual estimations using the end-of-year data of credits and deposits. GDP: Gross Domestic Product.
Source: Own elaboration.

Figure A4: Repo Operations in Nicaragua

(a) Inter-bank market (C$ millions)

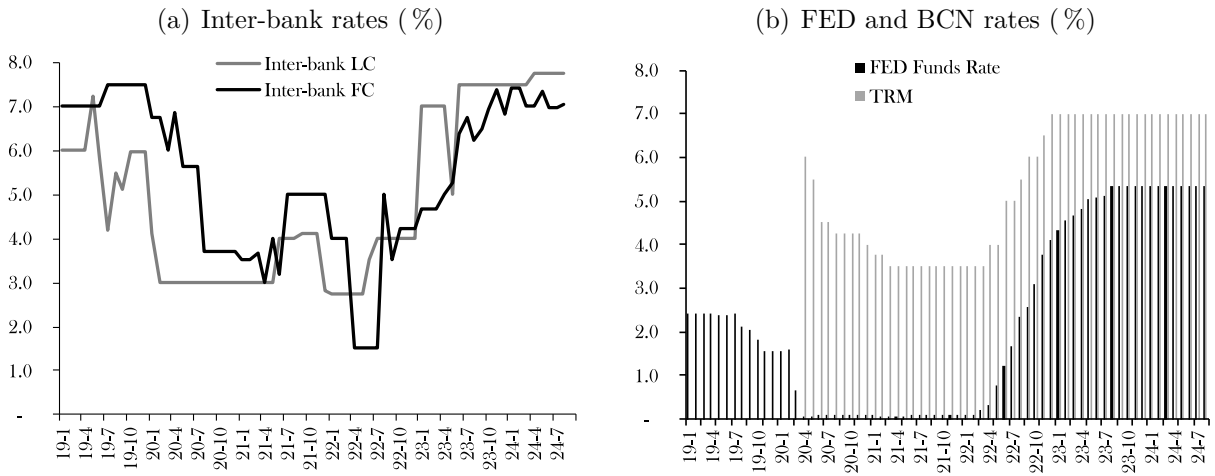


(b) Operations with the BCN (C$ millions)



Note:–Thousands of millions of local currency (C$: Cordoba). Includes repos and options with maturities of 30 or more days. The shadow area reflects the period post sociopolitical crisis in 2018. BCN: Central Bank of Nicaragua. Quarterly transactions.
Source: Torres (2023, p.50).

Figure A5: Interbank and Monetary Policy Interest Rates



Note:–LC: local currency. FC: foreign currency. FED: Federal Reserve. BCN: Central Bank of Nicaragua.
Source: Own elaboration, data from BCN and St. Louis FRED.

Table A2: Correlation Matrix of Main Variables

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Foreign instruments investment	1												
(2) Central bank bills investment	-0.01	1											
(3) Government bonds investment	0.29***	-0.01	1										
(4) FED funds rate	-0.15***	-0.32***	-0.36***	1									
(5) Shock 30-day FED funds futures	-0.03	0.01	-0.02	0.03	1								
(6) Shock 90-day SOFR rate futures	-0.03	0.01	-0.01	0.04*	0.80***	1							
(7) Shock S&P500 futures	-0.02	0.01	-0.05**	0.00	0.13***	0.23***	1						
(8) Policy indicator PC surprise J-K	-0.05**	-0.01	-0.02	-0.00	-0.04*	0.02	0.19***	1					
(9) S&P500 futures surprise J-K	0.03	-0.00	0.01	-0.01	-0.04	-0.11***	-0.14***	-0.67***	1				
(10) CB monetary policy shock SR-PM J-K	-0.05**	-0.00	-0.02	-0.01	-0.01	0.02	0.21***	0.98***	-0.73***	1			
(11) CB information shock SR-PM J-K	-0.01	-0.01	-0.00	0.02	-0.24***	0.01	-0.05*	0.17***	0.23***	-0.00	1		
(12) CB monetary policy shock SR-MR J-K	-0.05**	-0.00	-0.02	0.00	-0.00	0.07***	0.18***	0.91***	-0.92***	0.93***	-0.04	1	
(13) CB information shock SR-MR J-K	-0.02	-0.01	-0.00	-0.02	-0.10***	-0.11***	0.06***	0.34***	0.46***	0.26***	0.49***	-0.08***	1

