Prudential Regulation for Financial Stability in Economies with Financial Dollarization*

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Abstract

This paper quantifies the effects of allowing banks to issue financial obligations in foreign currency on welfare, financial stability, and the transmission of domestic monetary policy. It estimates a micro-structural model of imperfect competition within the dual-currency banking system of a small open economy, where domestic banks (i) issue loans and deposits in both local and foreign currencies, (ii) obtain foreign currency funding from run-prone non-resident banks, and (iii) participate in the foreign exchange market to hedge their currency exposure, as mandated by regulation. The model features two key aspects. First, domestic banks operate under limited liability and can default endogenously, allowing for multiple equilibria with self-fulfilling bank runs, driven by feedback loops between the financial distress of domestic banks and the supply of foreign currency funding by non-resident banks. Second, each domestic bank fails to internalize the impact of its portfolio choices on the exchange rate, creating a destabilizing mechanism for the entire banking system. The model is estimated using supervisory data from the Central Bank of the Republic of Türkiye, covering the period from 2010 to 2017. The findings reveal significant financial instability in the Turkish banking sector during this period, with fragility averaging 13 percentage points higher in alternative equilibria compared to the equilibrium observed in the data. Counterfactual experiments show that a 5 percent tax on domestic banks' foreign currency borrowing from non-resident banks reduces their default probability by 12 percent, albeit with some welfare costs for borrowers. Additionally, results indicate that this prudential measure can effectively complement domestic monetary policy, improving its transmission to both loan and deposit markets.

JEL Classification: E44; E52; E58; F31; F34; F38; G01; G21; L13; L51
Keywords: Financial stability; Financial dollarization; International banking flows; Bank runs; Multiple equilibria; Prudential regulation; Structural estimation

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1 Introduction

Financial dollarization, the practice of using foreign currency alongside the local currency in financial contracts, is prevalent in both advanced and emerging market economies, albeit to varying degrees and in different forms (Ivashina et al., 2015; Bräuning and Ivashina, 2020a; Kloks et al., 2023; Eguren-Martin et al., 2024).[1] This widespread practice is driven by significant benefits, with the "convenience yield" being particularly noteworthy: investors derive non-pecuniary benefits from holding dollar-denominated assets, viewing them as safer investments (Krishnamurthy and Vissing-Jorgensen, 2012; Jiang et al., 2018; Jiang, 2023). In many emerging markets, however, access to these safe assets is often facilitated by domestic banks via dollar-denominated deposits, resulting in a significant presence of dollars within their liabilities—a feature that, to some extent, distinguishes them from advanced economies (see Figure 1).

Given the perceived safety of dollar-denominated deposits, investors often accept lower returns on these investments. This creates a second benefit of financial dollarization: it provides domestic banks with a low-cost funding source. However, banking regulations in emerging markets often restrict or heavily penalize open foreign exchange (FX) positions. As a result, even when borrowers need liquidity in local currency, banks may favor issuing loans in foreign currency at rates lower than those for local currency loans, yet still secure higher returns than those from low-yielding dollar assets (see Figure A1).[2] From this perspective, allowing banks to freely issue dollar-denominated loans offers a third benefit of financial dollarization: it grants borrowers access to "cheap dollar credit" (Gutierrez et al., 2023).

These arrangements often entail residents engaging in financial transactions in dollars (*internal* financial dollarization), while domestic banks may also secure dollar funding from non-resident banks (*external* financial dollarization). This provides a fourth benefit: it facilitates foreign capital inflows into the domestic economy, enabling entrepreneurs to alleviate financial constraints and expand their production capacities (Salomao and Varela, 2021).

However, these benefits come with significant downsides. As the domestic banking system becomes increasingly dollarized, two risks emerge: threats to financial stability and weakened transmission of domestic monetary policy. From a financial stability perspective, capital inflows into the banking sector can create pecuniary (Korinek, 2010; Bianchi, 2011) and aggregate demand externalities (Farhi and Werning, 2016; Schmitt-Grohé and Uribe, 2016), leading to excessive foreign currency inflows and significant stability risks. In terms of monetary policy, banks that issue foreign currency obligations become more sensitive to the "global financial cycle," limiting domestic monetary autonomy (Rey, 2013). Even with a tight domestic monetary policy stance,

[1] Given that these contracts are predominantly denominated in US dollars, I will use "foreign currency" and "dollar" interchangeably throughout this paper.

[2] This practice enables banks to transfer direct foreign exchange rate risk from their balance sheets to the non-bank private sector (Keller, 2019). The process unfolds as follows: banks with more dollar liabilities than assets issue loans in foreign currency, thereby creating foreign currency deposits. Borrowers who need liquidity in local currency, such as to pay wages and bills, convert these deposits from foreign to local currency. This conversion assists banks in closing the open FX positions they initially had. It is important to note that while banks transfer the *direct* FX risk to the non-bank private sector, they remain exposed to FX-related default risk from their unhedged borrowers (*indirect* FX risk).

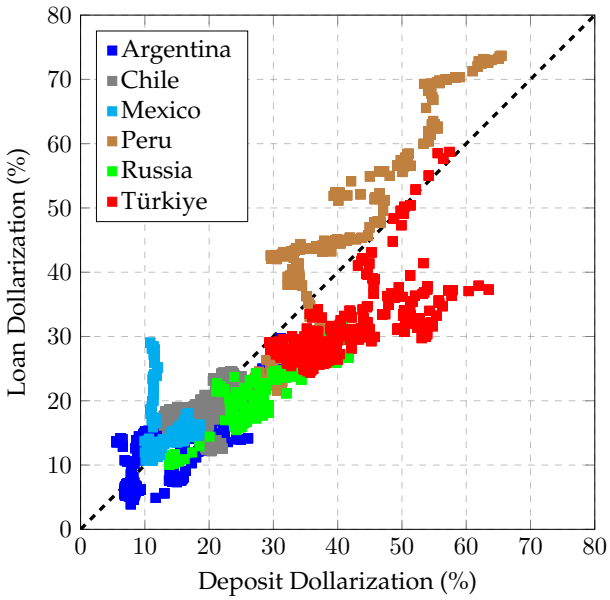


Figure 1. Deposit and Loan Dollarization in Selected Emerging Markets (2006-2021). This graph displays the shares of deposits and loans denominated in foreign currency across the banking sectors of six emerging market economies: Argentina, Chile, Mexico, Peru, Russia, and Türkiye. The data are presented on a monthly basis and sourced from the central banks of each respective country. Each country is represented by a unique color, and a dashed line at a 45-degree angle is included for reference.

banks might still access dollar funding from non-residents, maintaining favorable conditions for funding their assets.

Policies to manage the risks of financial dollarization while preserving its benefits differ widely across emerging market economies, highlighting the absence of a consensus on best practices.[3] Many quantitative macroeconomic models either exclude the banking sector, despite its critical role in financial crises, or present a simplified, homogeneous representation of it, overlooking the essential heterogeneity required to address financial stability risks. Moreover, reduced-form studies on such policies often fail to capture broader general-equilibrium effects and cannot differentiate between the impacts of prudential tools and monetary policy, nor simulate policies that have yet to be implemented.

This paper aims to bridge these gaps by developing and estimating the first micro-structural framework that quantifies both the benefits and risks of foreign currency intermediation. The model provides a mechanism under which increased financial dollarization can (i) make domestic banking systems more fragile; (ii) weaken the transmission of domestic monetary policy to loan and deposit markets; and (iii) turn episodes of monetary policy tightening into catalysts for financial instability. The quantitative results reveal that prudential measures can effectively mitigate the fragility in the domestic banking systems of financially dollarized economies and enhance the transmission of monetary policy, albeit at some welfare cost.

[3]The absence of clear frameworks guiding the use of these tools has recently become a central focus of the IMF's efforts (Basu et al., 2020; Adrian et al., 2020).

Specifically, I construct a structural empirical model of imperfect competition within the dual-currency banking system of a small open economy. I estimate this model using detailed micro-level data from the Central Bank of Türkiye (CBRT) for the period 2010 to 2017. The model reveals that the Turkish banking system was inherently fragile during this period, with a significant potential for alternative equilibria where banks faced a heightened likelihood of default. This multiplicity is driven by the self-fulfilling beliefs of non-resident banks regarding the riskiness of domestic banks and the limited liability, as in Egan et al. (2017) and Albertazzi et al. (2022). However, unlike in these studies, managing balance sheets under dual-currency, combined with regulatory constraints, creates a significant amplification effect that could destabilize the entire banking system. This key insight, not covered in single-currency banking studies, is a novel contribution of this model.

The mechanism operates as follows: When non-resident banks perceive an elevated risk of default by a domestic bank, similarly to a run scenario, they reduce dollar funding to that bank. In response, the affected bank raises interest rates on dollar deposits and unwinds FX swap positions to meet non-residents' withdrawals. This response diminishes the bank's profitability and elevates its risk of default. The impact, however, extends beyond this single bank. Financial distress at one bank affects other (non-distressed) banks by intensifying competition for dollar deposits. Non-distressed banks, losing cheap dollar deposits to the distressed competitor that has raised rates, similarly increase their own rates on dollar deposits, which narrows their profit margins and heightens their financial vulnerability. This, in turn, prompts a further reduction in dollar funding from non-resident banks. Forced into a similar situation, these banks also unwind their FX swap positions. The collective unwinding depreciates the exchange rate, an impact that individual banks do not internalize. As the exchange rate depreciates, depositors shift from local to foreign currency deposits, positioning banks as net dollar borrowers. Regulations prohibiting open FX positions then drive banks to increase their dollar demand in the FX spot market, further intensifying downward pressure on the exchange rate.

Türkiye offers an ideal setting for examining the benefits and risks of foreign currency intermediation. This analysis benefits from extensive micro-level administrative data, which includes detailed transaction-level information on bank lending, monthly bank balance sheets and income statements, deposit rates differentiated by bank and account type, cross-border lending and borrowing data at the transaction level, professional forecaster surveys, information on government bondholders, and a range of macroeconomic and financial market variables (Section 2). This rich dataset provides the variations necessary to estimate the model.

Furthermore, Türkiye shares several key characteristics with other emerging market economies, making its case widely applicable. The domestic banking sector, characterized by significant private and foreign involvement, serves as the primary lender to the non-bank private sector. Importantly, during the study period, policymakers refrained from introducing measures to reduce the banking system's reliance on foreign currencies. As of April 2017, the asset and liability dollarization ratios stood at approximately 38% and 46%, respectively. Of the foreign currency liabilities,

25% stemmed from deposits and 21% from non-resident banks. These figures underscore the relevance and generalizability of the findings to other emerging market economies.

I begin my analysis by outlining five stylized facts, derived from both cross-country macro-level data and detailed micro-data from Türkiye, which inform my modeling approach (Section 3). First, I analyze interest rates for local currency and foreign currency deposits in Argentina, Chile, Peru, Russia, and Türkiye, adjusted for expected exchange rate depreciation. Cross-country evidence indicates that depositors perceive a non-pecuniary value in holding foreign currency, as they are willing to incur higher costs to save in this currency. For banks, this premium serves as a cost-effective funding source, which they may pass on to borrowers through lower-cost foreign currency credit.

The second key fact, drawn from the Turkish credit registry data, shows that borrowers face significantly lower costs of borrowing in foreign currency −about 575 basis points lower on average than local currency loans without hedging, narrowing to 35 basis points with hedging. These findings highlight the importance of currency denomination in shaping the savings and borrowing decisions of both banks and the non-bank private sector. In my model, I estimate the sensitivity of depositors and borrowers to local and foreign currency deposit and loan products, thereby recovering demand elasticities related to currency denomination − a dimension that has not yet been quantified in the literature

The third stylized fact examines the vulnerability of uninsured deposits and wholesale foreign currency funding to runs.[4] While the existing literature primarily focuses on the positive feedback between a bank's financial health and the behavior of uninsured depositors, particularly in advanced economies (Egan et al., 2017; Albertazzi et al., 2022; Jiang et al., 2024; Chang et al., 2024; Drechsler et al., 2023), this study highlights a key difference in emerging market economies: bank fragility in these economies is more closely tied to wholesale foreign currency funding from non-resident banks. Using Turkish bank-level data, I show that uninsured depositors are not sensitive to a bank's default risk, whereas wholesale dollar funding declines by 3 percentage points for a 1 percentage point increase in a bank's default risk. Consequently, my model allows non-resident banks to be sensitive to a domestic bank's default risk when setting the interest rate on the corresponding cross-border loan.

The fourth fact examines whether easy access to wholesale funding in foreign currency weakens the transmission of domestic monetary policy to credit markets. By merging banks' balance sheet data with transaction-level lending data, I show that banks more reliant on foreign-currency wholesale funding experience a less pronounced increase in local currency loan rates following domestic monetary policy tightening. In addition, I find that this effect is particularly pronounced during periods of abundant global liquidity.

The last fact documents that as non-resident investors hold a larger share of local-currency government bonds, the exchange rate becomes increasingly sensitive to global risk. This high-

[4]Wholesale foreign currency funding refers to securing cross-border loans in foreign currency from non-resident banks.

lights the crucial role of non-resident bond investors in exchange rate dynamics and emphasizes the importance to model their demand for local currency government bonds.

Having established the facts and justified my modeling decisions, I present the structural empirical model, inspired by the works of Egan et al. (2017) and Albertazzi et al. (2022). (Section 4) The key feature of this model lies in its detailed characterization of domestic banks' activities, accommodating various dimensions of heterogeneity across banks and thereby placing them at the core of the analysis. This choice is supported by two key considerations: (i) the fact that most prudential policies are targeted at banks, and (ii) the pivotal role that banks play in transmitting monetary policy and facilitating international banking inflows, particularly in emerging market economies where the shadow banking sector is minimal.

On the asset side, banks allocate funds to loans and central bank reserves in both local and foreign currencies, as well as to investments in government bonds denominated in local currency. On the liabilities side, these assets are financed through deposits in both currencies and borrowing from the wholesale funding market—either in local currency via interbank loans or in foreign currency through cross-border loans. To mitigate exchange rate exposure on their balance sheets, as required by regulation, banks engage in synthetic forward creation and interact with non-resident currency traders.[5] Additionally, banks may endogenously default when a profit shortfall exceeds their equity value in the subsequent period. In the event of default, equity holders benefit from limited liability.

The model incorporates three distinct demand systems. First, it models households' and firms' demand for deposits, drawing on the literature on demand for differentiated products (Berry, 1994; Berry et al., 1995). It posits that depositors make a discrete choice between local and foreign currency deposit products offered by a range of domestic banks when allocating their savings. Next, the model outlines the demand for three types of loans −mortgages, unsecured consumer loans, and corporate loans− allowing borrowers to choose between local and foreign currency loan products from the same set of banks to meet their financing needs. This section also accounts for the potential risk of borrower default. Finally, the model applies the demand system approach for asset pricing, as developed by Koijen and Yogo (2019), to model the demand for local currency-denominated government bonds by resident non-bank investors and non-resident investors.

On the supply side, I model Bertrand-Nash imperfect competition among domestic banks, where each bank sets interest rates for its differentiated deposit and loan products. The model also includes non-resident currency traders and non-resident banks. Non-resident currency traders are depicted as more passive participants, supplying dollar liquidity in the foreign exchange spot and swap markets, given their risk aversion and balance sheet capacity. In contrast, non-resident banks, characterized by heterogeneous and time-varying marginal costs in providing loans to domestic banks, play a more pivotal role. These banks offer foreign currency loans to domestic banks, setting loan rates through posted prices. Notably, they respond to financial distress among

[5] A synthetic forward foreign currency position is created through the joint application of foreign exchange swap and spot transactions. See Appendix C for further details.

domestic banks, creating a dynamic feedback loop between non-resident banks and the financial health of domestic banks, which can potentially lead to multiple equilibria.

I take this model to the data through a two-step process. First, I estimate the demand systems. Then, by leveraging both the demand estimates and the revealed preferences of domestic banks, non-resident banks, and non-resident currency traders, I obtain the supply-side parameters (Section 5). The key findings are as follows: On the depositor side, I observe a positive and statistically significant impact of the interest rates offered on both retail and corporate deposits on deposit demand. Notably, the sensitivity of retail deposits is twice that of corporate deposits. Second, transaction services provided by local currency checking accounts are important for depositors. Third, the estimates reveal the non-pecuniary value that both retail and corporate depositors attribute to foreign currency-denominated deposit products. Quantitatively, I show that the hedging benefits of these products equate to a return of about 500 basis points in local currency. Importantly, there is a significant shift in depositor preferences from local currency-denominated products to those denominated in foreign currency during periods of exchange rate depreciation.

On the loan side, the results reveal downward-sloping demand curves across all loan products. Borrowers generally favor loans denominated in local currency, though their preference shifts toward foreign currency-denominated loans during periods of currency appreciation. Additionally, the findings indicate that borrowers' expected default rates increase with the cost of borrowing. For bond investors, the analysis identifies a downward-sloping demand curve for non-resident bond investors, contrasted by an upward-sloping demand curve for non-bank resident investors.

Equipped with the model's fundamentals, including estimated parameters for both demand and supply, I assess risks to financial stability by examining whether these fundamentals could support equilibria in a market distinct from the observed one, though under actual policy conditions (Section 6.1). This is referred to as alternative equilibria. The results confirm the existence of such equilibria, underscoring vulnerabilities in the banking system during the study period. Quantitatively, the fragility of the banking sector −defined as the asset-weighted average of banks' probabilities of default− is 13 percentage points higher compared to the realized equilibrium.

I then apply the model to assess the effectiveness of a specific prudential measure aimed at mitigating inherent fragility within the banking system. Specifically, I introduce a 5 percent prudential tax on banks' borrowing in foreign currency from non-resident banks, as in Aoki et al. (2016) and Korinek (2010). The objective is to reduce the risks associated with banks' reliance on foreign currency funding through wholesale markets, which has been shown to be volatile. The primary findings from this first counterfactual experiment provide empirical support for the effectiveness of the policy intervention in reducing banking system fragility by lowering banks' default risk. Quantitatively, the prudential tax results in an average reduction of 1.33 percentage points in the severity of instability within the banking sector, representing about a 12 percent decrease relative to the scenario without the tax. While the findings confirm the prudential tax's effectiveness in reducing banks' fragility, I also demonstrate that this policy intervention incurs certain costs for borrowers: on average, their surplus declines by 2 percent compared to the baseline scenario.

After assessing risks to financial stability, I investigate the implications of tightening domestic monetary policy, examining its transmission to loan and deposit markets as well as its impact on financial stability through two counterfactual experiments (Section 6.2). In these experiments, I increase the domestic monetary policy rate by 100 basis points under two distinct scenarios: one with a prudential tax and one without. Two main findings emerge. First, without the prudential tax, I observe an average increase in banks' default probability of 0.86 percentage points compared to the baseline, which corresponds to a 7 percent increase. Additionally, as the cost of borrowing in local currency for wholesale funding rises, banks adjust their funding composition to rely more on foreign currency wholesale funding. This shift weakens the transmission of tightening measures to loan and deposit markets.