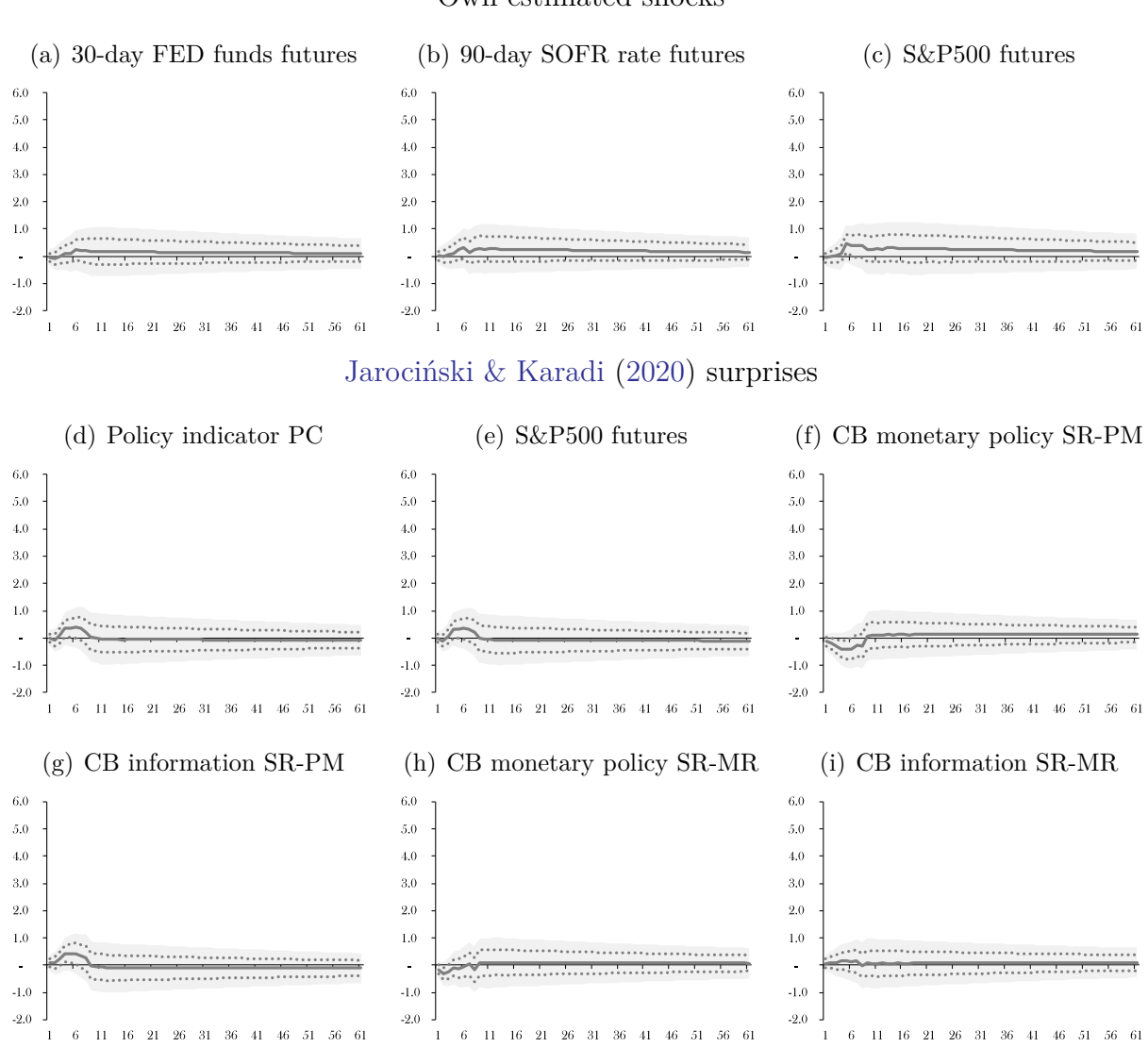
Note:–See section 5.1.1 and Table A1 for further details on shocks/surprises and variables. J-K corresponds to shocks provided by Jarociński & Karadi (2020). Data from January 2019 to March 2024. Variables are expressed either in percent or basis points, as described in Table 2. SR-PM: Poor Man's sign restriction. SR-MR: sign restriction with mean rotation from Jarociński & Karadi (2020). CB: Central Bank. FED: Federal Reserve Bank. SOFR: Secured Overnight Financing Rate. PC: Principal Component. * 10 percent, ** 5 percent, *** 1 percent statistical significance, respectively.
Source: Own elaboration.

Table A3: Lag-order Selection for Monetary Shocks

Instrument	Optimal Lag			
	FPE	AIC	HQIC	SBIC
Including endogenous and exogenous indicators				
Shock 30-day FED funds futures	8	8	2	1
Shock 90-day SOFR rate futures	8	8	2	1
Shock S&P500 futures	8	8	2	1
PC on rates futures J-K	8	8	2	2
Surprise on S&P500 futures J-K	8	8	2	1
CB monetary policy shock PM-SR J-K	8	8	2	2
CB information shock PM-SR J-K	7	8	2	1
CB monetary policy shock MR-SR J-K	8	8	2	1
CB information shock MR-SR J-K	8	8	2	1
Controlling for exogenous indicators				
Shock 30-day FED funds futures	18	18	1	1
Shock 90-day SOFR rate futures	20	20	1	1
Shock S&P500 futures	23	23	20	1
PC on rates futures J-K	18	18	2	1
Surprise on S&P500 futures J-K	18	18	1	1
CB monetary policy shock PM-SR J-K	18	18	2	1
CB information shock PM-SR J-K	18	18	1	1
CB monetary policy shock MR-SR J-K	18	18	1	1
CB information shock MR-SR J-K	18	18	1	1
Without controls				
Shock 30-day FED funds futures	18	18	1	1
Shock 90-day SOFR rate futures	20	20	1	1
Shock S&P500 futures	23	23	20	1
PC on rates futures J-K	18	18	2	1
Surprise on S&P500 futures J-K	18	18	1	1
CB monetary policy shock PM-SR J-K	18	18	2	1
CB information shock PM-SR J-K	18	18	1	1
CB monetary policy shock MR-SR J-K	18	18	1	1
CB information shock MR-SR J-K	18	18	1	1

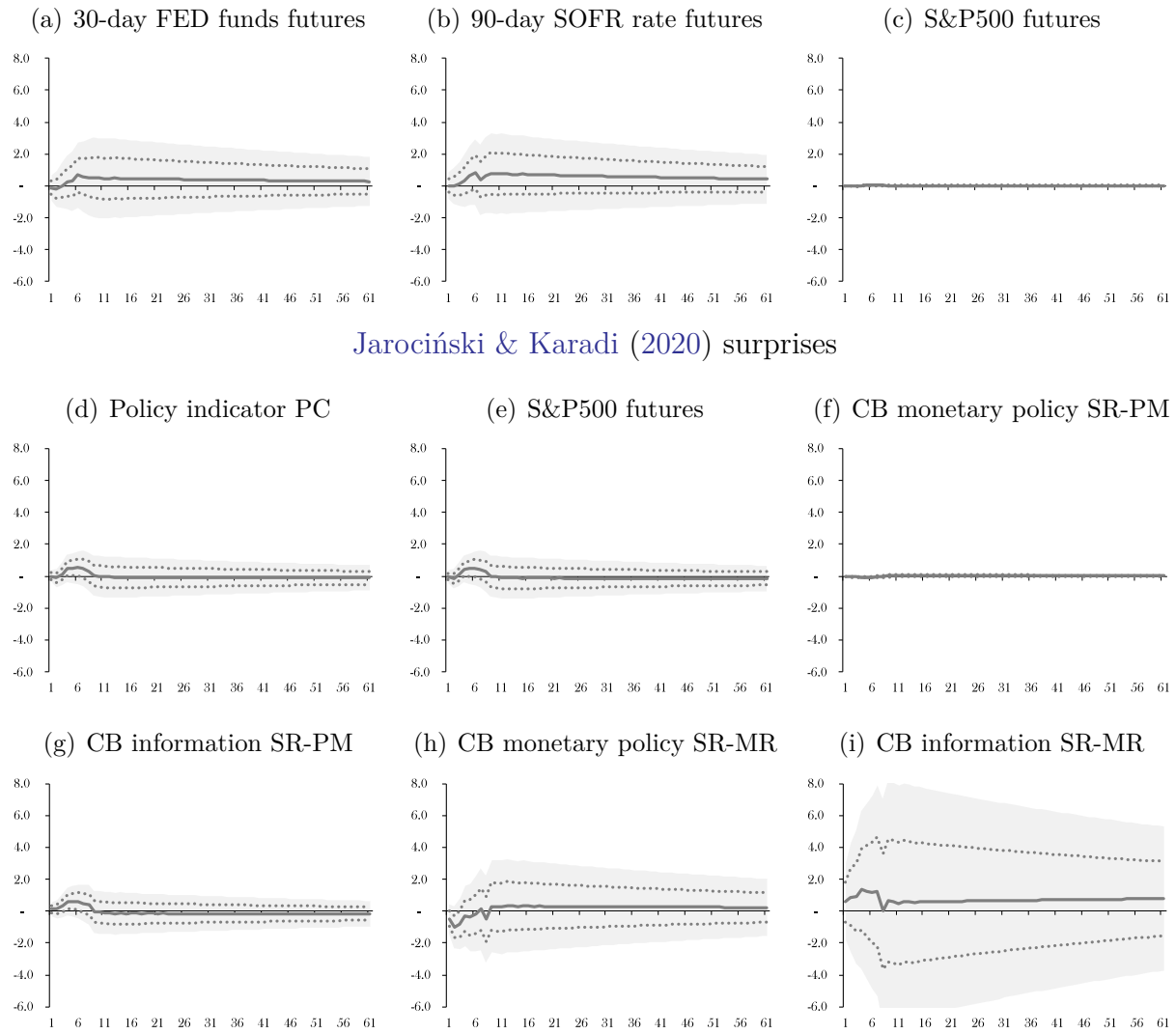
Note:–Sample period from February 2018 to March 2024. FPE: Final Prediction Error. AIC: Akaike Information Criterion. HQIC: Hanann Quinn Information Criterion. SBIC: Schwarz Bayesian Information Criterion. Exogenous indicators include: index variables for the 2018 sociopolitical crisis, the COVID-19 pandemic and the 2022 banking foreign investment regulation (dummy). As endogenous variables, we include the annual growth rate of deposits and credits in foreign currency, as well as the Nicaraguan uncertainty index. See Table A1 for further details on the variables.
Source: Own elaboration.

FIGURE A6: Monetary Shocks and Bank Flows (SVAR)