Second, the addition of a prudential tax enhances the effectiveness of domestic monetary policy tightening on both loan and deposit markets. In this scenario, banks are less inclined to substitute costly local currency funding from the wholesale market with foreign currency funding from non-resident banks due to the increased tax costs associated with the latter option. Consequently, my analysis shows significant increases in interest rates for deposits and loans in both local and foreign currencies.

Related Literature. This paper builds upon and contributes to four key areas of existing literature: (i) financial dollarization, (ii) global financial cycles and international monetary policy spillover effects, (iii) macroprudential and capital flow management measures, and (iv) the structural industrial organization of banking systems.

First, this study advances our understanding of financial dollarization by examining its effects on welfare, financial stability, and monetary policy implementation in emerging market economies. Previous research has shown that households in these economies often save in dollars to mitigate consumption risks related to dollar pricing (Gopinath and Stein, 2020) and financial instability (Bocola and Lorenzoni, 2020), which in turn enables entrepreneurs to secure affordable dollar financing (Oskolkov and Sorá, 2023; Dalgic, 2024). Additionally, external financial dollarization functions as a risk-sharing mechanism between local residents and foreign investors, allowing local entrepreneurs access to low-cost foreign dollar capital to overcome financial constraints and expand their production capacities (Dell'Ariccia et al., 2018; Salomao and Varela, 2021; Cingano and Hassan, 2022; Bau and Matray, 2023). However, financial dollarization also poses significant challenges for these economies, including exchange rate volatility, currency mismatches, heightened credit risk in the banking sector, and increased liquidity risks due to reliance on international dollar liquidity.[6] Moreover, it has been found to reduce the effectiveness of monetary policy transmission.[7] Unlike prior studies, this paper introduces substantial heterogeneity at the bank level

[6]The stability of domestic banks is threatened by risks on both the asset and liability sides of their balance sheets. On the asset side, borrowing in dollars can expose firms to exchange rate risk and currency mismatch (Chui et al., 2014; Acharya et al., 2015; Kim et al., 2015; Alfaro et al., 2019), thereby increasing the credit risk faced by domestic banks (Niepmann and Schmidt-Eisenlohr, 2022). On the liability side, the reliance of domestic banks on international wholesale dollar funding markets to finance their dollar assets may lead to liquidity risk and runs (Ivashina et al., 2015; IMF, 2019; Kumar and Mathur, 2021; Agarwal, 2021)

[7]Mora (2013), with regards to internal dollarization, show that deposits and lending of banks with a high proportion

and models the decision-making processes of banks, depositors, and borrowers at the micro level, accounting for their currency preferences. This approach provides a detailed assessment of the welfare implications of financial dollarization and its impact on financial stability and the effectiveness of monetary policy.

Second, this research contributes to the literature on the global financial cycle and international monetary policy spillovers. Rey (2013) first coined the term "global financial cycle," highlighting how small open economies with open capital accounts are affected by the monetary policy decisions of major economies, thereby diminishing the effectiveness of their own monetary policies. Further studies have pinpointed two main pathways through which EMDEs are impacted: dollar-denominated bank loans (Bruno and Shin, 2015a,b; Morais et al., 2019; Buch et al., 2019; Bräuning and Ivashina, 2020b; di Giovanni et al., 2022) and local currency government bonds (Han, 2022; Bertaut et al., 2022; Hofmann et al., 2022). The former exposes banks to currency risks, leading to the phenomenon known as "original sin" (Eichengreen and Hausmann, 1999), where increased risk premiums raise borrowing costs. Even transactions involving local currency do not insulate economies from global financial cycle effects, as adjustments by non-resident investors—referred to as "original sin redux" (Carstens and Shin, 2019)—can amplify exchange rate volatility impacts. This study delves into both channels, employing comprehensive micro-level data to simultaneously model the interbank loan market, exchange rates, and the government bond market.

Third, this study enriches the current policy discussion surrounding the effects of macroprudential and CFM policies, tackling two related strands of research. The first explores the expected benefits and unintended consequences of these policies. Prior studies have shown that they can safeguard local monetary policy from external shocks (Rey, 2013; Farhi and Werning, 2014; Davis and Presno, 2017; Cavallino and Sandri, 2019) and enhance financial stability (Ostry et al., 2012; Benigno et al., 2013; Korinek and Sandri, 2016; Meuleman and Vander Vennet, 2020), but also raise concerns about higher financing costs (Alfaro et al., 2017), restricted credit access (Amado, 2022), increased exchange rate vulnerability (Keller, 2019), and a shift towards bond issuance in dollars (Ahnert et al., 2021). The second strand examines the interplay between prudential and monetary policies domestically and internationally, revealing that monetary policy more effectively influences lending when paired with prudential measures (Bruno et al., 2017; Gambacorta and Murcia, 2020) and can mitigate the impact of global financial conditions on local credit cycles (Bush et al., 2021; Coman and Lloyd, 2022; Epure et al., 2021; Fabiani et al., 2022).[8] Unlike the prevailing literature, which primarily relies on either stylized macro-finance models or reduced-form methods, this study introduces a more data-driven, yet deeply micro-founded framework. Traditional macro-finance models often treat the banking sector as homogeneous and perfectly competitive, neglecting detailed bank-level analysis and relying on calibration from aggregated data moments.

of dollar deposits are less responsive to domestic monetary shocks. As for external dollarization, Cavallino and Sandri (2019); Ongena et al. (2021); Cao and Dinger (2022); Fabiani et al. (2022) document that if banks heavily rely on international wholesale dollar funding markets, the traditional bank-lending channel may be less effective, or even break down.

[8]The domestic (international) context encompasses the relationship between domestic prudential regulations and domestic (foreign) monetary policies.

In contrast, my approach embraces the differentiation and imperfect competition among banks, leveraging granular bank-level data. This enables us to capture an imperfect pass-through of monetary policy and quantify the degree of contagion across banks.

Finally, this paper build upon and extend the recent literature on estimating structural models of imperfect competition in the banking sector (Egan et al., 2017; Aguirregabiria et al., 2019; Albertazzi et al., 2022; Diamond et al., 2020; Xiao, 2020; Egan et al., 2022; Wang et al., 2022). Existing studies in this field have solely concentrated on economies operating with a single currency. For instance, Egan et al. (2017) estimate differentiated demand models for bank deposits in the US banking industry. They differentiate between insured and uninsured deposits, endogenize bank default, and quantify multiple equilibria with runs on deposits. Similarly, Albertazzi et al. (2022) construct and estimate a structural empirical model of the banking sector in the euro area with bank run (on deposits) features. However, unlike Egan et al. (2017), they allow the presence of a central bank and a market for bank loans in order to investigate the effects of unconventional monetary policy on the multiplicity of equilibria and welfare. This paper contributes to this body of literature by introducing two novelties. First, this paper is the first to develop and estimate a structural empirical model of the banking sector in a small open economy that experiences financial dollarization. Secondly, it shifts the focus to the instability in wholesale foreign funding markets, which are depicted as being more volatile and susceptible to abrupt withdrawals compared to deposits, a situation particularly acute in emerging market economies. The application of the demand system to the deposit, loan, and government bond markets also complements research on the use of demand systems in other financial markets (Koijen and Yogo, 2019, 2020; Koijen et al., 2022; Bretscher et al., 2022; Jiang et al., 2020).

Structure of the paper. The remainder of the paper is organized as follows. In Section 2, I offer insights into the institutional background and describe the data used in the empirical analyses. Section 3 introduces five stylized facts to motivate the modeling choices. The model is presented in Section 4, and its estimation is detailed in Section 5. Moving on to Section 6, I rely on the estimated model to illustrate and discuss multiple equilibria under existing policy environment. I then explore outcomes under various counterfactual policy designs. The paper concludes in Section 7.

2 Institutional Background and Data

This section is divided into three subsections. Section 2.1 examines the extent of financial dollarization in emerging market economies, validating the external applicability of the model and the conclusions drawn from it. Section 2.2 provides an overview of dollar intermediation within Türkiye's financial system. Lastly, Section 2.3 summarizes the micro-level data used in the empirical analysis.

2.1 Financial dollarization across EMDEs

Table A1 presents the average shares of loans, bank liabilities, and deposits denominated in foreign currency across various emerging and developing economies over the past two decades. This data offer two key insights. First, domestic banks significantly engage in foreign currency intermediation, with a substantial share of their assets in foreign currency-denominated loans, primarily funded by foreign currency liabilities. This pattern implies that the findings of this study could extend to other emerging and developing economies as well.

Second, the data reveal considerable heterogeneity among these countries, which may be attributed to unique macroeconomic conditions or specific de-dollarization policies. The persistence of financial dollarization, even during periods of macroeconomic stability, highlights the importance of diverse regulatory measures in addressing the challenges associated with financial dollarization. For example, Brazil and Mexico have enforced restrictions on foreign currency deposits (Galindo and Leiderman, 2005), South Korea has levied taxes on certain foreign currency liabilities (Ahn et al., 2022), India has set caps on foreign currency borrowing (Acharya and Vij, 2024), and and Chile has imposed capital controls on carry trade inflows Keller (2019). These diverse policies underscore the importance of establishing a clear framework to quantify the costs and benefits of each approach within various institutional settings, a key contribution of this paper.

2.2 Dollar intermediation in Türkiye

In Türkiye, the financial system comprises 55 commercial banks, of which 35 are deposit-taking institutions. These 35 banks hold over 80 percent of the system's total assets. The breakdown of these assets is approximately 50 percent in private banks, 15 percent in foreign banks, 30 percent in state banks, and 5 percent in participation banks. Given that participation banks adhere to unique lending standards, this study primarily focuses on private, foreign, and state banks that create deposits.[9] These banks serve as effective representations of emerging market economies.

Each bank offers its customers the option to hold deposits and obtain loans in dollars, in addition to those in local currency. While firms are permitted to borrow in dollars, a legal prohibition prevents households from doing so.[10] However, both firms and households can freely convert their local currency deposit balances into dollars, which are also held as deposits at the same banks. The majority of firms that borrow in dollars lack natural or financial hedges, making them significantly short in dollars and vulnerable to currency mismatches. In contrast, households, restricted by law from holding dollar debt, tend to save in dollars, thus maintaining a long position

[9]The term "participation banking" refers to Islamic banking in Türkiye and the broader MENA region. These banks offer services compliant with Islamic law, enabling them to conduct various banking activities in accordance with Islamic principles.

[10]On June 16, 2009, the Turkish government implemented a policy change by removing a provision from its existing laws that previously permitted Turkish residents to borrow funds denominated in foreign currency from domestic banks for consumption purposes. This alteration marked a significant milestone as it effectively put an end to the practice of foreign currency lending to consumers in Türkiye. Corporations are still allowed to borrow in foreign currency.

in dollars. Consequently, both entities display open foreign exchange positions on their balance sheets.

While there are no regulations specifically restricting households' and firms' exposure to exchange rate risks, banks are legally required to hedge their foreign currency positions. Banks' total foreign currency exposure—including both on-balance and off-balance sheet items—is strictly capped at a level proportional to their equity. Moreover, banks are required to maintain reserves in both domestic and foreign currencies, calculated as percentages of their deposits in the respective currencies.

Table A2 presents two distinct snapshots of the banking sector's aggregate balance sheet, comparing data from July 2010, a year following the global financial crisis, and April 2017, a year before the Turkish debt crisis of 2018. These snapshots offer key insights into the sector's evolution. On the asset side, the total assets of banks increased by around 50% in US dollar terms, climbing from $500 billion in October 2009 to approximately $740 billion by April 2017. This period saw significant shifts in the currency composition of assets, with the proportion of dollar-denominated assets increasing by around 10 percentage points. It is important to note that this increase primarily resulted from an expansion in dollar lending by domestic banks.

On the liability side, I categorize liabilities into deposits and non-deposit liabilities. Deposits include household and commercial deposits, both insured and uninsured. Non-deposit liabilities represent other, more fragile forms of bank funding, such as bilateral cross-border loans, that are prone to sudden dry-ups. During the study period, the growth of the banking sector was predominantly driven by increases in non-deposit liabilities, as illustrated in Table A2. The share of deposits decreased from 63% to approximately 56% of total liabilities, while non-deposit liabilities increased from about 25% to over 33% of total liabilities. This rise in non-deposit liabilities was significantly influenced by capital inflows, predominantly short-term dollar-denominated loans from non-residents.

Furthermore, Table A2 highlights that banks significantly engage in off-balance-sheet operations to manage their on-balance-sheet foreign exchange exposure. The table demonstrates a notable growth in the importance of off-balance-sheet items, which have tripled in absolute foreign currency terms. In 2010, 12 percent of foreign currency liabilities were backed by off-balance-sheet foreign currency assets, increasing to 18 percent by 2017.

2.3 Data and Summary Statistics

All data for this study were collected and managed by the Banking Regulation and Supervision Agency of Türkiye and were provided to us by the Central Bank of the Republic of Türkiye (CBRT). The dataset spans from July 2010, a year after the global financial crisis, to April 2017, just prior to the Turkish debt crisis in 2018. It consists of multiple micro-level panel datasets that I have combined for comprehensive analysis.

First, I compiled data on the composition of banks' on- and off-balance sheet items and their income statements, categorized by currency. This dataset contains monthly records of various

components, such as deposits, loans, non-performing loans, derivatives transactions, and income statement entries like interest and non-interest income. I complemented these records with time-varying bank-level characteristics, including the number of branches, ATMs, and employees. I also incorporated confidential data concerning deposit rates differentiated by bank, currency, and deposit type. Additionally, monthly data on banks' probability of default were obtained from the Credit Research Initiative (CRI) at the National University of Singapore.[11]

Second, I collated data from three credit registries: household, corporate, and international. These registries offer transaction-level details on consumer and commercial loans, and cross-border borrowings by domestic banks. The panel structure of these registries facilitates the tracking of individual loans, pinpointing default occurrences and their timing. The data include comprehensive loan attributes such as interest rates, maturity and extended maturity dates, credit limits, loan currency, detailed industry codes for activity classification, and loan types (e.g., mortgages, credit cards). It also includes bank-determined risk measures for the loans. This dataset provides a complete view of each bank's loan issuance activities beyond the simple stock of loans, filling a gap noted in existing literature, which typically focuses only on stock data or, at most, on mortgage origination data. (Aguirregabiria et al., 2019; Albertazzi et al., 2022; Wang et al., 2022)

Lastly, I complemented the dataset with information on the expectations of major financial institutions and large non-financial corporates, as well as government bondholders. I also integrated a series of macroeconomic and financial market variables from Bloomberg, including spot and forward exchange rates, and money market rates across different currencies and yields. Table A3 summarizes the data.

3 Stylized Facts

In this section, I present five stylized facts about financial dollarization in emerging market economies, derived from both macro- and micro-level data as detailed in Section 2.3. These findings provide the empirical foundation for the modeling approach discussed in the subsequent section.

Fact 1. Depositors are willing to pay a premium to save in foreign currency. Figure A2 presents a comparative analysis of monthly interest rates on local currency deposits versus foreign currency deposits, factoring in the expected exchange rate depreciation in Argentina, Chile, Peru, Russia, and Türkiye. This comparison uncovers a uniform trend across emerging market economies: a marked preference among depositors for higher interest rates on local currency deposits over foreign currency deposits. This trend highlights the non-monetary value depositors assign to foreign currency deposits, showcasing their willingness to accept a premium for the benefits of saving in foreign currency. Such a premium is widely recognized as the cost for households to protect themselves against the consumption risk associated with foreign currency pricing (Gopinath and Stein, 2020) and to guard against financial instability (Bocola and Lorenzoni, 2020). These findings provide a strong basis for the design of an empirical model, which is tailored to reflect depositor

[11] For the methodology, see https://nuscri.org/en/.

preferences for the currency denomination of their deposits. Consequently, the model quantifies the premium depositors are willing to pay for foreign currency deposits relative to local currency, enabling a thorough analysis of the benefits households derive from internal financial dollarization.

Fact 2. Foreign currency-denominated loans carry significant discounts relative to local currency loans. Banks, considering depositors' preference for saving in foreign currencies, can choose to obtain funding in foreign currencies and offer loans in local currency, taking on the potential risk of a foreign exchange mismatch. Alternatively, they may choose to pass the discount on foreign currency deposits on to their borrowers by offering inexpensive foreign currency credit. As previously mentioned, in many emerging markets, regulatory mandates require banks to closely match their foreign currency assets and liabilities. Therefore, this analysis primarily concentrates on the impact of offering loans denominated in foreign currency at a discount.

First, I define the credit spread of loan l issued in month t, denoted as spread_{lt}, to represent the differential between the interest rate on the loan and the risk-free rate applicable to the loan's currency denomination. This spread is adjusted for either Covered Interest Parity (CIP) or Uncovered Interest Parity (UIP) relative to the corresponding risk-free rates. Specifically, the calculation of spread_{lt} is articulated as follows:

$$spread_{lt} \equiv \left(i_{lt} - r_t^{c(l)}\right) + 1\{D_{c(l)} = 1\}\left[r_t^{LC} - r_t^{FC} + (z_t - s_t)\right] \tag{1}$$

Here, i_{lt} is the interest rate on loan l originated in month t; $r_t^{c(l)}$ is the risk-free rate in the loan's currency, either foreign currency or local currency; s_t represents the log spot exchange rate, quoted in local currency per foreign currency, and z_t is used for the log forward rate in the case of Covered Interest Parity (CIP) adjustments or the survey expectation of the exchange rate for Uncovered Interest Parity (UIP) adjustments. Finally, the term $D_{c(l)}$ is an indicator that equals one if loan l is in a foreign currency (i.e., $c(l) = FC$), signifying the loan's currency denomination.

Building on this definition, I employ an empirical model to quantify the residualized credit spread differential between loans denominated in local currency and those in foreign currency:

$$spread_{lt} = \beta D_{c(l)} + \Gamma X_{lt} + \alpha_{b(l),t} + \gamma_{j(l),t} + \varepsilon_{lt} \tag{2}$$

where X_{lt} includes controls for loan amount and maturity as the loan characteristics. Additionally, the terms $\alpha_{b(l),t}$ and $\gamma_{j(l),t}$ represent fixed effects for bank-time and firm-time, respectively. The primary focus of this analysis is the dummy variable Equation 2, $D_{c(l)}$, through which the model measures the relative cost of borrowing, whether hedged or unhedged. A negative estimate for β signifies a cost advantage linked to borrowing in foreign currency.

In the baseline specification, I control for loan size and loan maturity. I introduce bank-year-quarter fixed effects denoted as $\gamma_{j(l),t}$ to account for time-varying bank heterogeneity. I incorporate borrower fixed effects to mitigate potential demand-related explanations for differential loan rates, including considerations of firm size, geographical location, and industry classification. In an

alternative specification aimed at restricting the influence of loan-demand effects on the results, I introduce borrower-year-quarter fixed effects. The identification strategy in this case relies on firms securing a minimum of two loans within the same quarter – one denominated in foreign currency and the other in local currency. The results are robust to the inclusion of these fixed effects.