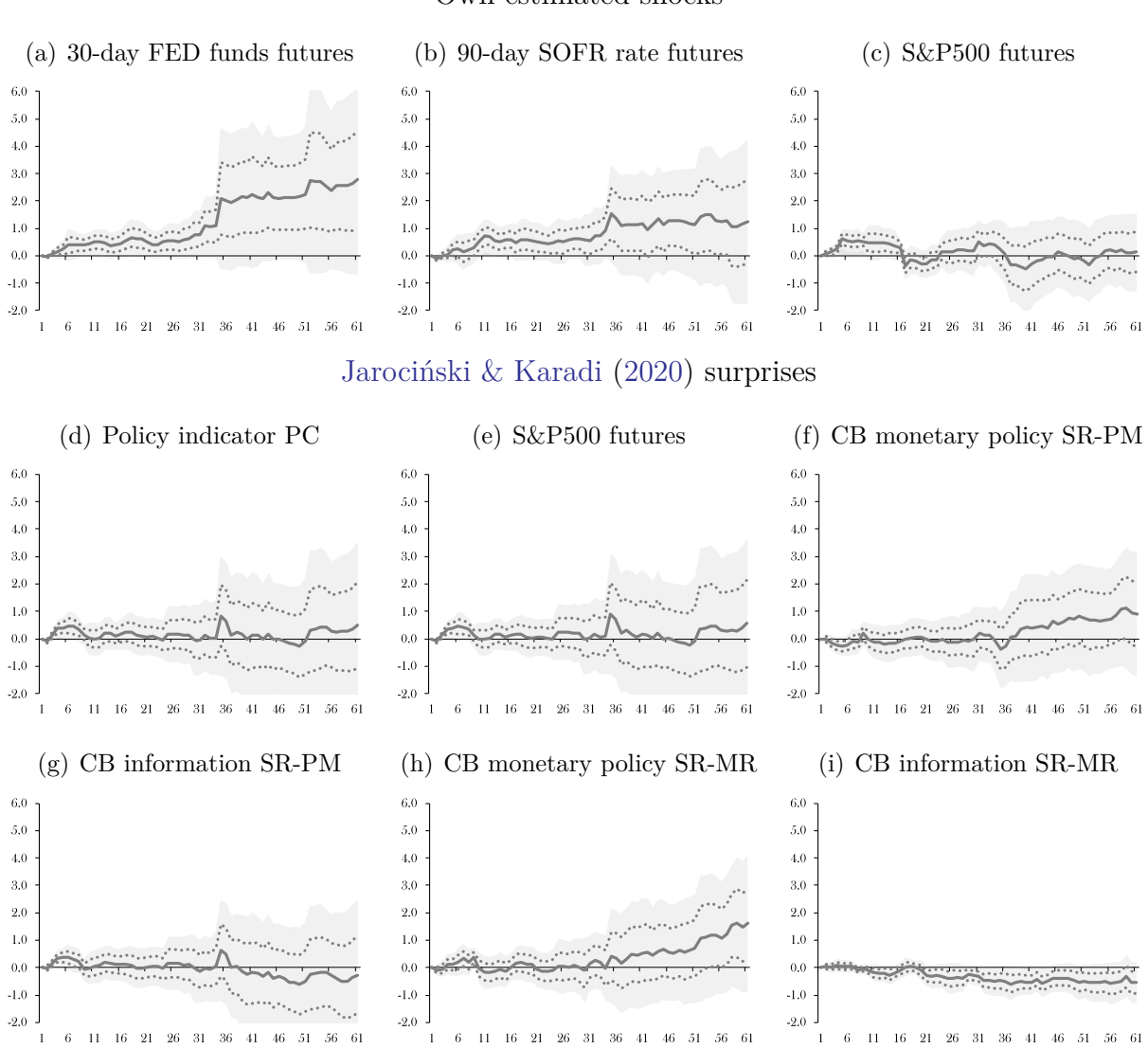
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

FIGURE A7: Standard Monetary Shock and Bank Flows (SVAR)



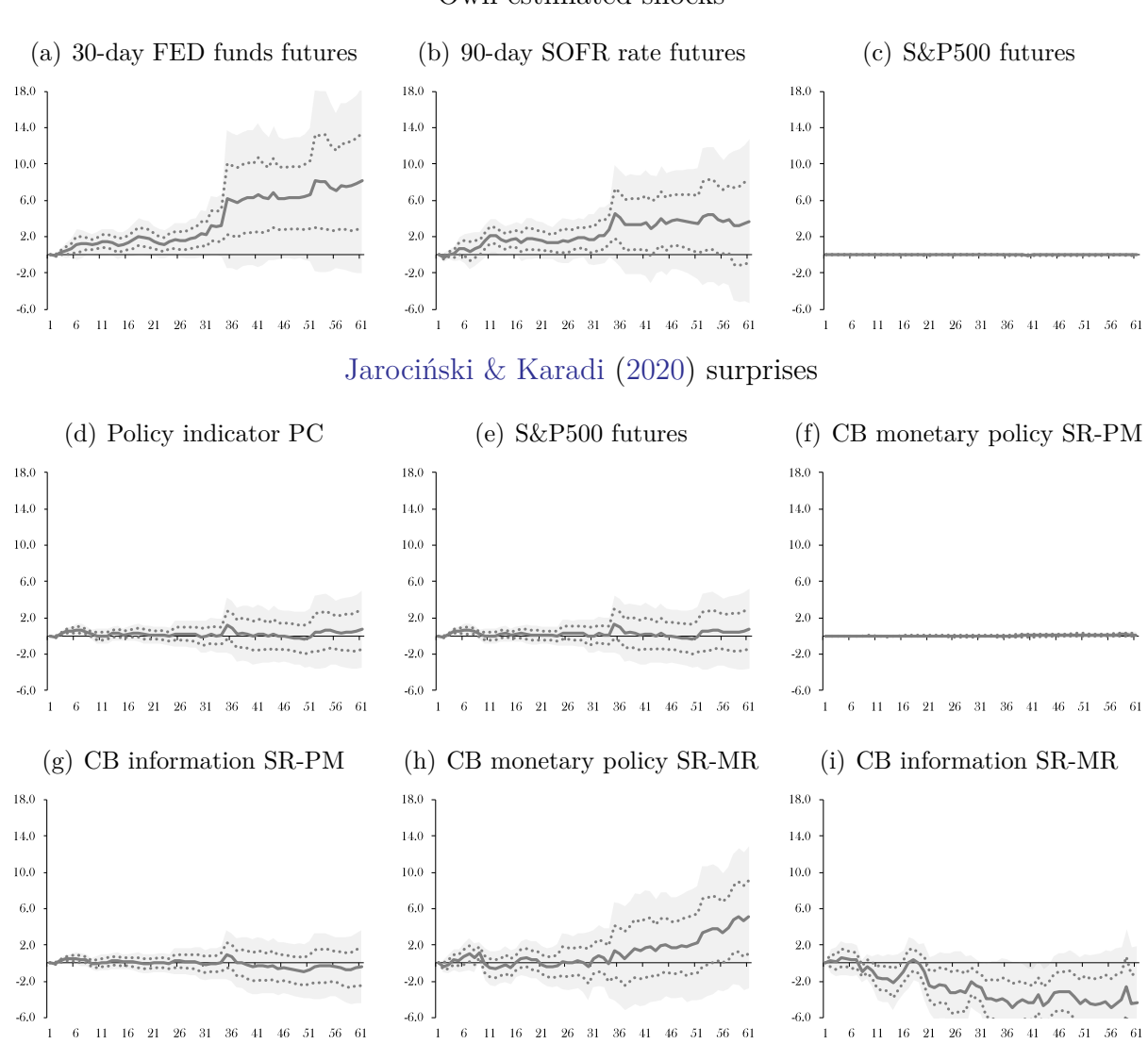
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 percentage point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