Table A4 summarizes the results. The first and fourth columns present the findings based on the baseline specification, drawing on observations from the entire sample. In the subsequent columns, I restrict the sample to firms that have participated in borrowing in both currencies at least once within any given year-quarter. The key finding that emerges across all model specifications is the notable difference in unhedged borrowing costs, which favors borrowing in foreign currencies over local currencies. In contrast, when hedging is applied, the cost differential between borrowing in local and foreign currencies becomes marginal. Quantitatively, the findings indicate that the borrowing cost in foreign currency is on average 577 basis points lower than that in local currency when unhedged, narrowing to a mere 35 basis points when hedged. As mentioned in Section 2.2, a substantial majority of the firms in the sample do not engage in financial hedges. Consequently, for most firms, the key factors affecting their decision-making processes are the expected movements in exchange rates and the associated unhedged discount.

Fact 3. Wholesale funding in foreign currency faces higher run vulnerability than uninsured deposits. The role of uninsured depositors in explaining which banks encounter trouble has been extensively examined, both empirically and theoretically, within the prevailing literature, albeit predominantly in the context of advanced economies. (Jiang, 2023; Chang et al., 2024; Egan et al., 2017; Albertazzi et al., 2022) Recent developments underscore this theme, as exemplified by the substantial presence of uninsured deposits at Silicon Valley Bank and the consequential losses in its significant securities portfolio amid escalating interest rates. These occurrences have contributed to a narrative attributing the Regional Banking Crisis of 2023 to the concerns of flighty uninsured depositors apprehensive about potential bank defaults.

Nevertheless, within the realm of emerging markets, scholarly focus—particularly in the aftermath of the global financial crisis—has predominantly centered on the vulnerability of the banking system to runs originating from wholesale foreign currency funding obtained from non-resident banks. (Schnabl, 2012) As the next stylized fact, I empirically examine which channel is pronounced in the context of Türkiye using granular bank-level data. Specifically, I conduct separate regression analyses to assess the impact of banks' financial health on the growth in funding acquired by them from insured depositors and non-resident banks, controlling for both bank-specific and time-invariant characteristics.

Table A5 presents the results. I observe no statistically significant evidence indicating a reduction in uninsured deposit funding following an escalation in the probability of default for banks. However, the findings reveal a noteworthy decline of 3 percentage points in the growth of wholesale foreign funding for every 100 basis points increase in the banks' default risk. This observation guides the modeling approach, highlighting the significance of feedback mechanisms between

the financial distress of banks and foreign wholesale funding. In contrast to the approach taken by Egan et al. (2017) and Albertazzi et al. (2022), this model prioritizes the relationship between banks' default risk and foreign wholesale funding over the connection with uninsured depositors.

Fact 4. Domestic banks' reliance on foreign-currency denominated wholesale funding weakens the transmission of local monetary policy to local currency loan rates. As discussed in Section 1 and documented in various macro-finance papers, the improvement in global liquidity conditions may impede the transmission of local monetary policy to local markets. (Rey, 2013; Fabiani et al., 2022; Cao and Dinger, 2022) I investigate whether the detailed credit registry data offers corroborative evidence in this regard. Specifically, I examine whether banks relying more on wholesale foreign currency funding adjust their local currency-denominated loan rates differently in response to local monetary policy tightening. To explore this, I use the following empirical specification:

$$i_{lt} = \alpha_{j(l),t} + \delta_{b(l)} + \sum_{\tau=0}^{3} \gamma_\tau \times \left(\Delta r_{t-\tau} \times \text{Wholesale USD Funding Share}_{j(l),t-\tau}\right) + \varepsilon_{lt} \tag{3}$$

where i_{lt} represents the interest rate level on the local currency loan l originated in month t, and $\Delta r_{t-\tau}$ denotes the change in the local monetary policy rate from month $t-\tau$ to t. The term "Wholesale USD Funding Share" is defined as the ratio of wholesale foreign currency funding to total assets. Additionally, $\alpha_{j(l),q(t)}$ accounts for bank-year-quarter fixed effects, capturing unobserved time-varying bank characteristics, while $\delta_{b(l)}$ represents borrower fixed effects, absorbing any unobserved time-invariant firm characteristics. Furthermore, the model incorporates several monthly macro variables.

In the specification above, I examine whether banks with a higher global funding share exhibit a smaller increase in their loan rates following a local monetary tightening, expressed as $\sum_{\tau=0}^{3} \gamma_\tau < 0$. The first column in Table A6 presents the primary result: banks relying more on foreign funding increase their loan rates significantly less after a local monetary policy tightening. Quantitatively, following a cumulative 100 basis point increase in the local policy rate over the preceding three months, a bank at the 90th percentile of "Wholesale USD Funding Share" raises its loan rate by approximately 31.93 basis points less than a bank at the 10th percentile.

Next, I extend the empirical specification in Equation 3 by introducing a triple interaction term involving (i) changes in local policy rates, (ii) banks' wholesale follar funding share, and (iii) the change in the Wu-Xia Shadow Federal Funds Rate, Δr_t^{US}, which serves as a proxy for global liquidity conditions.[12] This extension seeks to investigate whether softer global liquidity conditions mitigate the transmission of local monetary policy. The extended equation is presented

[12]The Wu-Xia shadow rate represents the effective minimum threshold for interest rates, particularly in situations where conventional monetary policy benchmarks, such as the Federal Reserve's federal funds rate, have reached or are near zero. The shadow rate broadens the concept of interest rates to include negative values, allowing economists and policymakers to assess the impact of unconventional monetary policies as though they were standard policy changes below zero. Lower shadow rates, therefore, indicate more favorable global liquidity conditions.

as follows:

$$i_{lt} = \alpha_{j(l),t} + \delta_{b(l)} + \sum_{\tau=0}^{3} \gamma_\tau \times \left(\Delta r_{t-\tau} \times \text{Wholesale USD Funding Share}_{j(l),t-\tau} \times \Delta r_t^{USD}\right) + \varepsilon_{lt} \quad (4)$$

where I retain the previous variable definitions. The primary coefficient of interest remains $\sum_{\tau=0}^{3} \gamma_\tau$. I hypothesize that this sum is positive, implying that a softening in global liquidity conditions weakens the effectiveness of local monetary policy tightening.

The findings presented in the second column of Table A6 indeed support the argument that softer global liquidity conditions diminish the transmission of local monetary policy tightening. Quantitatively, following a cumulative 100 basis point increase in the local monetary policy rate, banks relying more on foreign funding increase their loan rates by 47.78 basis points less when the Wu-Xia Shadow Federal Funds Rate is lower by 100 basis points.

Fact 5. Higher non-resident ownership of local-currency government bonds is associated with an increased sensitivity to global risk conditions. Historically, emerging market economies seeking external financing were primarily limited to obtaining funds exclusively in foreign currencies. Eichengreen and Hausmann (1999) describe this as "original sin." The resulting currency mismatches, however, have been identified as a significant factor contributing to financial dislocations and amplifying crises. Following the emerging market crises of the 1990s, emerging market economies have developed deeper domestic capital markets. This development has been accompanied by a significant increase in the participation of global portfolio investors in local currency-denominated sovereign bonds. While the rapid growth of these local currency bond markets appeared to mitigate the "original sin" problem by reducing vulnerabilities related to currency mismatches, it has become evident that issuing debt in local currency does not entirely shield borrowers from fluctuations in global financial conditions. This is because even when debt is denominated in the local currency, it does not eliminate currency risk; rather, it shifts this risk to foreign investors, exposing them to exchange rate fluctuations. Carstens and Shin (2019) refer to this transfer of currency risk from the borrower to the lender as "original sin redux."

In Figure A3, I examine the relationship between sensitivity to global risk and foreign participation in local-currency government bond markets across various emerging market economies. To do this, I first calculate the sensitivity of 5-year local-currency government bond yields to fluctuations in global shocks, as measured by the VIX index. The figure reveals a notable relationship between the responsiveness of local financial conditions to foreign shocks and the proportion of local-currency sovereign bonds held by foreign investors, with greater foreign ownership amplifying the impact of external influences on domestic financial conditions.

4 Model Framework

This section begins with an overview of the model economy. It then details the preferences and demand systems of depositors, borrowers, and local-currency denominated government bond investors, based on loan and deposit rates, bond prices, and both spot and forward exchange rates. Following this, the section outlines the optimization problems faced by domestic banks, non-resident banks, and non-resident currency traders, deriving their respective supply systems from these problems. The section concludes by characterizing the equilibrium of the model

4.1 Model

Figure A4 outlines the structure of our model economy. This static model features several sets of actors: (i) domestic banks, (ii) depositors, (iii) borrowers, (iv) investors in local-currency-denominated government bonds, (v) non-resident banks, and (vi) non-resident currency traders. Domestic banks, central to the model, invest in loans denominated in both local currency and foreign currency, hold central bank reserves in these currencies, and invest in local-currency-denominated government bonds. Their liabilities consist of local and foreign currency deposits issued to resident households and corporates. Additionally, they secure funding from non-resident banks via bilateral foreign currency loans, which are susceptible to runs. Finally, domestic banks secure local currency funding through the wholesale funding market.

Investing and raising funds in multiple currencies expose domestic banks to exchange rate risks. To mitigate this exposure on their balance sheets, as required by regulations, they engage in synthetic forward transactions with non-residents and actively participate in both the FX spot and swap markets.[13] Figure 2 provides the stylized overview of a domestic bank's balance sheet.

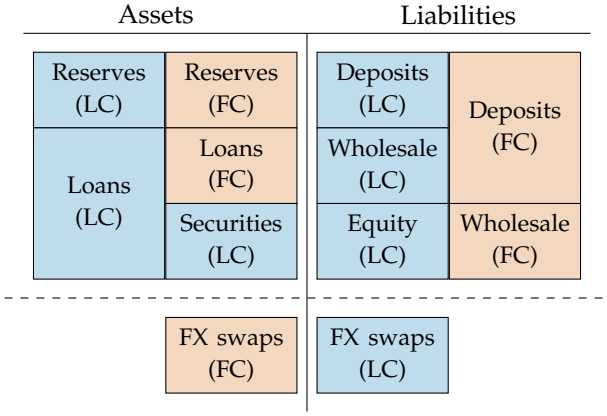


Figure 2. Stylized view of a domestic bank's balance sheet. This figure presents a stylized view of a domestic bank's balance sheet, categorizing assets (on the left) and liabilities (on the right) in local (LC) and foreign (FC) currencies. The section above the dashed line shows on-balance sheet items, while the section below the dashed line details off-balance sheet items. FX swaps are shown in net terms. Different colors are used to indicate the type of currency for clarity: red for foreign currency and blue for local currency.

[13] Please refer to Appendix C for technical details on the creation of these synthetic forward positions.

The model also incorporates the possibility of endogenous bank defaults, allowing for multiple equilibria with self-fulfilling solvency bank runs. These runs are driven by the interplay between the default risk of domestic banks and the pricing decisions of run-prone non-resident banks. Banks default if, upon experiencing a loss, their expected equity value in the next period is lower in absolute terms than the incurred loss.

In addition to domestic banks, the model includes non-resident currency traders and non-resident banks on the supply side. Non-resident currency traders, who play a passive role, solely supply foreign currency liquidity in the FX spot and swap markets. Their participation is driven by risk aversion and balance sheet capacity. Non-resident banks, characterized by heterogeneous and time-varying marginal costs of providing foreign currency loans to domestic banks, play an essential role. They supply foreign currency loans to domestic banks and set loan rates through posted pricing. Crucially, as highlighted by the third stylized fact in Section 3, these non-resident banks incorporate the default risk of domestic banks into their pricing decisions. This creates a positive feedback loop between non-resident banks and the financial health of domestic banks, potentially leading to multiple equilibria.

Finally, authorities control both monetary and prudential policies. They conduct monetary policy by exogenously setting the interest rate in the local currency wholesale funding market, thereby regulating overall liquidity provision. The equilibrium of the model, contingent on the central bank's interest rate, determines a bank's net position in the local currency interbank market. Based on the net positions of private banks, the central bank's position is also endogenously determined to ensure the clearing of the interbank market. On the prudential regulation front, authorities set reserve requirements and remuneration ratios for both currencies and enforce various prudential measures

A crucial aspect of my model is that banks' balance sheet management, amid both internal and external financial dollarization under regulatory constraints, introduces a significant amplification mechanism that could potentially destabilize the entire banking system. Specifically, individual banks do not internalize how their joint behavior affects the level of exchange rates at the macro level. This key insight, absent in Egan et al. (2017) and Albertazzi et al. (2022) that focus on banking sectors operating with a single currency, represents a distinctive feature of this study.

4.2 Demand systems

The demand side of the model comprises three main groups of agents: depositors, borrowers, and investors in government bonds denominated in local currency. Each month, depositors decide how to allocate a predefined amount of funds among various deposit products. These products are offered either by domestic banks, referred to as inside banks, or through an outside option. This outside option consists of placing funds with a collection of smaller, fringe banks, termed outside banks. The definition of the outside option excludes extensive margin activities, a decision supported by the insights from Figure A5 and Figure A6. These figures reveal negligible inflows and outflows of funds within the banking sector, justifying the rationale for excluding extensive

margin activities in this context.

Similarly, borrowers meet their predetermined financing needs by choosing loan products offered by inside banks. Like depositors, borrowers also have the option to seek financing from smaller fringe banks, referred to as the outside option. However, there is a key difference: for loans, I focus on flow measures, whereas for deposits, I concentrate on stock measures. I will explain the rationale behind this modeling choice later in the discussion. Additionally, borrowers must decide whether to default on their loans.

Finally, investors in local-currency-denominated government bonds optimally allocate their portfolios across different bond maturities. I assume the portfolio's total size remains constant and unchanged across different counterfactual scenarios.

Depositor preferences. The economy consists of two primary depositor groups: households ($d = H$) and corporates ($d = F$). Each depositor group, denoted by d, is endowed with a total amount of funds, $\mathcal{W}_t^d$, available at time t. I assume that depositors make discrete choices from among a set of deposit products, labeled by $k \in \{0, 1, \ldots, \mathcal{K}\}$, for the allocation of their endowments.[14] A deposit product is characterized by three non-price attributes: (i) the issuing bank, indexed by $j \in 1, 2, \ldots, \mathcal{J}$; (ii) the currency denomination of the account, labeled by $c \in \{\text{LC}, \text{FC}\}$; and (iii) the type of deposit account, distinguishing between demand and term deposits.

Table 1. Overview of services provided by deposit products

This table displays the specific features offered by different types of deposit products, including local currency (LC) and dollar denominated deposits. It compares the availability of interest rates, hedging benefits, and transaction convenience across four distinct deposit types: LC term deposits, LC demand deposits, dollar term deposits, and dollar demand deposits. The "Yes" indicates the availability of a feature, while a dash "–" denotes its absence.

	Interest rate	Hedging benefit	Transaction convenience
LC term deposits	Yes	–	–
LC demand deposits	–	–	Yes
Dollar term deposits	–	Yes	–
Dollar demand deposits	Yes	Yes	–

Demand for deposit product k at time t is influenced by two primary factors: (i) the expected return, denominated in local currency, and (ii) the ancillary services offered to depositors. Depositor i of type d, when offered an interest rate r_{kt}^d, derives utility $\alpha^d \mu_{kt}^d$ from choosing deposit product k at time t. The expected return μ_{kt}^d for deposit product k at time t is defined based on the currency in which the returns are calculated:

$$\mu_{kt}^d = \begin{cases} r_{kt}^d, & \text{if } c(k) = LC \\ r_{kt}^d + \mathbb{E}_t(\Delta s_{t+1}), & \text{if } c(k) = FC \end{cases}$$

[14] This setup can be interpreted as each depositor making multiple discrete choices per unit of available funds, with the probability of choosing each option considered as a portfolio weight (Wang et al., 2022).

Here, r_{kt}^d is the interest rate offered to depositor i of type d for product k at time t. The function $c(k)$ determines the currency type of the returns. When returns are in foreign currency, the expected return also includes the expected (log) change in the spot exchange rate, Δs_{t+1}, between time t and $t+1$.

Depositors also derive utility from the various services associated with deposit product k, represented as $F_{kt}(X_{kt}) + \varepsilon_{ikt}^d$. Here, $F_{kt}(X_{kt})$ quantifies the value depositors place on the services linked to product k, while ε_{ikt}^d represents an idiosyncratic utility shock that depositor i of type d experiences upon choosing product k. I parameterize the function $F_{kt}(X_{kt})$ as follows:

$$F_{kt}(X_{kt}) = \beta^d X_{kt}^d + \xi_{kt}^d$$

where X_{kt} includes the observable product characteristics, β^d reflects depositors' sensitivity to these characteristics, and ξ_{kt}^d is a product-time-specific term that captures the unobservable value depositors derive from the services of product k at time t. The observable characteristics in X_{kt} are particularly noteworthy. They include binary indicators for features such as whether the deposit product offers hedging benefits against currency fluctuation and whether it provides transaction services (see Table 1). Additionally, X_{kt} includes time-varying bank characteristics such as the number of branches, the average number of employees per branch, and ATM availability, each of which can affect depositor choices.

Finally, I define the total indirect utility derived by depositor i of type d from product k at t as follows:

$$\mathcal{U}_{ikt}^d = \underbrace{\alpha^d \mu_{kt}^d + \beta^d X_{kt}^d + \xi_{kt}^d}_{\overline{U}_{kt}^d} + \varepsilon_{ikt}^d \tag{5}$$

where $\overline{U}_{kt}^d$ is the mean utility of product k at t. I normalize to zero the utility from choosing the outside option. I also normalize to zero the utility from choosing the outside option, $k = 0$.

The depositor's problem is then to choose the deposit product that offers the highest utility among all products $k \in \{0, 1, \ldots, \mathcal{K}\}$, given the menu of offered deposit rates $(r_{kt}^d, \mathbf{r_{-kt}^d})$ and the spot exchange rate (S_t). Following standard assumptions in discrete choice demand models, I assume that the utility shocks ε_{ikt}^d are independently and identically distributed following a Type 1 extreme value distribution. Consequently, the quantity of deposits invested in product k by depositors of type d at time t is determined by the following expression:

$$\mathcal{D}_{kt}^d(r_{kt}^d; \mathbf{r_{-kt}^d}, S_t) = \mathcal{W}_t^d \left[\frac{\exp(\overline{U}_{kt}^d)}{1 + \sum_{k'} \exp(\overline{U}_{k't}^d)} \right] \tag{6}$$

Borrower preferences and default. The modeling approach for loan demand is similar to that for deposits, but with a crucial distinction: for loans, I focus on flow measures, whereas for deposits, I concentrated on stock measures. This distinction is based on the relative flexibility consumers

have with deposits—they can choose where to keep their deposit stock with relative ease. In contrast, consumers are generally unable to shift their existing loan stock due to high switching costs. Instead, they can only adjust their demand for new loans or refinancing options each period across different products. This focus on loan demand rather than loan stock is necessary because the costs of transferring loans, such as financial penalties and prepayment fees, are significantly higher than the minor time and effort costs involved in moving deposits between banks.[15]

The model features three categories of new borrowers: mortgage borrowers ($b = M$), unsecured consumer loan borrowers ($b = C$), and corporate loan borrowers ($b = F$). I define the total financing needs of each borrower type b at time t as $\mathcal{F}_t^b$. In each period t, these borrowers select from a set of loan products, indexed by $l \in \{0, 1, 2, \ldots, \mathcal{L}\}$, to meet their financial requirements. Mortgage and consumer loan borrowers are restricted to borrowing in local currency, whereas corporate borrowers may choose loans in either local or foreign currency. Thus, a product for consumer and mortgage loans is identified solely by the lending bank, while for corporate loans, it is identified by both the bank and the loan's currency denomination.