FIGURE A8: Monetary Shocks and Bank Flows (Local Projections)



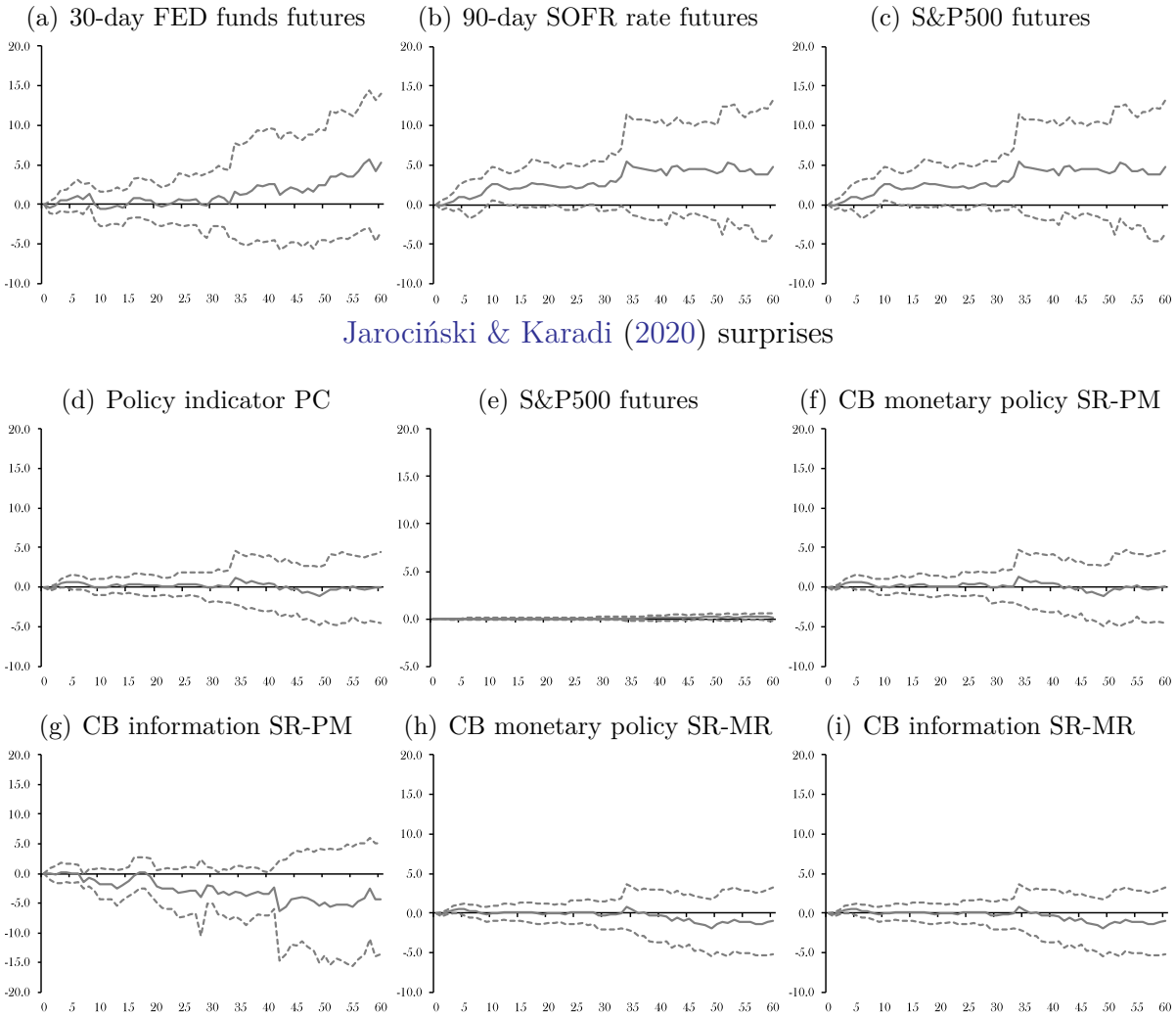
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

FIGURE A9: Standard Monetary Shock and Bank Flows (Local Projections)



Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 68 percent confidence interval (±1.0 standard error), and the shaded area represents the 95 percent confidence interval (±1.96 standard error). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 percentage point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

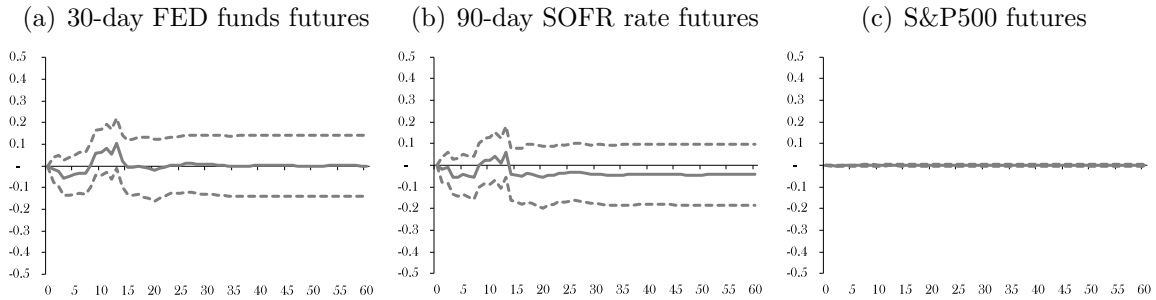
FIGURE A10: Local Projections Estimates of Monetary Shocks (LAFISE)