The indirect utility derived by borrower i of type b from product l at time t is expressed as:

$$\mathcal{U}_{ilt}^b = \underbrace{\alpha^b \mu_{lt}^b + \beta^b X_{lt}^b + \delta_{lt}^b}_{\overline{U}_{lt}^b} + \varepsilon_{ilt}^b \tag{7}$$

where μ_{lt}^b represents the expected borrowing cost (in local currency terms), calculated as:

$$\mu_{lt}^b = \begin{cases} r_{lt}^b, & \text{if } c(l) = LC \\ r_{lt}^b + \mathbb{E}_t(\Delta s_{t+1}), & \text{if } c(l) = FC \end{cases}$$

Here, all remaining terms are defined as previously described. Consequently, the demand function for borrower type b for product l at time t can be expressed as follows:

$$\mathcal{D}_{lt}^b(r_{lt}^b; \mathbf{r}_{-\mathbf{lt}}^{\mathbf{b}}, S_t) = \mathcal{F}_t^b \left[\frac{\exp(\overline{U}_{lt}^b)}{1 + \sum_{l'} \exp(\overline{U}_{l't}^b)} \right] \tag{8}$$

Additionally, I let borrower i of type b default on her loan based on the following indirect utility function:

$$\mathcal{U}_{ilt}^{b,D} = \underbrace{\alpha^{b,D} r_{lt}^b + \beta^{b,D} X_{lt}^b + \delta_{lt}^{b,D}}_{\overline{U}_{lt}^{b,D}} + \varepsilon_{ilt}^{b,D} \tag{9}$$

which yields the following share of defaulting borrowers of type b on product l, expressed as a

[15] This modeling choice is similar to Aguirregabiria et al. (2019). However, the richness of data here provides a more complete picture of issuance activity, as opposed to their framework, which focuses only on mortgages due to data limitations.

function of the loan rate and the spot exchange rate:

$$d_{lt}^{b,D}(r_{lt}^{b,D}; S_t) = \left[\frac{\exp(\overline{U}_{lt}^{b,D})}{1 + \sum_{l'} \exp(\overline{U}_{l't}^{b,D})} \right] \tag{10}$$

Demand for local currency denominated government bonds. I adopt the demand system approach to asset pricing developed by Koijen and Yogo (2019) to model the demand curves for two distinct groups: (i) non-bank resident investors and (ii) non-resident bond investors, focusing on local-currency-denominated government bonds. For each investor group i, I denote the book value of their holdings within a given maturity bucket $m \in \mathcal{M}$ as $\mathcal{D}_t^i(m)$. The holdings of the outside asset are denoted as $\mathcal{O}_t^i$. The portfolio weights are derived as follows:

$$w_t^i(m) = \frac{\mathcal{D}_t^i(m)}{\mathcal{O}_t^i + \sum_h^H \mathcal{D}_t^i(m)} = \frac{\delta_t^i(m)}{1 + \sum_m^{\mathcal{M}} \delta_t^i(m)} \tag{11}$$

where

$$\delta_t^i(m) \equiv \mathcal{D}_t^i(m)/\mathcal{O}_t^i = \exp\Big(\alpha^i + \beta^i y_t(m) + \gamma^i X_t(m)\Big)\varepsilon_t^i(m) \tag{12}$$

Demand for a given maturity bucket m depends on several factors: the average yield $y_t(m)$, a set of asset characteristics $X_t(m)$, and an unobserved latent demand component $\varepsilon_t^i(m)$. This latent component accounts for variations in expected returns and perceived risks, which differ across investors and assets. The asset characteristics include average coupons, duration, convexity, and the total amount outstanding, following the methodology outlined by Jansen (2021). A key focus of our analysis is β^i, a parameter that measures the sensitivity of demand from investor group i to changes in bond prices.

4.3 Supply systems

The supply side of the model includes three distinct groups: domestic banks, non-resident banks, and non-resident currency traders. Domestic banks make decisions regarding their portfolio allocation, funding composition, and survival. Non-resident banks play a crucial role in meeting the foreign currency funding needs of domestic banks by offering cross-border loans and optimally setting loan prices. Finally, non-resident currency traders optimize their net provision of foreign currency liquidity across both spot and forward currency markets.

Domestic Banks. At the core of the model are domestic banks that facilitate intermediation in both local and foreign currencies. Each bank selects its portfolio of assets and liabilities across these currencies. Additionally, banks decide on their survival based on whether equity holders, subject to limited liability, find it profitable to cover any potential shortfalls.

On the asset side, banks maintain three primary classes of assets: (i) loans issued to households and firms in both local and foreign currencies, (ii) local-currency-denominated government bonds, and (iii) central bank reserves in both currencies. To meet their funding needs, banks have several

options: (i) borrowing local currency from the wholesale market at a rate set by the central bank, (ii) borrowing foreign currency from non-resident banks, (iii) issuing local- and foreign-currency-denominated deposits to residents, or (iv) engaging in synthetic forward creation.

The expected return of bank j at time t, denoted by $\mathbb{R}_{jt}$, depends on its diverse asset portfolio, which includes (i) its loan portfolio, (ii) holdings of government bonds denominated in local currency, and (iii) holdings of remunerated reserves. The calculation of $\mathbb{R}_{jt}$ is as follows:[16]

$$\mathbb{R}_{jt} = \underbrace{\sum_{b\in\{M,C,F\}} \sum_{l\in L_j, c(l)=LC} \mathcal{D}^b_{lt}(r^b_{lt}; \mathbf{r^b_{-lt}}, S_t)\left[R^b_{lt}\left(1-\Phi^b_{lt} d^{b,D}_{lt}(r^b_{lt}; S_t)\right)\right] + \mathcal{R}_{jt}R^r_t + \mathcal{S}_{jt}\Sigma_s(\mathbb{N}_{jt};\rho_{jt})}_{\text{Local currency assets}}$$
$$+\frac{F_t}{S_t}\underbrace{\left\{\sum_{l\in L_j, c(l)=FC} \mathcal{D}^F_{lt}(r^F_{lt}; \mathbf{r^F_{-lt}}, S_t)\left[R^F_{lt}\left(1-\Phi^F_{lt} d^{F,D}_{lt}(r^b_{lt}; S_t)\right)\right] + \widetilde{\mathcal{R}}_{jt}\widetilde{R}^r_t\right\}}_{\text{Foreign currency assets}} \tag{13}$$

where

- R^b_{lt} is the gross interest rate set by bank $j(l)$ for loan product $l \in L_j$, targeting borrower type b at time t;
- $\mathcal{R}_{jt}$ and $\widetilde{\mathcal{R}}_{jt}$ denote the volumes of reserves held in local and foreign currencies, respectively;
- R^r_t and $\widetilde{R}^r_t$ are the remuneration rates for reserves in local and foreign currencies, set by the central bank;
- $\Sigma_s(\mathbb{N}_{jt};\rho_{jt})$ represents the expected net benefit to bank j from holding each unit of local currency denominated government bond $\mathcal{S}_{jt}$ at time t; and
- Φ^b_{lt} indicates the loss given default for loans to borrower type b in loan product l, with values ranging between 0 and 1.

Additionally, the demand function for borrower type b for loan product l in month t, $\mathcal{D}^b_{lt}(r^b_{lt}; \mathbf{r^b_{-lt}}, S_t)$, and the proportion of type b borrowers defaulting on product l during the same period, $d^{b,D}_{lt}(r^b_{lt}; S_t)$, are specified in Equation 8 and Equation 10, respectively. On the other hand, the total expected cost of bank j's balance sheet can be formulated as follows:

$$\mathbb{C}_{jt} = \underbrace{\mathcal{C}^O_{jt}(\Theta_{jt};\Gamma_{jt})}_{\text{Operational costs}} + \underbrace{\mathcal{C}^H_{jt}(\mathbb{H}_{jt};\Omega_{jt})}_{\text{Costs of wholesale funding}} + \sum_{d\in\{H,F\}} \sum_{k\in\mathcal{K}_j, c(k)=LC} \mathcal{D}^d_{kt}(r^d_{kt}; \mathbf{r^d_{-kt}}, S_t)R^d_{kt} + \mathcal{M}_{jt}R^m_{jt}$$
$$+\frac{F_t}{S_t}\left\{\sum_{d\in\{H,F\}} \sum_{k\in\mathcal{K}_j, c(k)=FC} \mathcal{D}^d_{kt}(r^d_{kt}; \mathbf{r^d_{-kt}}, S_t)R^d_{kt} + \widetilde{\mathcal{M}}_{jt}\widetilde{R}^m_{jt}\right\} \tag{14}$$

[16] I will follow this convention throughout the remainder of the paper: variables with a tilde denote foreign currency items, while those without a tilde refer to local currency items.

where

- R^d_{kt} denotes the interest rate that bank $j(k)$ sets for deposit product $k \in K_j$, aimed at depositor type d at time t;
- $\mathcal{M}_{jt}$ and $\widetilde{\mathcal{M}}_{jt}$ represent the volume of other (net) liabilities on the bank's balance sheet in local and foreign currencies, respectively, with R^m_{jt} and $\widetilde{R}^m_{jt}$ are their corresponding prices[17]; and
- $\mathcal{D}^d_{kt}(r^d_{kt}; \mathbf{r^d_{-kt}}, S_t)$ is the demand function for depositors of type d for deposit product k in month t, outlined in Equation 6.

In Equation 14, the term $\mathcal{C}^O_{jt}(\Theta_{jt}; \Gamma_{jt})$ represents the operational costs of bank j at time t, which are not directly observable from the data. These costs arise from lending activities and the provision of services to depositors. The variable Θ_{jt} includes balance sheet items such as the volumes of various types of loans and deposits at bank j, while Γ_{jt} encompasses the parameters that dictate how these quantities influence the bank's overall operational costs. Additionally, $\mathcal{C}^H_{jt}(\mathbb{H}jt; \Omega jt)$ denotes the total costs associated with obtaining funds through the wholesale market. Here, $\mathbb{H}jt$ reflects the total funds that bank j has borrowed from this market, and Ωjt represents the governing parameters related to these borrowing activities. These parameters are fundamental to the model and will be estimated as described in Section 5.

A key aspect of the model is the regulatory environment within which banks operate. The model requires banks to fully hedge their foreign exchange risk exposure. This is a common practice in many emerging markets, including Türkiye, where regulatory constraints limit banks' ability to maintain positions with currency mismatches.[18] To comply with these regulations, banks often resort to off-balance sheet strategies, primarily through synthetic forwards. These financial instruments, which combine FX spot and swap transactions, are used to hedge against exchange rate fluctuations. Therefore, I incorporate the forward premium, F_t/S_t, instead of the expected change in the exchange rate, $\mathbb{E}_t[S_{t+1}/S_t]$, in both the revenue and cost equations to represent complete protection against exchange rate fluctuations.

As part of the regulatory framework, the model introduces reserve requirement regulations that apply to deposits in both local and foreign currencies. These regulations require banks to keep a certain fraction of the deposits, either in local currency or foreign currency, at the central bank. These fractions are represented by θ_t for local currency and $\widetilde{\theta}_t$ for foreign currency. I assume that banks strictly comply with these requirements, maintaining only the necessary reserves at the central bank, with no excess. Introducing a decision variable for excess reserves would complicate the model unnecessarily, as there is limited empirical evidence to support the inclusion of such a variable.

[17] The "other liabilities" components, including both their prices and quantities, are not considered within the model and are therefore kept as constant across all counterfactual scenarios.

[18] Typically, banks are restricted to open FX positions that do not exceed 10 to 20 percent of their equity. However, banks effectively manage their positions; on average, their open FX positions are maintained at just 0.4 percent of their equity, demonstrating significant stability over the study period.

The model posits that the total amount of funds borrowed by bank j at time t from the wholesale market, $\mathbb{H}_{jt}$, is determined by the following expression:

$$\mathbb{H}_{jt} = \theta_{jt}\left[\alpha_{jt}^{1/\eta}\mathcal{H}_{jt}^{\frac{\eta-1}{\eta}} + \widetilde{\alpha}_{jt}^{1/\eta}\widetilde{\mathcal{H}}_{jt}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{15}$$

In this formulation, $\mathcal{H}_{jt}$ and $\widetilde{\mathcal{H}}_{jt}$ represent the volumes of wholesale borrowing in local currency and foreign currencies, respectively. The elasticity parameter $\eta > 0$ measures the ease with which banks can switch their wholesale funding sources between local and foreign currencies. The use of a Constant Elasticity of Substitution (CES) functional form is justified by its capacity to accommodate a variety of scenarios, ranging from fixed proportions of funding sources (as depicted when $\eta = 1$, resulting in a Cobb-Douglas function) to perfect substitutability (as η approaches infinity), thereby allowing banks to flexibly adjust the currency composition of their wholesale funding needs.

The optimization of the wholesale funding mix by banks, under this framework, leads to the following expression for the unit cost of wholesale funding:

$$\mathbb{P}_{jt}^{H} = \theta_{jt}^{-1}\left(\alpha_{jt}p_t^{1-\eta} + \widetilde{\alpha}_{jt}\widetilde{p}_{jt}^{1-\eta}\right)^{\frac{1}{1-\eta}} \tag{16}$$

In this equation, $p_t = R_t^n$ represents the price of local currency wholesale funding, which aligns with the central bank's policy rate. In contrast, $\widetilde{p}_{jt} = \frac{F_t}{S_t}\widetilde{R}_{jt}^{H}$ represents the cost of foreign currency wholesale funding. This cost is influenced by the interest rate set by non-resident banks ($\widetilde{R}_{jt}^{H}$) and the forward premium (F_t/S_t), highlighting the importance of hedging against foreign exchange risks on banks' balance sheets.

I assume that the total cost of wholesale funding is influenced not only by the borrowed amount, as suggested by Wang et al. (2022), but also by a stochastic per-unit funding cost parameter, c_{jt}. This parameter follows a normal distribution under the risk-neutral measure, represented as $c_{jt} \sim N(\mu_{jt}, \sigma_{jt}^2)$. This stochastic component captures the uncertainties in accessing the wholesale market. Challenges include the potential stigma of borrowing in local currency from the central bank and the unpredictable access to funding from non-resident banks, which might decline loan applications. Thus, the total cost of wholesale funding is calculated as follows:

$$\mathcal{C}_{jt}^{H}(\mathbb{H}_{jt}; \Omega_{jt}) = \mathbb{N}_{jt}\left(\mathbb{P}_{jt}^{H} + 0.5c_{jt}\mathbb{H}_{jt}\right) \tag{17}$$

I propose that the expected benefits for bank j from holding a single unit of local currency denominated government bond at time t include not only the expected bond yield (R_{t+1}^{s}), but also specific unobserved net benefits (ρ_{jt}). These benefits are described by the following equation:

$$\Sigma_s(\mathbb{H}_{jt}) = \mathbb{E}_t[R_{t+1}^{s}] + \rho_{jt}\mathbb{H}_{jt} \tag{18}$$

This equation indicates that the unobserved benefits, ρ_{jt}, vary with the bank's funding gap on its balance sheet. The fundamental rationale is that government bonds are essential for securing local currency wholesale funding from the central bank. Commonly used as collateral, these bonds accrue value beyond their direct expected yield. This enhanced value underscores their strategic significance in secured repo operations and other financial activities that necessitate collateral.

Finally, I let banks' risk-neutral equity holders will decide to finance a shortfall if the sum of current profits, Π_{jt}, defined as the difference between Equation 13 and Equation 14, added to the present discounted value of the future equity value of the bank in the next period, $\mathcal{E}_{jt}$, exceeds the shortfall. This decision is based on the following condition:

$$\Pi_{jt} + \mathcal{E}_{jt}/R > 0$$

where the equity value for the next period is determined by the expected net cash flow, conditioned on survival, and multiplied by their survival probability. In other words, I define a threshold level of c_{jt} at which equity holders are indifferent between financing the shortfall at time t and allowing the bank to default, denoted as $\bar{c}jt$. The optimal cutoff rule can then be determined as follows:

$$\begin{aligned} -\Pi_{jt}(\bar{c}_{jt}) &= \frac{1}{R}\Phi\left(\frac{\bar{c}_{jt}-\mu_{jt}}{\sigma_{jt}}\right)\mathbb{E}_c\left[\Pi_{jt}(c_{jt}) - \Pi_{jt}(\bar{c}_{jt})\middle|\Pi_{jt}(c_{jt}) - \Pi_{jt}(\bar{c}_{jt}) \geq 0\right] \\ &= \frac{1}{R}\underbrace{\Phi\left(\frac{\bar{c}_{jt}-\mu_{jt}}{\sigma_{jt}}\right)}_{\text{Survival probability}}\underbrace{\left\{0.5\mathbb{H}_{jt}^2\left[\bar{c}_{jt}-\mu_{jt}+\sigma_{jt}\lambda\left(-\frac{\bar{c}_{jt}-\mu_{jt}}{\sigma_{jt}}\right)\right]\right\}}_{\text{Expected net cash flow conditional on survival}} \end{aligned} \tag{19}$$

Prior to observing the realization of the costs c_{jt}, each bank determines the gross rates for deposits and loans, denoted as R_{kt}^d and R_{lt}^b respectively, and decides on the amount of local currency-denominated government bond holdings, $\mathcal{S}_{jt}$, to maximize its equity value. This involves solving the following optimization problem under conditions of limited liability and risk neutrality, and within the constraints imposed by regulatory requirements and the balance sheet identity.

$$\max_{\{R_{kt}^d, R_{lt}^b, \mathcal{S}_{jt}\}} \int_{-\infty}^{\bar{c}_{jt}} \left\{\Pi_{jt} + \mathcal{E}_{jt}/R\right\} dF(c_{jt})$$

I rewrite the above problem by incorporating the equality constraints related to reserve re-

quirements and foreign currency regulations into the profit function as follows:

$$\begin{aligned}\max_{\{R^d_{kt},R^b_{lt},\mathcal{S}_{jt}\}}\Bigg\{ &\sum_{b\in\{M,C,F\}}\sum_{l\in L_j,c(l)=LC}\mathcal{D}^b_{lt}(r^b_{lt};\mathbf{r^b_{-lt}},S_t)\left[R^b_{lt}\Big(1-\Phi^b_{lt}d^{b,D}_{lt}(r^b_{lt};S_t)\Big)\right]\\ &+\sum_{l\in L_j,c(l)=FC}\mathcal{D}^F_{lt}(r^F_{lt};\mathbf{r^F_{-lt}},S_t)\left[\frac{F_t}{S_t}R^F_{lt}\Big(1-\Phi^F_{lt}d^{F,D}_{lt}(r^b_{lt};S_t)\Big)\right]\\ &-\sum_{d\in\{H,F\}}\sum_{k\in\mathcal{K}_j,c(k)=LC}\mathcal{D}^d_{kt}(r^d_{kt};\mathbf{r^d_{-kt}},S_t)\left[R^d_{kt}-\theta_tR^r_t\right]\\ &-\sum_{d\in\{H,F\}}\sum_{k\in\mathcal{K}_j,c(k)=FC}\mathcal{D}^d_{kt}(r^d_{kt};\mathbf{r^d_{-kt}},S_t)\frac{F_t}{S_t}\left[R^d_{kt}-\widetilde{\theta}_t\widetilde{R^r_t}\right]\\ +\mathcal{S}_{jt}\Sigma_s(\mathbb{N}_{jt};\rho_{jt})-\mathcal{C}^N_{jt}(\mathbb{N}_{jt};\Omega_{jt})-\mathcal{C}_{jt}(\Theta_{jt};\Gamma_{jt})-R^m_{jt}\mathcal{M}_{jt}-\frac{F_t}{S_t}\widetilde{R}^m_{jt}\widetilde{\mathcal{M}}_{jt}&\Bigg\}\Phi\left(\frac{\overline{c}_{jt}-\mu_{jt}}{\sigma_{jt}}\right)\end{aligned}\tag{20}$$

where the following balance sheet identity holds:

$$\begin{aligned}\mathbb{H}_{jt}=\mathcal{S}_{jt}+\sum_{b\in\{M,C,F\}}\sum_{l\in L_j}\mathcal{D}^b_{lt}(r^b_{lt};\mathbf{r^b_{-lt}},S_t)-\sum_{d\in\{H,F\}}\sum_{k\in\mathcal{K}_j,c(k)=FC}(1-\theta_t)\mathcal{D}^d_{kt}(r^d_{kt};\mathbf{r^d_{-kt}},S_t)\\ -\sum_{d\in\{H,F\}}\sum_{k\in\mathcal{K}_j,c(k)=FC}(1-\widetilde{\theta}_t)\mathcal{D}^d_{kt}(r^d_{kt};\mathbf{r^d_{-kt}},S_t)-\mathcal{M}_{jt}-\widetilde{\mathcal{M}}_{jt}\end{aligned}$$

and

$$c_{jt}\equiv\mu_{jt}-\sigma_{jt}\lambda\left(-\frac{\overline{c}_{jt}-\mu_{jt}}{\sigma_{jt}}\right)$$

Non-resident banks. Non-resident banks extend foreign currency funding to local banks through cross-border loans. They take into consideration the default probability of each domestic bank, and incorporate these beliefs when determining the cross-border loan rates. This generates a dynamic feedback mechanism between non-resident banks and the domestic banks' distress, potentially resulting in multiple equilibria.