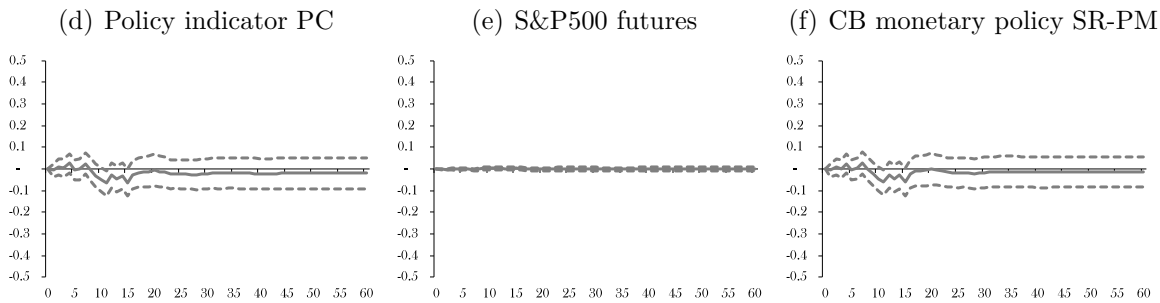
Note:–Vertical axis in percentage points. Horizontal axis in days. The dashed lines indicate a 95 percent confidence interval (±1.96 standard error band). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 basis point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

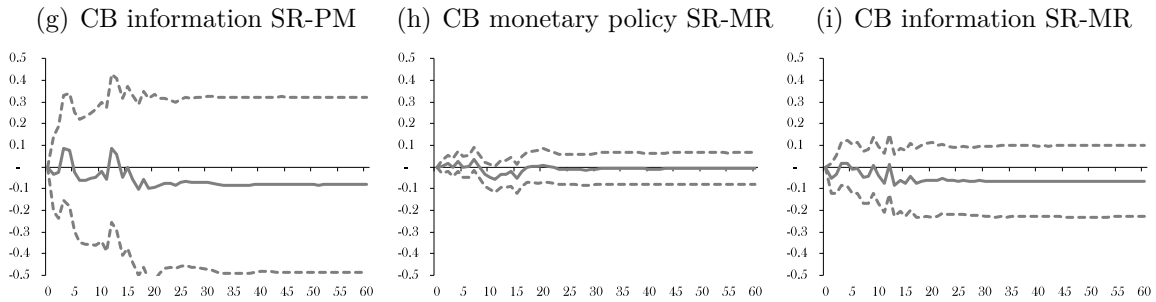
FIGURE A11: Influence of Monetary Shocks on Credit in Foreign Currency (SVAR)