Given the demand system across local banks, non-resident banks aim to maximize their expected profits by setting the loan rate $\widetilde{R}^n_{jt}$ it charges to the domestic bank j at time t as follows:

$$\max_{\widetilde{R}^n_{jt}}\ \Pi^H_{jt}=\widetilde{\mathcal{H}}_{jt}\left[\widetilde{R}^H_{jt}(1-\phi_{jt}\Phi^H_{jt})-mc^H_{jt}\right]\tag{21}$$

where $\widetilde{\mathcal{H}}_{jt}$ represents the demand of domestic bank j for foreign currency wholesale funding at time t, ϕ_{jt} is the endogenously determined probability of default of bank j at time t, $(1-\Phi^H_{jt})$ signifies the recovery rate specific to bank j, and mc^H_{jt} denotes the marginal cost for the global bank of lending to local bank j at time t, not observable by the econometrician.

Non-resident currency traders. The model features non-resident currency traders who adopt a

trading strategy by taking a synthetic forward position of $\widetilde{X}_t^s$ in dollars. This trading activity involves two simultaneous transactions. Firstly, traders sell $\widetilde{X}_t^s$ dollars to acquire $S_t\widetilde{X}_t^s$ local currency in the FX spot market. Subsequently, they enter into a swap contract with domestic banks, delivering $S_t\widetilde{X}_t^s$ in local currency and receiving $\widetilde{X}_t^s$ in dollars at the spot leg of the contract. Simultaneously, they agree to deliver $\widetilde{X}_t^s$ in dollars and receive $\widetilde{X}_t^s F_t$ in local currency at the forward leg.

The trading strategy described above entails the following log currency excess return:

$$r_{t+1} = (f_t - s_t) - (s_{t+1} - s_t)$$

I assume that the currency trader has mean-variance utility as follows:

$$V_t = \mathbb{E}_t[r_{t+1}\widetilde{X}_t^s] - \frac{\gamma_t}{2}\mathbb{V}_t[r_{t+1}\widetilde{X}_t^s]$$

which yields the following optimal (synthetic) forward position:

$$\widetilde{X}_t^s = \frac{(f_t - s_t) - \mathbb{E}_t[\Delta s_{t+1}]}{\gamma_t \mathbb{V}_t[\Delta s_{t+1}]} \tag{22}$$

where γ_t is the time-varying risk aversion parameter. If currency traders anticipate a depreciation in lira, coupled with an increase in exchange rate volatility, then they opt to reduce their exposure to lira by decreasing their position. Additionally, if there is an escalation in risk aversion, then this serves as an additional motivation for the trader to reduce their exposure in order to avoid losses.

4.4 Equilibrium

The equilibrium in the model is characterized by a set of

- default probabilities ϕ_j for domestic banks $j \in \mathcal{J}$;
- interest rates on local and foreign currency term deposits r_k^d for $d \in \{H, F\}$;
- interest rates on local and foreign currency loans r_l^b for $b \in \{C, M, F\}$
- interest rates on cross-border dollar loans $\widetilde{R}_j^H$ provided by the non-resident bank;

and the local currency denominated government bond prices, P_t^s, spot exchange rate, S_t, and the price of currency forward contract, F_t, such that:

i. All banks solve the problem given by equation Equation 20 and the optimal default condition for each bank in Equation 19 holds.

ii. Depositors and borrowers maximize their utilities, given the product prices put forth by banks and spot exchange rate, satisfying Equation 6, Equation 8, and Equation 10

iii. The non-resident currency trader maximizes its mean-variance utility given the spot FX rate and the price of currency forward contract, satisfying Equation 22

iv. Taking the local currency-denominated government bond prices as given, local currency-denominated government bond investors, other than domestic banks, decide on their allocation to local currency-denominated government bond prices across maturity buckets, satisfying Equation 11

v. Given domestic banks' demand of cross-border credit and non-resident banks' beliefs about domestic banks' bankruptcy probabilities, phi_j, cross-border loan rates satisfy Equation 21.

vi. Non-resident banks' beliefs about domestic banks' bankruptcy probabilities are correct in equilibrium.

vii. Local currency government bond, spot and forward foreign currency markets clear.

5 Estimation

In this section, I apply the model to the data. The main goal is to estimate the policy-invariant preference parameters, which will serve as the foundation for subsequent counterfactual analyses.

5.1 Demand estimates

Deposit demand. Using bank and product characteristics data, together with product-level market share data described in Section 2.3, I estimate the utility parameters from Equation 5. I consider the nine largest banks and designate all the remaining fringe banks as the outside good, which I index by 0. I normalize the benefits depositors derive from the outside good to zero. Therefore, the regression equation implied by the Equation 6 becomes:

$$\ln(s^d_{kt}) \quad = \quad \alpha^d r^d_{kt} + \beta^d X^d_{kt} + \delta^d_{j(k)} + \eta^d_{c(k),t} + \xi^d_{kt} \tag{23}$$

where $\delta^d_{j(k)}$ are bank-specific fixed effects controlling for differences in depositors' mean utilities due to unobserved bank characteristics; $\eta^d_{c(k),t}$ are currency-time specific fixed effects that absorb time-varying currency related common shocks to every product; and ξ^d_{kt} are unobserved product-time-specific characteristics, which are likely positively correlated with deposit rates, r^d_{kt}. To address this endogeneity concern, I construct an instrument for interest rates from the product-specific pass-through of interbank rates into deposit rates in the spirit of **?**. Specifically, I instrument for r^d_{kt}, the deposit rate of product k at time t, with the fitted value of a product-specific regression of r^d_{kt} on the interbank rates in the corresponding currency markets.

Table A7 reports the preference estimates of retail and commercial depositors for interest rate and transaction convenience. Several findings emerge. First, as anticipated, the demand curves

for both retail and commercial deposit products are upward-sloping, indicating that higher deposit rates increase demand for these products. Second, the demand parameters suggest median own-rate elasticities of 4.72 for retail and 1.99 for commercial deposits in local currency. For deposits in foreign currency, the elasticities stand at 1.16 for retail and 0.49 for commercial deposits. Third, both retail and corporate depositors value the transaction services provided by checking accounts in local currency. Additionally, the parameter estimates for interest rates and transaction preferences remain stable when controlling for lagged product market shares to account for persistence in the deposit stock.

It is evident that retail deposits are significantly more sensitive to interest rate changes than corporate deposits. This heightened sensitivity can be largely attributed to the fact that deposits represent more than 70% of household financial assets in Türkiye, the highest percentage among OECD countries (see Figure A8). With a substantial proportion of household financial assets held in deposits, households are more responsive to changes in deposit rates. Conversely, as shown in Figure A6, this is not the case for commercial entities, where deposits make up only about 10 percent of their financial assets. Moreover, it is well-documented that these entities use their deposit accounts for various financial operations beyond simple savings, including trade finance and cash management services.

Having obtained the currency-time fixed effects after estimating the Equation 23, I proceed to examine the hedging preferences of depositors and explore how these preferences change in response to exchange rate fluctuations. Specifically, I estimate the following empirical specification:

$$\widehat{\eta^d_{ct}} = \eta^d_0 + \eta^d_1 D_c + \eta^d_2 \Delta s_t + \eta^d_3 \big(D_c \times \Delta s_t\big) + \nu^d_{ct} \tag{24}$$

where D_c takes the value of one when the denomination is in foreign currency, and Δs_t represents the (log) annual changes in the exchange rate.

Table A8 presents the results. Consistent with the first stylized fact in Section 3, the estimates in the first and second columns indicate that both household and commercial depositors prefer the hedging services offered by dollar-denominated deposit products, even in the absence of exchange rate depreciation. Quantitatively, the estimates suggest that the hedging benefit associated with these products is equivalent to a return of approximately 500 basis points in local currency. This figure is calculated by dividing the estimated hedging benefit (expressed in utils) by the rate sensitivity parameter. Additionally, the coefficient estimate on the interaction term shows that during periods of exchange rate depreciation, depositors tend to shift their preferences from local currency-denominated products to dollar-denominated ones. The results also demonstrate that the hedging benefit is more relevant for household depositors than for commercial entities, supporting the view that commercial entities use their accounts for a broader array of financial activities beyond savings.

Loan demand and borrower default. As was the case for deposits, the regression equation im-

plied by the Equation 8 is:

$$\ln(s_{lt}^b) = \alpha^b r_{lt}^b + \beta^b X_{lt}^b + \delta_{j(l)}^b + \eta_{c(l),t}^b + \xi_{lt}^b \tag{25}$$

for $b =\in \{M, C, F\}$. Notice that corporate loans differ from mortgages and consumer loans as they can also be denominated in dollars. The estimation deals with the possible correlation between interest rate r_{jt}^b and unobserved characteristics ξ_{lt}^b by leveraging interest rate swap rates as cost shifters for loan rates, following Benetton et al. (2021). Interest rate swaps serve as hedging instruments used by banks during loan origination, and they exhibit variations over time and across loan products through maturity and currency denomination.

Table A9 presents the loan demand estimates in columns one to three. The key findings are as follows: First, the estimates indicate that demand curves slope downward across all loan products. Second, the coefficient estimate for mortgages is statistically insignificant, which may be attributed to Türkiye's relatively small mortgage market and the fact that mortgages, being secured by property, exhibit little variation in interest rates across banks. Third, unsecured consumer loans are highly price-sensitive, with a model-implied interest rate elasticity of approximately 11. In contrast, corporate loans display a more moderate interest rate elasticity, around 1.2.

After obtaining the parameter estimates for loan demand, I proceed with the analysis of borrowers' currency denomination preferences in response to fluctuations in exchange rates using the same approach as described in Equation 24. The corresponding parameter estimates are displayed in the third column of Table A8. Remarkably, all the parameter estimates exhibit the opposite sign compared to the deposit estimates. Notably, all estimates show the opposite sign compared to those for deposits. Specifically, while borrowers generally prefer local currency-denominated loans, their demand shifts toward dollar-denominated loans during periods of currency appreciation.

This, combined with the findings on depositor preferences, highlights a key policy challenge in financially dollarized banking systems. After a currency depreciation shock, banking sector liabilities become increasingly dollarized, as depositors move from local currency deposits to dollar deposits. However, on the asset side, we observe the opposite trend, with a decline in demand for foreign currency loans. This creates an open FX position on banks' balance sheets, which they are required by law to close. To do so, banks often rely on synthetic FX forwards, adding further pressure on the exchange rate. I will elaborate on this point later.

Finally, to investigate whether an increase in loan rates leads to a riskier pool of borrowers, I estimate the Equation 10 that describes the default decision of mortgage, consumer loan, and corporate loan borrowers:

$$\ln(d_{jt}^{b,D}) - \ln(1 - d_{jt}^{b,D}) \quad = \quad \alpha^{b,D} r_{jt}^b + \beta^{b,D} X_{jt}^{b,D} + \delta_j^{b,D} + \eta_t^{b,D} + \xi_{jt}^{b,D} \tag{26}$$

Two important caveats should be taken into consideration. First, the loan rates are associated with the time of origination of the loans that defaulted at time t. Second, corporate loan defaults

are exclusively booked in the local currency, thereby eliminating any currency dimension in this aspect. To address the issue of endogeneity, I employ the same set of instruments used during the estimation of loan demand. Starting from the forth column of Table A9, I report the default estimates. The findings suggest that higher loan rates generally lead to a riskier pool of borrowers, with the exception of corporate loans.

Demand for local currency government bonds. While the demand system approach in Section 4.2 generates empirically tractable portfolio weights, it presents two significant challenges. First, in Equation 12, the latent demand $\varepsilon_t^i(m)$ is jointly determined with yields $y_t(m)$. Second, due to the unavailability of complete portfolios for investor groups, the holdings of the outside asset remain unobservable.

To tackle the endogeneity problem, I leverage the regulatory changes in the maturity-specific haircuts applied to the local currency-denominated government bonds, which serve as collateral for domestic banks to access liquidity from the central bank. I assume that banks' demand shift resulting from the regulatory changes is exogenous, and I employ it as an instrument to estimate the demand curves of other investors. This approach is justified by the fact that the demand shift impacts the holdings of other investors solely through its effect on prices. Moreover, banks are the primary holders of local currency-denominated government bonds, making their demand behavior a crucial factor to consider in the analysis.

To address the problem associated with the outside option, I assume the holdings of the outside asset take the following form (Jansen, 2021; Fang et al., 2022): $\mathcal{O}_t^i = \mathcal{O}^i + \exp\left(\xi^i Z_t(m)\right)$, where $Z_t(m)$ is a vector of observables that captures factors affecting the holdings of the outside asset. Under these assumptions, I estimate the following equation for both non-bank resident and non-resident bond investors with two-stage least squares:

$$\log(\mathcal{D}_t^i) = (\alpha^i + \mathcal{O}_i) + \beta^i y_t(m) + \gamma^i X_t(m) + \xi^i Z_t(m) + \zeta_m + t + t^2 + \varepsilon_t^i(m) \tag{27}$$

where ζ_m is the maturity-specific fixed effects to capture time-invariant omitted characteristics; and t, t^2 to control time trend.

Table A10 presents the estimation results. The findings reveal statistically significant evidence supporting different demand curves for non-resident bond investors and non-bank residents. Specifically, I observe a downward-sloping demand curve for non-resident bond investors, while a contrasting upward-sloping demand curve exists for non-bank residents. Quantitatively, the study indicates that in response to a 100 basis points increase in local currency-denominated government bond yields, the holdings of non-bank residents decrease by 3.5%, while the holdings of non-residents increase by 4.7%.

Additionally, I calculate the demand elasticities for both investor groups. A demand elasticity close to zero suggests inelastic demand, meaning less sensitivity to price changes, while a higher elasticity indicates greater responsiveness. The results show that both demand curves are price elastic, with values of 3.82 for non-residents and 2.76 for non-bank residents.

5.2 Quantifying the supply side parameters

On the supply side, I recover from first order conditions the set of parameters that govern the behavior of domestic banks, the non-resident bank, and the non-resident currency trader, which are not directly observable in the data.

Domestic banks. Firstly, I solve for bank j's optimization over local currency $(\mathcal{H}_{jt})$ and foreign currency $(\widetilde{\mathcal{H}}_{jt})$ funding in the wholesale market, given its total wholesale funding need $\mathbb{H}_{jt}$ and the corresponding prices $(R_t^H, \widetilde{R}_{jt}^H, F_t, S_t)$. This leads to the following equation linking the wholesale funding amounts and prices:

$$\frac{\mathcal{H}_{jt}}{\widetilde{\mathcal{H}}_{jt}} = \left(\frac{R_t^H}{F_t \widetilde{R}_{jt}^H / S_t}\right)^{-\eta} \left(\frac{\alpha_{jt}}{\widetilde{\alpha}_{jt}}\right)$$

This equation serves as the basis for estimating the elasticity of substitution between local and foreign currency wholesale funding, denoted by η. To conduct the estimation, I employ the following regression specification:

$$\log(\mathcal{H}_{jt}/\widetilde{\mathcal{H}}_{jt}) = \overline{\eta} + \eta \log\left(\frac{F_t \widetilde{R}_{jt}^H / S_t}{R_t^H}\right) + \zeta_t + \varepsilon_{jt} \tag{28}$$

where I include time-fixed effects ζ_t to absorb common shocks to every bank in each month; and the term $(\alpha_{jt}/\widetilde{\alpha}_{jt})$ is also absorbed by ε_{jt}. The findings reveal an elasticity of substitution between local and foreign funding sources with a magnitude of 30, as depicted in Table A11. Subsequently, using the estimated value of η, I proceed to calibrate the parameters in Equation 15, namely $\alpha_{jt}, \widetilde{\alpha}_{jt}$, and θ_{jt}.

With the demand estimates obtained in Section 5.1, along with the parameter estimates associated with the wholesale market $\{\eta, \alpha_{jt}, \widetilde{\alpha}_{jt}, \theta_{jt}\}$, and the available data, I determine the bank-specific cost parameters that align with each bank's optimization problem outlined in Equation 20, as well as their default behavior described by Equation 19. Specifically, for each bank, I have ten parameters, denoted as $\Gamma_{jt} = \{c_{jt}^M, c_{jt}^C, c_{jt}^N, \widetilde{c}_{jt}^M, c_{jt}^T, c_{jt}^F, \widetilde{c}_{jt}\}$, $\Omega_{jt} = \{\mu_{jt}, \sigma_{jt}\}$, and ρ_{jt} to quantify and ten equations.

Once I back-out these unobserved cost parameters, I assume that they remain constant in the counterfactual experiments. Furthermore, I perform a qualitative check to ascertain whether the time series patterns of the moments of the obtained stochastic uncertainty cost, stemming from excessive reliance on the wholesale market, align with instances of financial instability episodes (Figure A7). The findings reveal that both the mean and standard deviation of the stochastic costs increase during periods marked by challenges in securing wholesale funding from the interbank markets, such as the global financial crisis of 2008-2009 and the Euro area debt crisis in 2011. I observe a subsequent normalization after these crisis periods. Moreover, there is noteworthy heterogeneity across banks, underscoring the significance of incorporating heterogeneity within the banking sector.

To gain insights into how dollar intermediation affects banks' optimal behavior, I analyze the

first-order conditions pertaining to deposit and loan rates. For illustrative purposes, I choose the local currency corporate loans, which lead to the following pricing equation based on the first-order condition with respect to corresponding interest rates:[19]

$$\underbrace{R_j^N\left(1-\Phi_j^N d_j^{N,D}\right)}_{\text{Expected return}} = \underbrace{\left(\mathbb{P}_j^H + c_j\mathbb{H}_j - \rho_j S_j + c_j^N\right)}_{\text{I. Effective marginal cost}} + \underbrace{\left(\frac{-1}{\alpha^N(1-s_j^N)}\right)\left(1-\alpha^{N,D}\Phi_j^N d_j^{N,D}\left(1-d_j^{N,D}\right)R_j^N\right)}_{\text{II. Effective mark-up}} + \underbrace{\frac{\widetilde{s}^N}{1-s_j^N}\left(\frac{F}{S}\widetilde{R}_j^H - \left(\mathbb{P}_j^H + c_j\mathbb{H}_j - \rho_j\mathcal{S}_j\right) - \widetilde{c}_j^N\right)}_{\text{III. Multi-product}}$$

where $\mathbb{H}_j$ and $\mathbb{P}_j^H$ are already defined in Equation 15 and Equation 16, respectively. Optimal pricing ensures that the expected return from unit lending in local currency aligns with its effective cost. While determining the expected return is straightforward, given that the bank internalizes the immediate impact of its loan pricing on the default probability of the borrower, the right hand side exhibits distinct features that warrant attention. This component is divided into three terms: (i) effective marginal cost, (ii) the standard mark-up term, and (iii) the term arising from the multi-product nature of the banks' problem in the corporate loan market.

The term for effective marginal cost reveals the imperfect pass-through of the local policy rate to loan prices. This is evident in the expression $\mathbb{P}_j^H$, which serves as a composite cost index for acquiring a unit of wholesale funding. Specifically, this index is influenced by both the local policy rate and the costs linked to obtaining foreign currency funds from the non-resident bank through cross-border loans, as delineated in Equation Equation 16. Additionally, it also incorporates the stochastic cost of excessive reliance on the wholesale market through the term $c_j\mathbb{N}_j$, where $\mathbb{H}_j$ the total amount borrowed by the bank j in the wholesale market (i.e., the total funding gap). Moreover, it also captures the fact the originating a unit of loan is less costly for banks having a large portfolio of local currency-denominated government bonds S_j since they are used as collateral in the local currency interbank market. Lastly, there exists a (net) cost of originating a local currency corporate loan, c_j^N, which captures all the unobserved fee and administrative component of lending operations. These mechanisms also hold significance for banks when they set deposit rates. For brevity, I refrain from presenting them here.

Non-resident banks. The first-order condition resulting from the profit function, as outlined in Equation 21, yields the following pricing equation:

[19] I drop the subscript t from the notation for ease of exposition.

$$\widetilde{R}^H_{jt} = \underbrace{\frac{mc^H_{jt}}{1-\phi_{jt}\Phi^H_{jt}}}_{\text{Effective marginal cost}} + \underbrace{\frac{1}{\eta\left(1-\frac{\widetilde{\alpha}_{jt}\widetilde{p}_{jt}^{1-\eta}}{p_t^{1-\eta}+\widetilde{p}_{jt}^{1-\eta}}\right)}}_{\text{Mark-up}}$$

where the first term on the right-hand side represents the effective cost of lending to domestic bank j at time t, which is influenced by the bank's probability of default ϕ_{jt}, a factor endogenously determined in equilibrium. Here I assume that the global bank does not consider the impact of the interest rate it charges on the banks' default probability. The second term denotes the markup.

With the knowledge of the banks' elasticity of substitution between local currency and dollar funding in the wholesale market, along with the corresponding quantities, I am able to recover the marginal costs from the pricing equations.

Non-resident currency traders. These traders' optimization problem plays a crucial role in determining the supply of dollar liquidity in both spot and swap markets, as described in Equation 22. Using this optimal decision rule, I invert the parameter that summarizes the risk aversion as well as the balance sheet frictions of the non-resident currency trader.

6 Results

This section proceeds as follows: First, I simulate the model under the actual policy (baseline scenario) to determine if the estimated fundamentals could lead to riskier alternative equilibria. If such equilibria exist, I then examine whether prudential regulation can shift these alternatives toward safer region. Second, I assess the impact of domestic monetary tightening on financial stability and its transmission to loan and deposit markets, both with and without prudential regulation. To facilitate this analysis, I use a subsample of quarter-end data from 2010 to 2017, chosen for computational reasons.

6.1 Financial Stability

Having endowed with the fundamentals of the model, which include the estimated parameters on the demand side in Section 5.1 and the calibrated parameters on the supply side in subsection 5.2, I examine the potential for the same fundamentals to sustain alternative equilibria beyond the observed one, following Egan et al. (2017). Here, an alternative equilibrium arises when non-resident banks, under the same cost structure, rationally believe that domestic banks' bankruptcy probabilities differ from observed ones. Based on these beliefs, domestic banks adjust their portfolio and default decisions to align with the perceived bankruptcy probability held by non-resident banks.

Bank-level analyses. I begin by comparing key model outcomes between observed and alternative equilibria, focusing on average bank-level outcomes while controlling for time-varying, bank-specific factors. For this analysis, I regress each model outcome using bank-year fixed effects and a dummy variable for alternative equilibria. Table A12 shows the distribution moments for key outcomes under observed equilibria, with dummy coefficients for alternative equilibria in the last column.

On average, findings show that under the actual policy, bank default probabilities in alternative equilibria are about 10 percentage points higher than those observed (see Panel A of Figure 3). This implies that if non-resident banks adjust their beliefs to anticipate a higher likelihood of domestic bank defaults, these expectations would be justified|even with unchanged fundamentals in the domestic banking system. Additionally, I conduct quantile regressions to explore the rise in banks' default probabilities under alternative equilibria relative to those observed across the distribution of initial bank default risk. Figure A9 presents the results, showing that banks at higher percentiles of the default risk distribution are more vulnerable to bank-run equilibria.

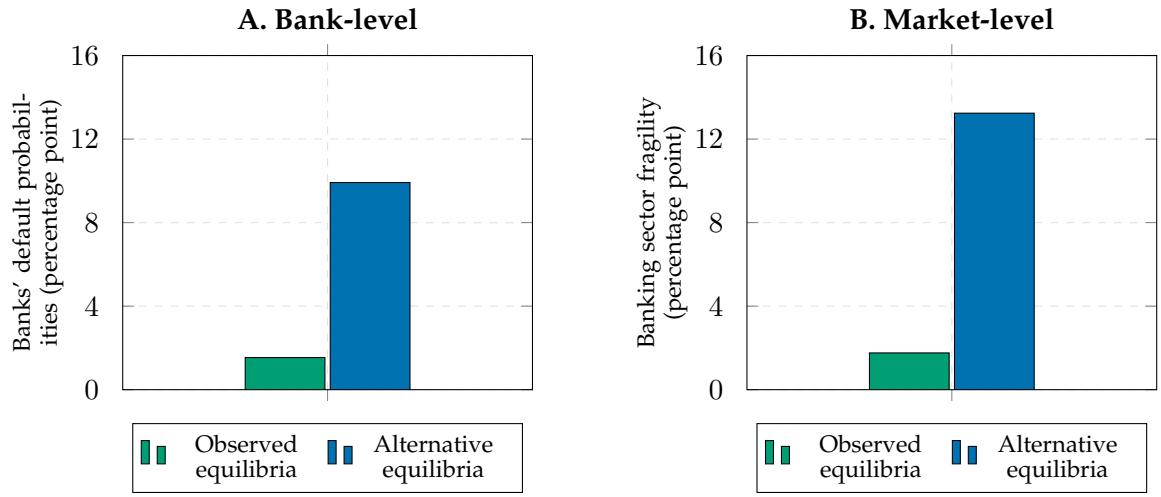


Figure 3. Comparison Between Observed and Alternative Equilibria Under the Baseline Scenario. Panel A displays the average default probabilities for banks under the actual policy environment, comparing observed equilibria with alternative equilibria. Panel B extends this comparison to a market-level perspective, presenting the aggregate banking sector fragility (defined as the asset-weighted average of default probabilities across banks within specific month-equilibrium combinations).

The increasing fragility at the bank level can be explained as follows: When non-residents perceive a heightened risk of default by a domestic bank, they reduce their foreign currency funding to that bank. In response, the affected bank raises interest rates on foreign currency deposits and unwinds FX swap positions to counter withdrawals by non-resident banks.[20] This reduces bank profitability and increases default risk.

[20]Note that banks can only adjust new loan originations within a period, as the existing loan stock is fixed from the period's start and requires funding.

Financial distress in one bank can spill over to other banks by intensifying competition for dollar deposits. When non-distressed banks lose cheap dollar deposits to a distressed competitor that has raised rates, they increase their own rates on dollar deposits as well. This response narrows their profit margins and amplifies financial strain, which in turn can lead to a reduction in dollar funding from non-resident banks. Consequently, these banks also begin unwinding their FX swap positions (see Figure 4). Collectively, this unwinding depreciates the exchange rate —an effect not internalized by individual banks. Indeed, Figure 5 shows an average 16 percent depreciation of the exchange rate in alternative equilibria compared to the observed ones.

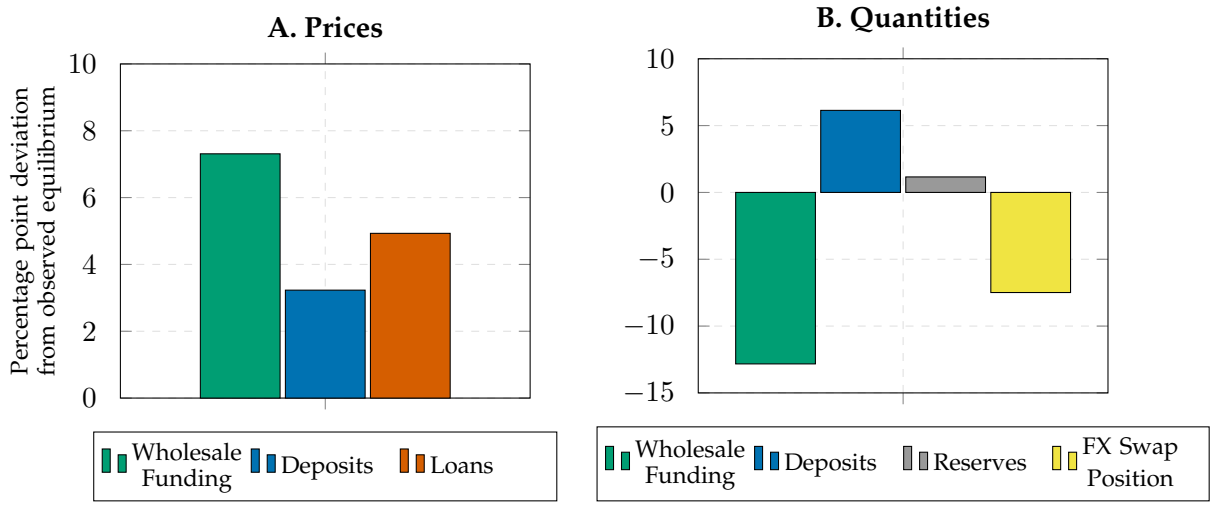


Figure 4. Dollar-Denominated Portfolio: Comparison Between Observed and Alternative Equilibria Under the Baseline Scenario. This figure displays the deviations, in percentage points, of prices (Panel A) and quantities (Panel B) of key balance sheet items denominated in foreign currency from the observed equilibrium. Quantities are scaled relative to the balance sheet size.

Market-level analyses. I extend my analysis to examine key market-level outcomes, including sector-wide banking fragility (measured as the asset-weighted average of banks' default probabilities), depositor and borrower surpluses, as well as the discounted sum of banks' equity and the exchange rate. Specifically, I regress each outcome on market fixed effects and a dummy variable for alternative equilibria. I find that sector-wide fragility is, on average, 13.24 percentage points higher in alternative equilibria compared to those observed under actual policy conditions (see Panel B of Figure 3).

Additionally, I summarize the percentage deviations in depositor and borrower surpluses, banks' equity, and the exchange rate from the observed equilibrium in Figure 5. The results indicate an average exchange rate depreciation of 16 percent, a 58 percent reduction in banking sector equity, and an 11 percent decrease in new borrower surplus. However, as documented in Section 5, depositors benefit from both rising deposit rates and exchange rate depreciation, resulting in an approximate 23 percent increase in depositor surplus in the alternative equilibria.

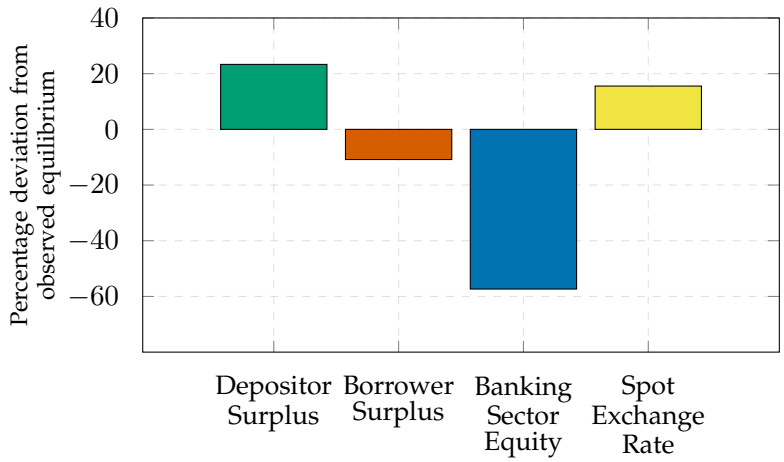


Figure 5. Market-level Comparison Between Observed and Alternative Equilibria in the Baseline Scenario This figure displays the percentage deviations in depositor and borrower surpluses, as well as the discounted sum of banks' equity and the exchange rate, from the observed equilibrium.

Counterfactual #1. Prudential Regulation — Next, I use the estimated model to assess the effectiveness of prudential regulations aimed at reducing the inherent fragility within the banking system. Specifically, I implement a 5 percent prudential tax on banks' foreign currency borrowing from non-resident banks, following Aoki et al. (2016) and Korinek (2010). To assess the policy's impact, I compute alternative equilibria under this policy and compare them to those without the tax. The main finding of this counterfactual analysis, shown in Figure 6, suggests that the policy intervention effectively reduces banking system fragility by lowering the risk of default. Quantitatively, the prudential tax leads to an average decrease of approximately 12 percent relative to the baseline scenario.

Panel B of Figure 7 shows that domestic banks reduce the share of run-prone wholesale dollar funding in their overall funding mix by 2.22 percentage points in response to the increased effective cost imposed by the prudential tax. To offset this reduction, domestic banks raise dollar deposit rates, attracting additional deposit funding and unwinding FX swap positions. While this adjustment results in a further 3 percent depreciation of the exchange rate, certain run-like beliefs among non-resident banks no longer become self-fulfilling. In other words, domestic banks experience less pressure to scramble for dollars in both the deposit and FX markets when non-resident banks hold negative beliefs about their riskiness. This shift in dynamics moves the distribution of alternative equilibria under the prudential tax toward a more stable region compared to those seen in the absence of the tax.

From a welfare perspective, however, there is a cost borne by borrowers as they experience a decrease of about 2 percent in surplus, while there is no statistically significant change in depositor surplus or bank equity.

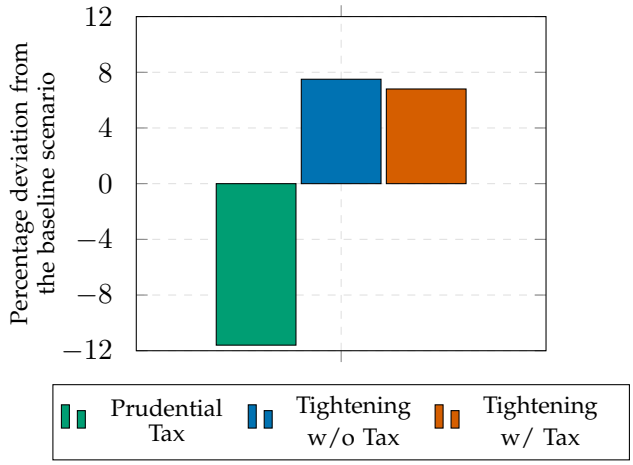


Figure 6. Banks' Default Probabilities Across Counterfactual Experiments. This figure displays the deviation in banks' average default probability under three different scenarios compared to the baseline scenario. "Prudential Tax" applies a 5 percent tax on domestic banks' foreign currency borrowing from non-resident banks. "Tightening w/o Tax" and "Tightening w/ Tax" represent monetary tightening of 100 basis points, without and with the prudential tax, respectively.

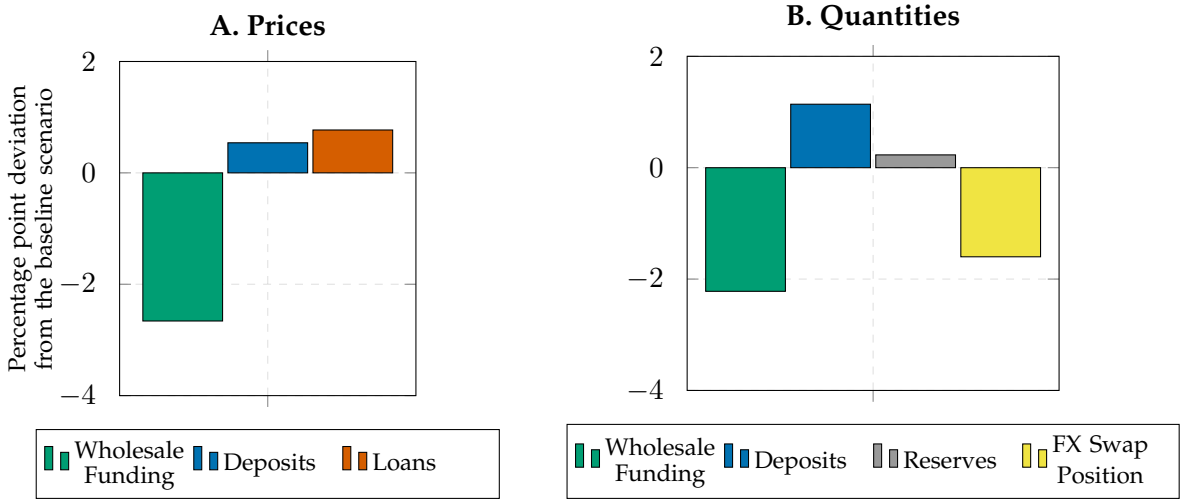


Figure 7. Dollar-Denominated Portfolio: Comparison of Alternative Equilibria Under Prudential Tax vs. Baseline Scenario. This figure displays the percentage point deviations in prices and quantities of key balance sheet items denominated in foreign currency under prudential tax versus baseline scenario. Panel A and Panel B focus on price and quantity comparisons, respectively. Quantities are scaled relative to the size of the balance sheet.