Own-estimated shocks



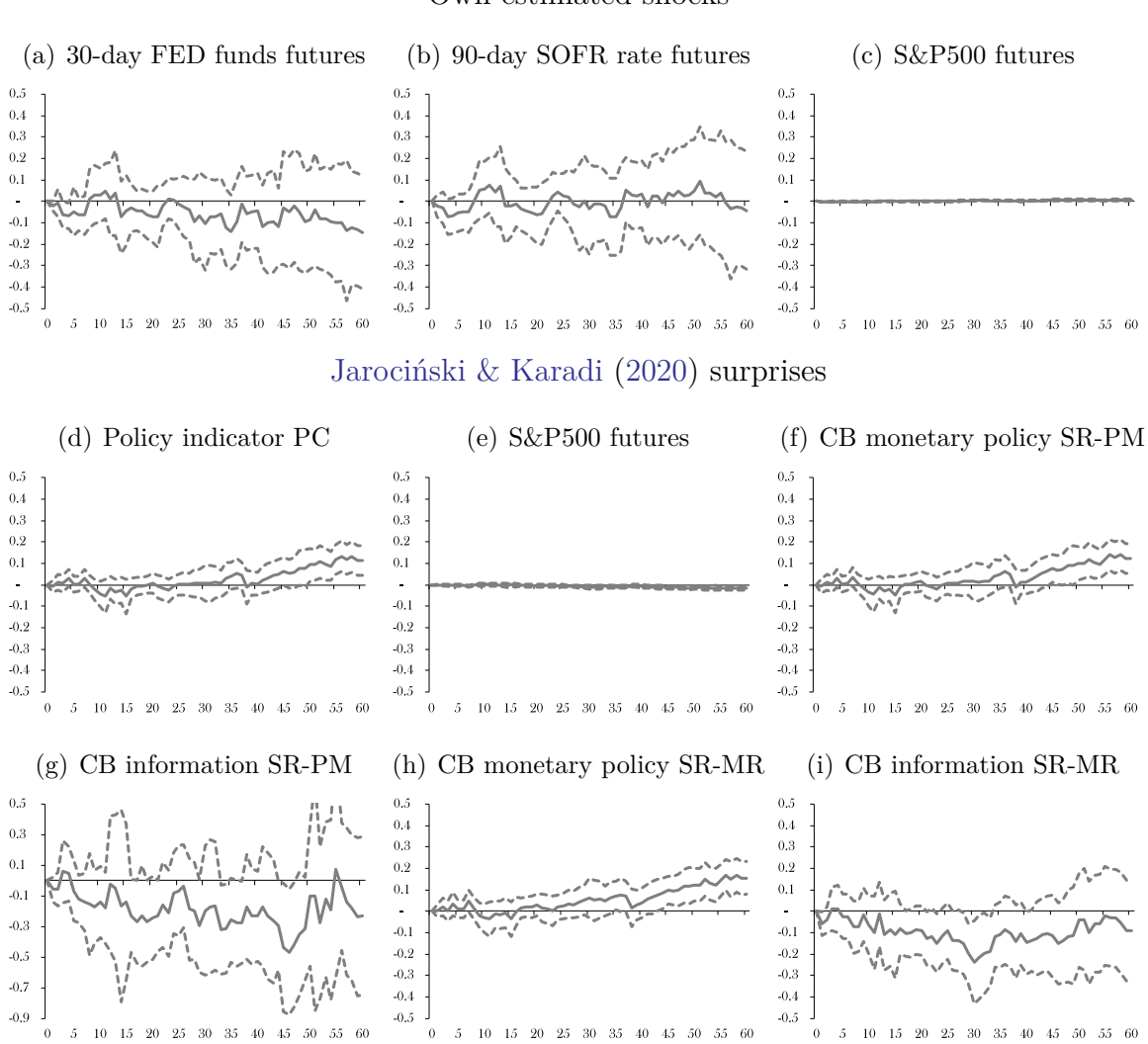
Jarociński & Karadi (2020) surprises





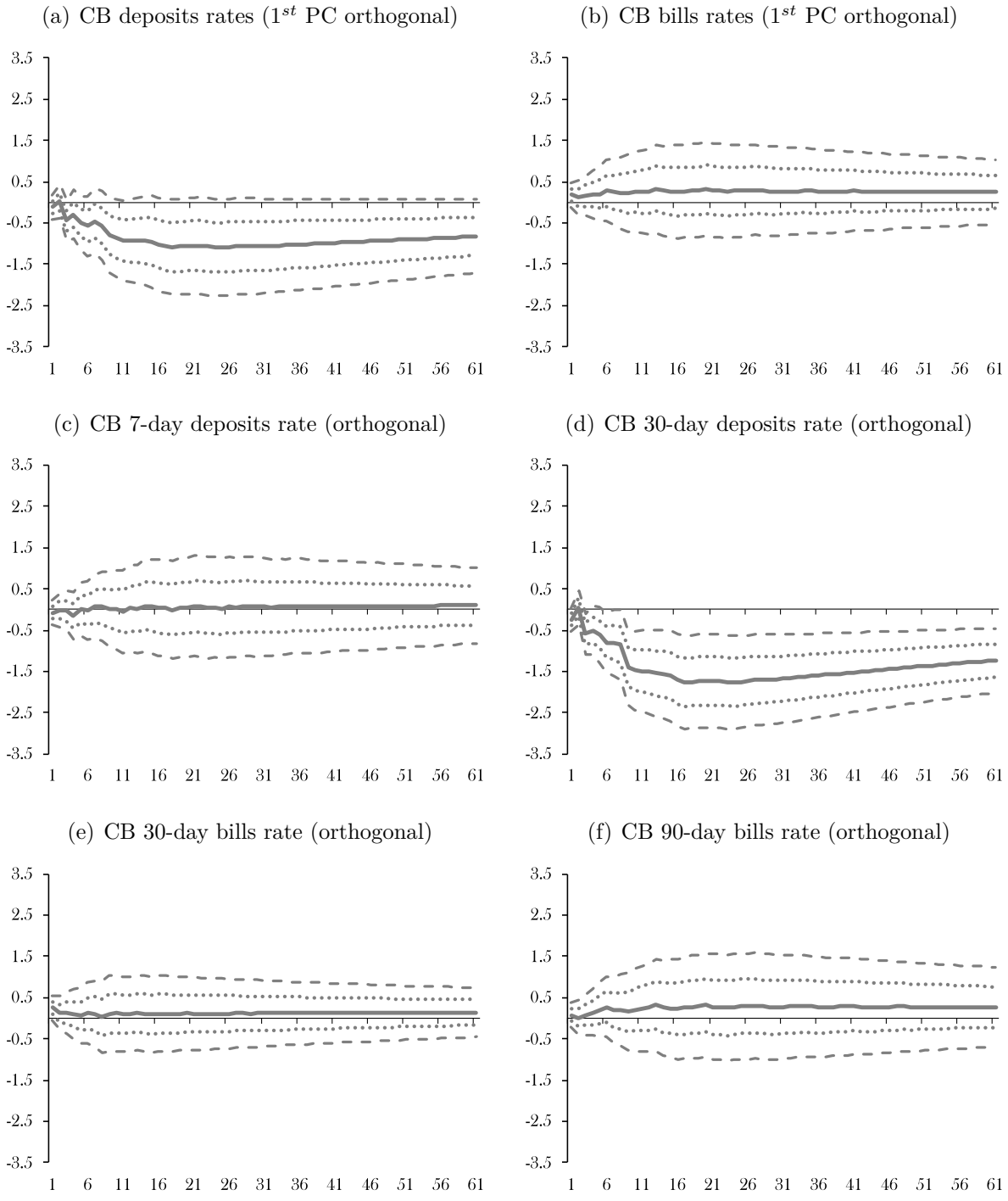
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 95 percent confidence interval (±1.96 standard error band). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 basis point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

FIGURE A12: Influence of Monetary Shocks on Credit in Foreign Currency (LP)