6.2 The Transmission of Domestic Monetary Policy

This section examines key bank-level variables across alternative equilibria under two distinct counterfactual scenarios. First, I analyze how model outcomes respond to a tightening of domestic monetary policy. Next, I investigate the interaction between prudential tax and domestic monetary tightening, examining the implications of this interaction for financial stability and monetary policy.

Counterfactual #2. Tightening Domestic Monetary Policy — This counterfactual scenario assesses the impact of a 100-basis-point increase in the domestic monetary policy rate. Two key results emerge. First, the probability of bank defaults increases by an average of approximately 8 percent compared to the baseline as monetary policy tightens (see Figure 6). Second, access to foreign currency funding from non-resident banks weakens the impact of transmission of domestic monetary policy.

When I raise the domestic policy rate, the underlying economic mechanism that shapes the counterfactual outcomes can be understood as follows: Domestic banks, faced with increased costs for wholesale funding in local currency, shift towards using foreign currency to fund their assets, as illustrated in Panels B and C of Figure 8. Quantitatively, their share of foreign currency wholesale funding rises by 0.82 percentage points, shifting the distribution of bank default probabilities toward higher-risk equilibria. However, this shift is mitigated by an approximate 4 percent appreciation in the exchange rate, fueled by investments from non-resident bond investors and currency traders in local currency government bonds and synthetic swap positions. This appreciation tempers the potential for establishing excessively risky equilibria.

In terms of the impact on the loan and deposit markets, there is a modest increase in both local currency loan and deposit rates. However, as the exchange rate appreciates, loan demand shifts toward foreign currency borrowing. Coupled with the banks' ability to raise dollar funding relatively cheaply, this leads to an average decrease of around 66 basis points in the interest rates on foreign currency loans, which corresponds to a 7 percent decline in the cost of foreign currency borrowing for firms relative to the baseline scenario, as shown in Figure 8. Consequently, even with a tight domestic policy stance, borrower surplus increases by around 2 percent.

Counterfactual #3. Tightening Domestic Monetary Policy Under Prudential Regulation — Lastly, I use the model to study how prudential regulation interacts with domestic monetary policy. The key finding is that, while this measure serves as a complement to monetary policy, enhancing the transmission of policy tightening to both loan and deposit markets, it does not eliminate the risky self-fulfilling equilibria that we demonstrate under the tightening-only scenario.

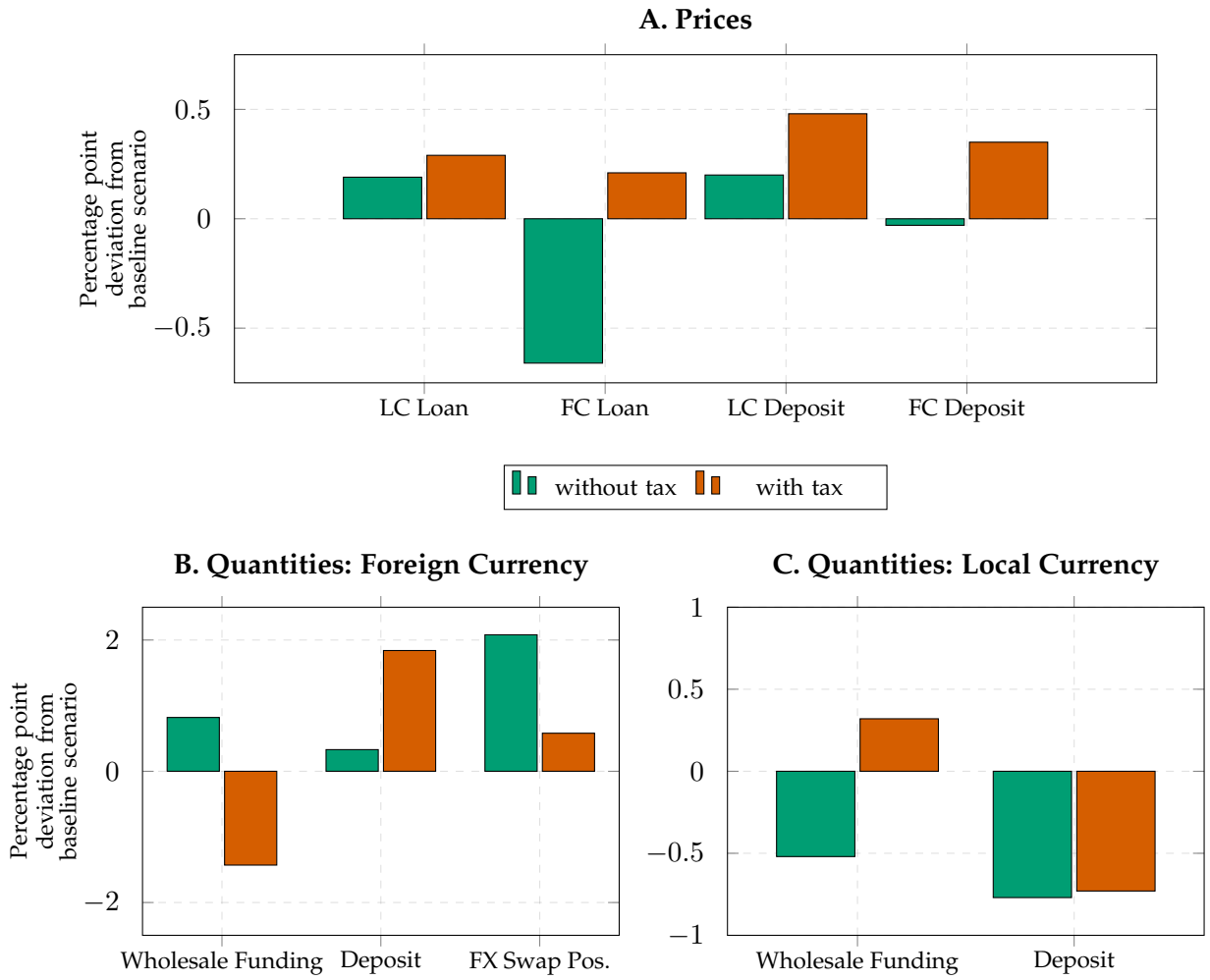


Figure 8. Comparison of Alternative Equilibria Under Monetary Policy Tightening vs. Baseline Scenario: Panel A displays the percentage point deviation of prices in both local and foreign currencies under domestic monetary policy tightening (with and without tax) versus baseline scenario. Additionally, Panel B and Panel C show the percentage point deviations of quantities in foreign currency and local currency, respectively, of key balance sheet items denominated under the prudential tax scenario from the baseline scenario. Quantities are scaled relative to the balance sheet size.

As shown in Panel B and C of Figure 8, contrary to what we observe in the tightening-only scenario, banks refrain from substituting costly wholesale funding in local currency with wholesale funding in foreign currency from non-resident banks. This avoidance occurs as the effective cost of the latter increases due to the prudential tax. I observe approximately a 1.4 percentage point reduction in the proportion of foreign currency wholesale funding within the banks' funding mix. However, one immediate consequence of this reduction is less currency appreciation compared to what is observed in the tightening-only scenario.

Panel A of Figure 8 shows, on the other hand, that banks increase both loan and deposit rates across the board when the tax is present compared to the no-tax scenario. This highlights the improved transmission of monetary policy compared to the tightening-only scenario. Notably, we observe that banks increase foreign currency loan rates, which they were decreasing when there was no tax.

7 Conclusion

In this paper, I develop and estimate a micro-structural model of imperfect competition within the dual currency banking system of a small open economy. The model aims to assess the welfare and financial stability impacts of prudential measures and their interaction with traditional monetary policy tools. It features endogenous bank default and allows for multiple equilibria primarily driven by the exogenous, self-fulfilling beliefs of non-resident banks and the limited liability of domestic banks' equity holders, as in Egan et al. (2017) and Albertazzi et al. (2022). A imporatnt aspect of the model is that banks' balance sheet management under financial dollarization and regulatory constraints introduces a significant amplification mechanism through endogenous exchange rate that could potentially destabilize the entire banking system. This key insight, absent in studies that focus on banking sectors operating with a single currency, represents a distinctive contribution of the model.

The model is estimated using comprehensive micro-level data from 2010 to 2017, compiled from proprietary databases of the Central Bank of the Republic of Türkiye. This dataset includes details on bank lending at the transaction-level, monthly updates on banks' balance sheets and income statements, deposit rates differentiated by bank and account type, cross-border borrowing, annual financial data of firms, forecasts by professional forecasters, government bondholder information, and various macroeconomic and financial market indicators.

The findings shows how increased financial dollarization can (i) make domestic banking systems more fragile; (ii) weaken the transmission of domestic monetary policy to loan and deposit markets; and (iii) turn episodes of monetary policy tightening into catalysts for financial instability. Our quantitative results reveal that prudential measures can effectively mitigate the fragility in the domestic banking systems of financially dollarized economies and enhance the transmission of monetary policy, albeit at some welfare cost.

In contributing both empirically and theoretically, the paper aligns with ongoing initiatives by international organizations, such as the IMF, to understand the effects of prudential measures and their interaction with monetary policy in emerging market economies. While the primary focus is on emerging markets, the modeling approach yields insights applicable to the banking sectors of advanced countries operating under a dual-currency system, relying on FX swaps and cross-border loans for managing currency risks, engaging in arbitrage, or serving customers. Recent BIS papers highlight the significance of these FX swaps, which they term as "unseen dollar borrowing," for banking sector balance sheets globally (Kloks et al., 2023; Borio et al., 2022). They

estimate that on a typical day, nearly $4 trillion in new FX swap contracts are initiated, constituting two-thirds of the daily global FX turnover. Importantly, these contracts involve a payment in US dollars, with the BIS estimating the outstanding stock of obligations to pay US dollars in FX swaps/forwards and currency swaps to exceed $80 trillion.

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Appendix

A Figures

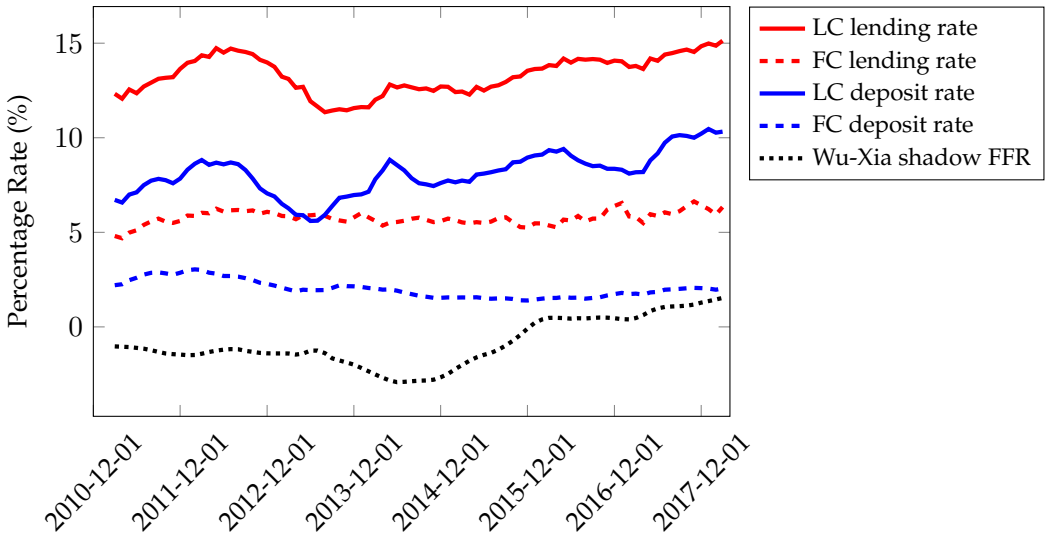


Figure A1. Lending and Deposit Rates in Local and Foreign Currencies (2010–2018). This figure displays monthly data from December 2010 to April 2018, illustrating the sector-wide lending and deposit rates offered by Turkish banks in local currency (solid lines) and foreign currency (dashed lines). The lending rates, which include interest expenses and origination fees, are shown in red, while the deposit rates are represented in blue. The black dotted line denotes the Wu-Xia shadow federal funds rate (FFR), a benchmark for low-yield, liquid foreign currency assets. In the legend, LC stands for local currency, and FC for foreign currency.

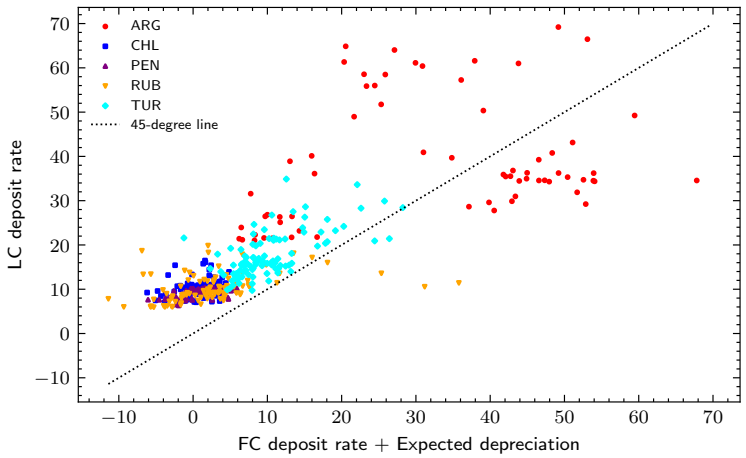


Figure A2. Evidence from Macro Data on UIP Deviation for Depositors in Selected Emerging Markets. This figure displays monthly data from the central banks of Argentina (ARG), Chile (CHL), Peru (PEN), Russia (RUB), and Türkiye (TUR), showing local currency deposit rates (y-axis) versus foreign currency deposit rates plus expected depreciation (x-axis). Each country is represented by unique colors and symbols. The dotted 45-degree line helps evaluate the Uncovered Interest Parity (UIP), which predicts that interest rate differentials between countries should equal the expected exchange rate depreciation.

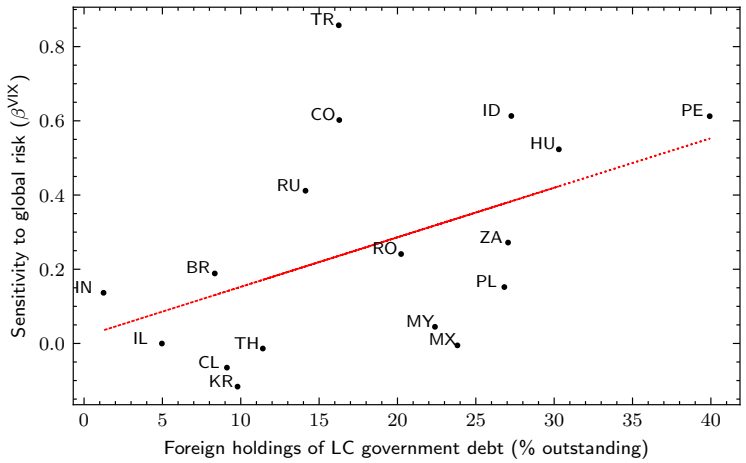


Figure A3. Original-Sin Redux. This figure illustrates the relationship between the proportion of government debt in local currency held by non-resident investors and the sensitivity of sovereign bond yields to global risks across selected emerging market economies. The x-axis represents the median percentage of government debt owned by foreign investors during the study period, with data sourced from the International Monetary Fund (IMF). Each data point corresponds to a specific country, identified by its country code. The y-axis indicates the median sensitivity of bond yields to global risks throughout the study period, measured as β_t^{VIX}. This sensitivity is estimated using a rolling window method, where each window covers one quarter. Daily data are utilized to regress monthly changes in bond yields against logarithmic changes in the VIX index for each country, represented in the following equation:

$$\Delta y_t = \alpha_t + \beta_t^{\text{VIX}} \Delta \ln(VIX_t) + \varepsilon_t$$

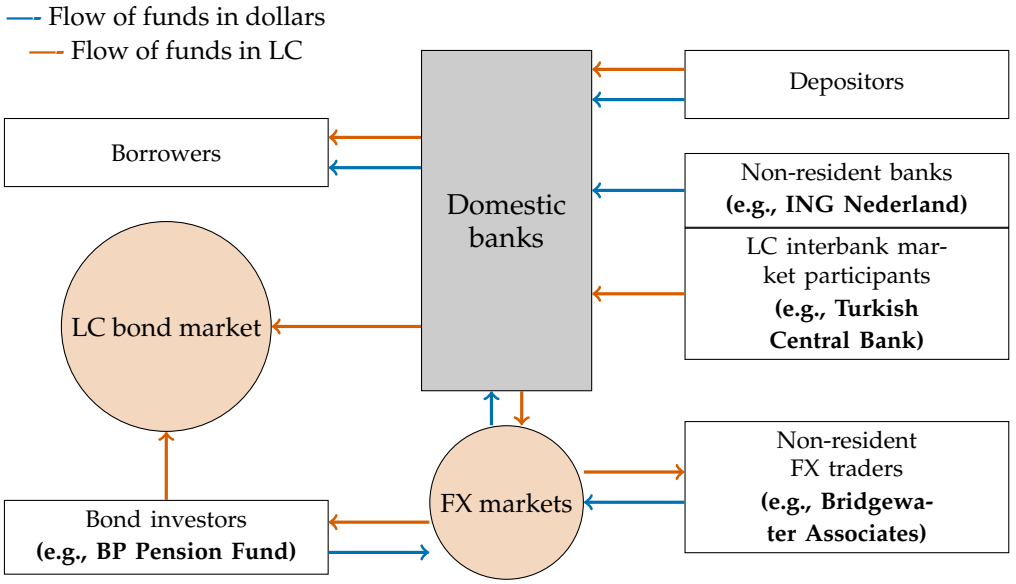


Figure A4. Overview of the Model Economy

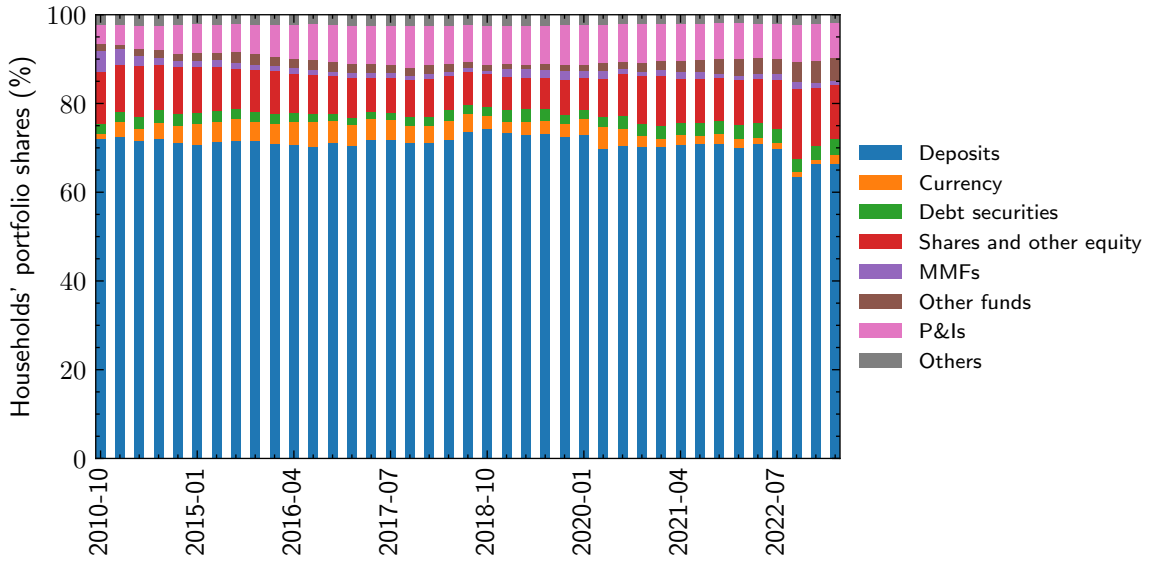


Figure A5. Composition of Household Asset Portfolios Over Time. This figure displays the changing composition of household assets from the fourth quarter of 2010 to the second quarter of 2023. The vertical axis displays the asset categories, expressed as percentages of total household assets. The horizontal axis represents the timeline across the quarters. Various asset types, including deposits, currency, debt securities, shares and other equities, money market funds (MMFs), other investment funds, pensions and insurances (P&Is), and miscellaneous assets (Others), are shown in different colors for enhanced clarity.