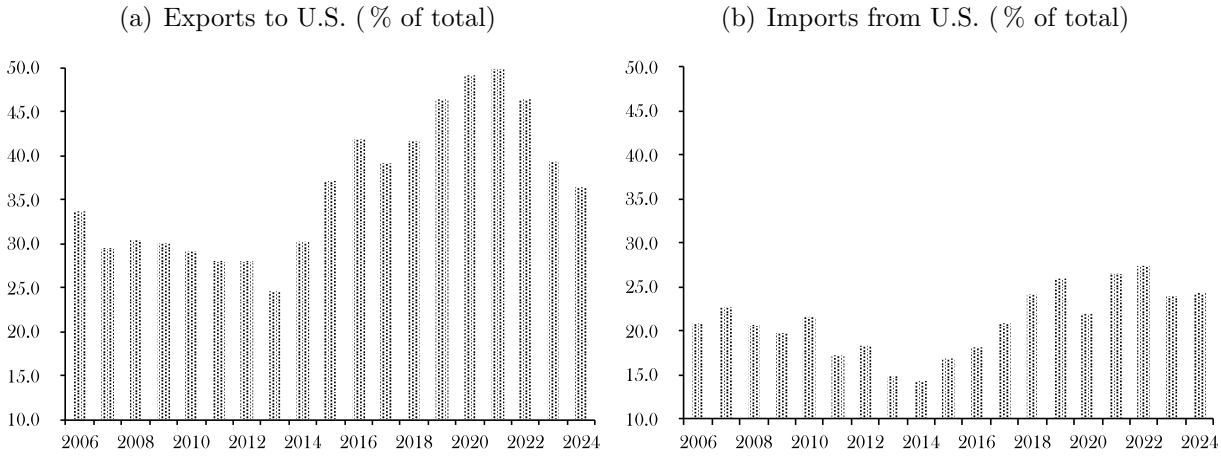
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The dashed lines indicate a 95 percent confidence interval (±1.96 standard error band). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 basis point in any shock/surprise included. The system includes two indicative variables for exogenous indicators: the 2018 socio-political and the other for the COVID-19 pandemic. PC: Principal Component. CB: Central Bank. SR-PM: Poor Man's sign restriction and SR-MR: mean rotative sign restriction from Jarociński & Karadi (2020).
Source: Own elaboration.

FIGURE A13: Local Interest Rates and Banking Flows (SVAR)



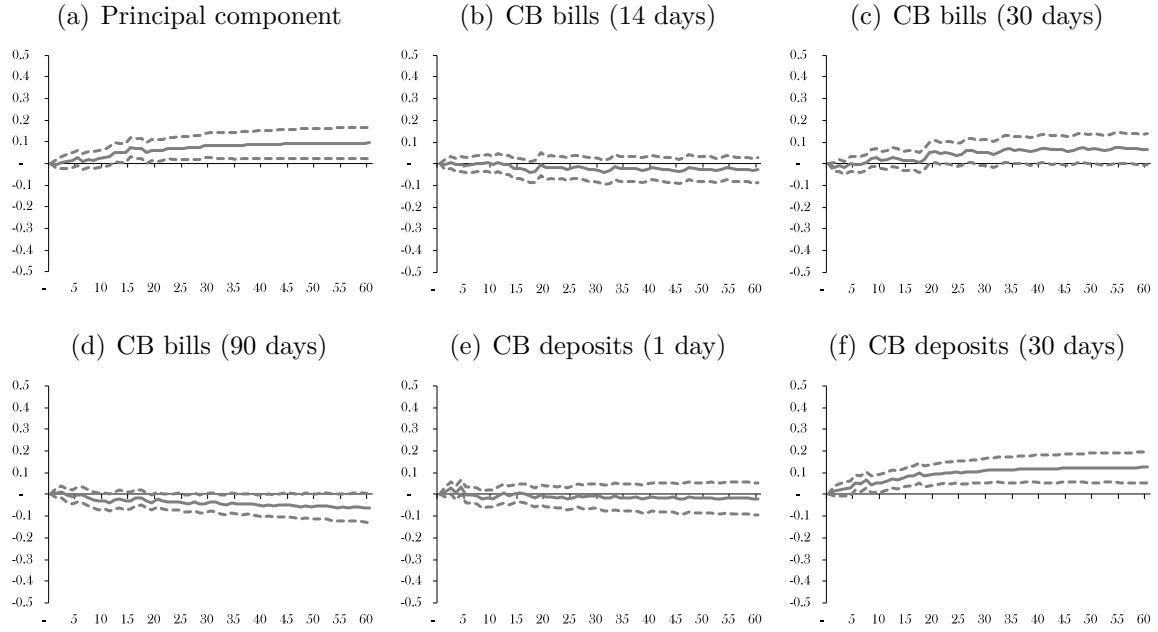
Note:–Vertical axis in percentage points (p.p). Horizontal axis in days. The variables are orthogonalized using the regression method, controlling for the FED funds rate and the growth rate of banking external investment (residual of the regression). The dashed lines indicate a 95 percent confidence interval (±1.96 standard error), and the dotted lines represent a 68 percent confidence interval (±1.0 standard error). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes three indicative variables for exogenous indicators: one for the 2018 socio-political turmoil, one for the COVID-19 pandemic and another for the 2022 investment limit law. CB: Central Bank.
Source: Own elaboration.

Figure A14: Trade Links Between Nicaragua and the U.S. Economy



Note:–Includes information for merchandise trade, but excluding the industrial free zone exports and imports. U.S.: United States of America.
Source: Own elaboration, data from BCN.

Figure A15: Local Interest Rates and Banking Credit in Foreign Currency (SVAR)



Note:–Vertical axis in percentage points (p.p). Horizontal axis in months. The dashed lines indicate a 95 percent confidence interval (±1.96 standard error band). See Table A1 for further details of the variables. Shock simulated equivalent to an increase of 1 standard deviation in any shock/surprise included. The system includes two indicative variables for exogenous indicators: one for the 2018 socio-political turmoil and the other one for the COVID-19 pandemic. CB: Central Bank.
Source: Own elaboration.