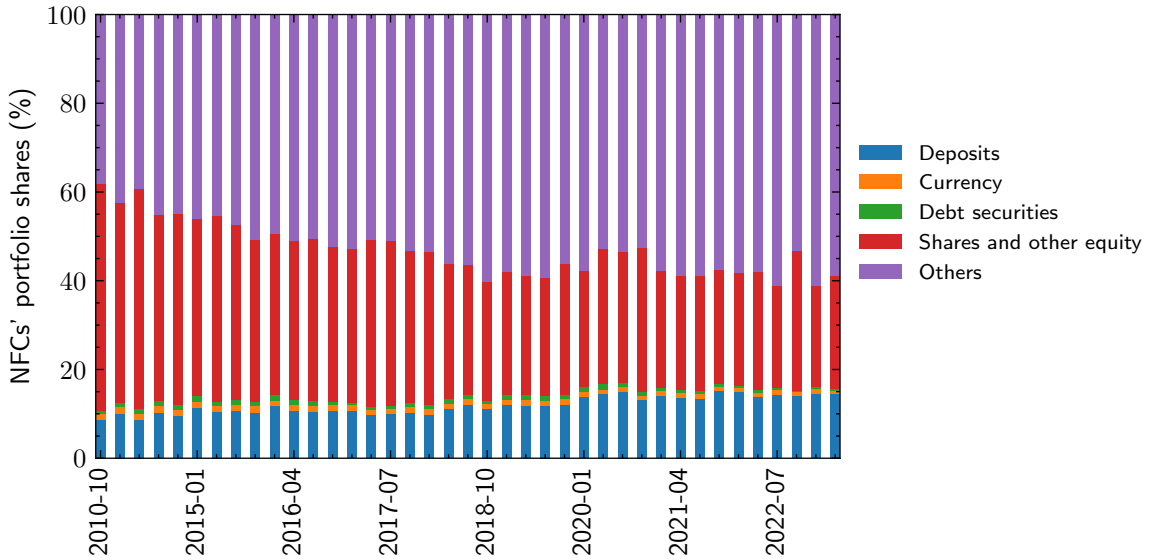
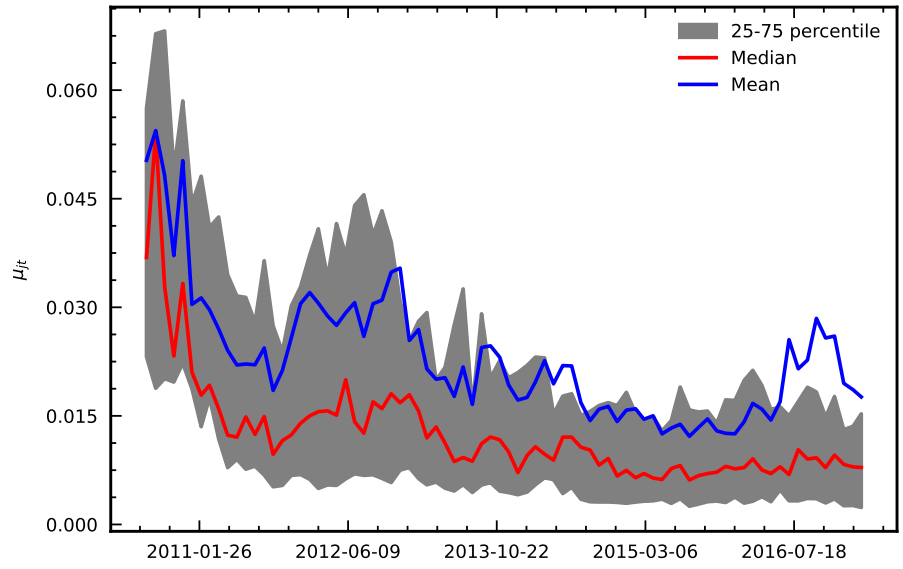
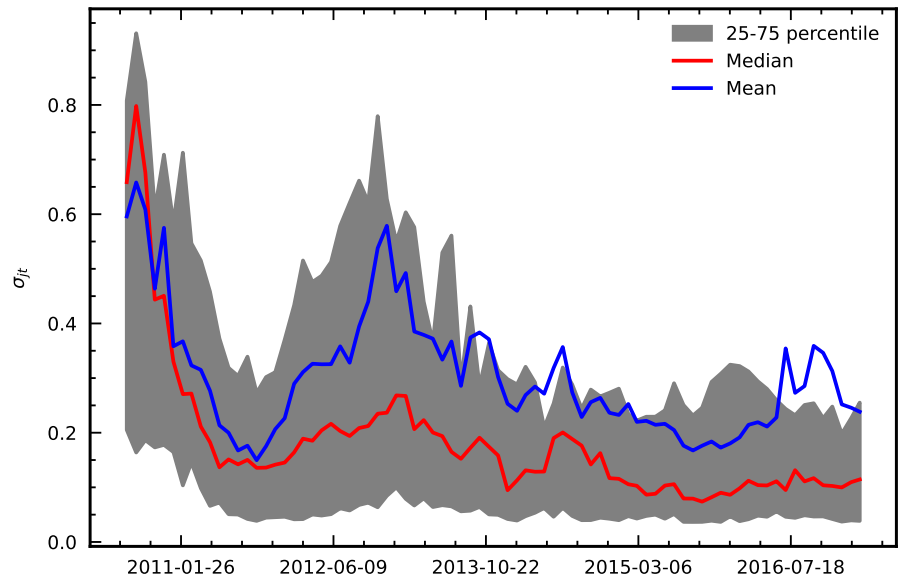


Figure A6. Composition of Non-financial Corporate Asset Portfolios Over Time. This figure displays the changing composition of non-financial corporate (NFC) assets from the fourth quarter of 2010 to the second quarter of 2023. The vertical axis shows the asset categories expressed as percentages of total NFC assets. Various asset types, including deposits, currency, debt securities, shares and other equities, and miscellaneous assets (Others), are depicted in different colors for enhanced clarity.



(a) μ_{jt}



(b) σ_{jt}

Figure A7. Distributional moments of the stochastic cost (c_{jt})**.** This figure displays the distributional moments of the stochastic cost (σ_{jt}, μ_{jt}), across banks from 2010 to 2017, showing the median (red line), mean (blue line), and the 25th to 75th percentile range (gray shaded area).

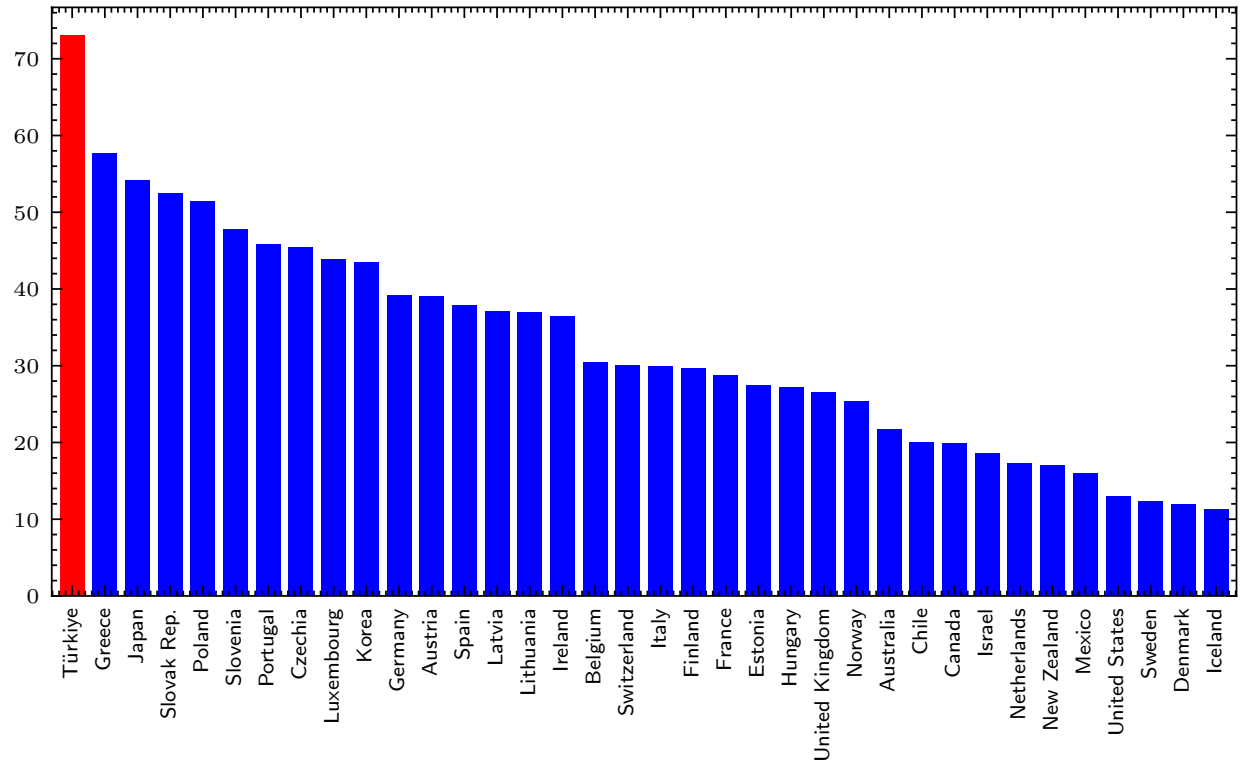


Figure A8. Currency and deposits, % of total financial assets (OECD).

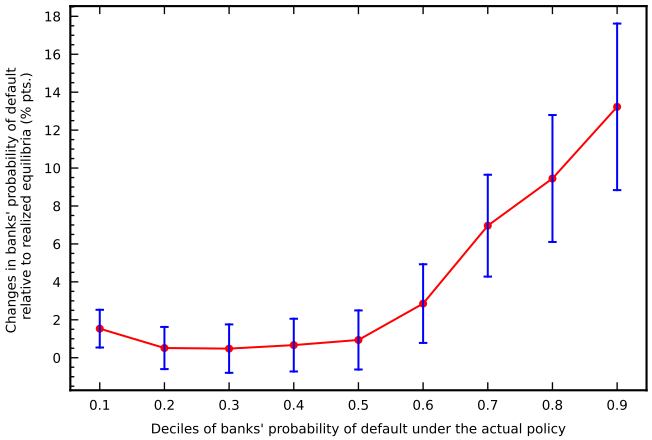


Figure A9. Quantile Regressions of Bankruptcy Probabilities: Observed versus Alternative Equilibria under Actual Policy This figure displays the results of quantile regressions analyzing bank default probabilities. The analysis uses a dummy variable set to 1 for alternative equilibria and includes bank-year fixed effects. The horizontal axis displays the initial level of each bank's default probability, while the vertical axis represents the coefficient of the dummy variable for alternative equilibria. The estimated coefficients are depicted by a red line, and the blue bars indicate confidence intervals.

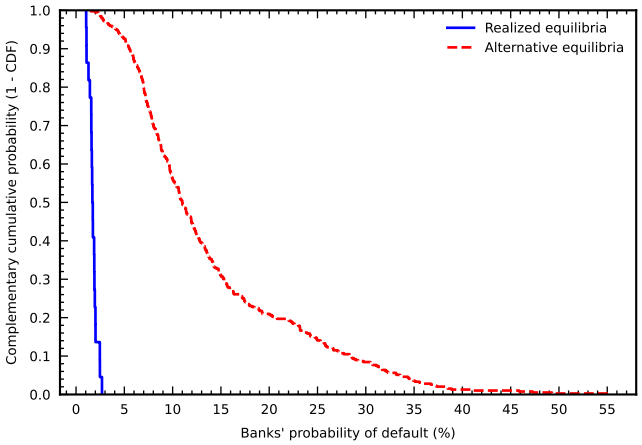
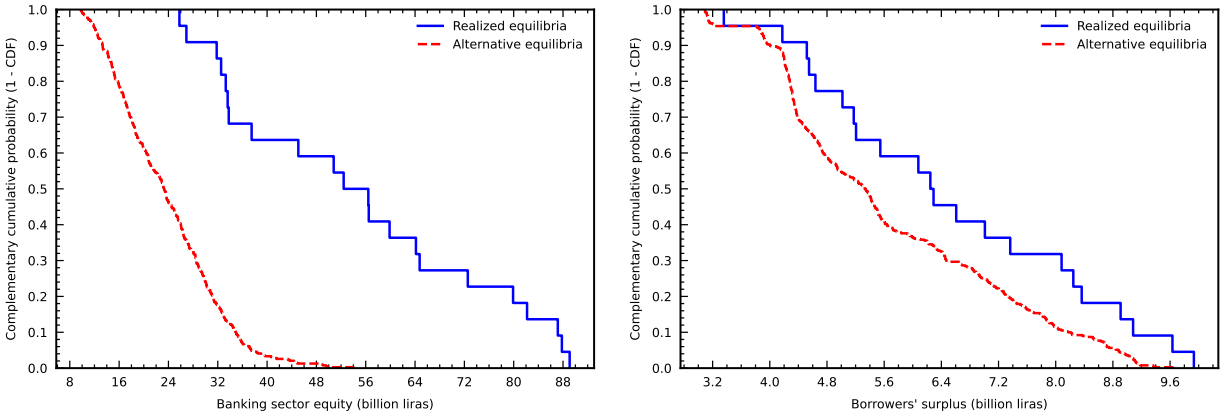
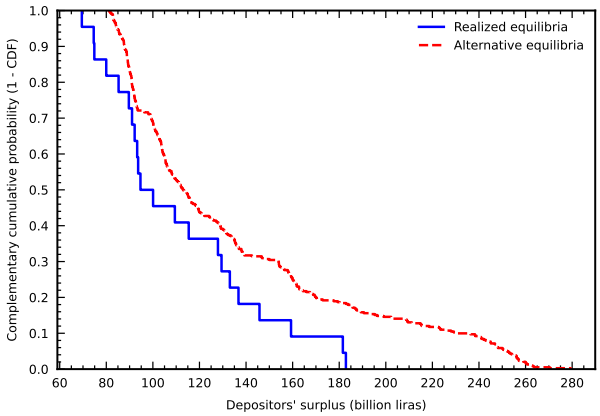


Figure A10. Complementary CDF of Bank Default Probabilities: Realized vs. Alternative Equilibria. This figure displays the complementary cumulative distribution functions (CCDF) for the probability of default among banks, comparing "Realized equilibria" (blue) with "Alternative equilibria under the actual policy" (red).



(a) Banking sector equity

(b) Depositor surplus



(c) Borrower surplus

Figure A11. Complementary CDF of Market-level Welfare Outcomes: Realized vs. Alternative Equilibria. This figure displays the complementary cumulative distribution functions (CCDFs) for market-level welfare outcomes, namely banking sector equity, depositor surplus, and borrower surplus. Red and blue lines represent the functions under observed and alternative equilibria, respectively.

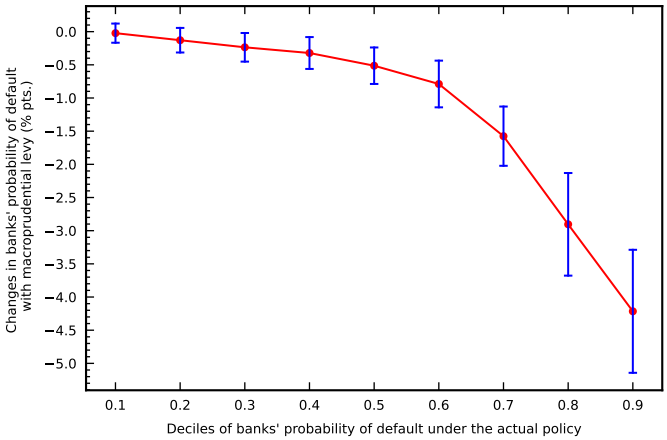


Figure A12. Quantile Regressions of Bankruptcy Probabilities: Prudential Tax versus Baseline Scenario. This figure displays the results of quantile regressions analyzing bank default probabilities. The analysis uses a dummy variable set to 1 for alternative equilibria and includes bank-year fixed effects. The horizontal axis displays the initial level of each bank's default probability, while the vertical axis represents the coefficient of the dummy variable for alternative equilibria. The estimated coefficients are depicted by a red line, and the blue bars indicate confidence intervals.

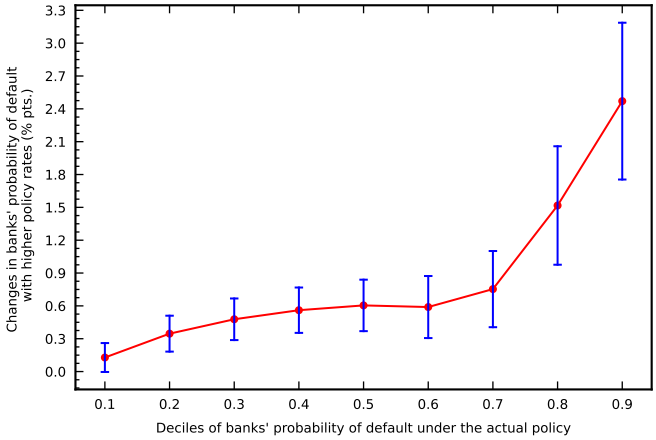


Figure A13. Quantile Regressions of Bankruptcy Probabilities: Domestic monetary policy tightening versus Baseline Scenario. This figure displays the results of quantile regressions analyzing bank default probabilities. The analysis uses a dummy variable set to 1 for alternative equilibria and includes bank-year fixed effects. The horizontal axis displays the initial level of each bank's default probability, while the vertical axis represents the coefficient of the dummy variable for alternative equilibria. The estimated coefficients are depicted by a red line, and the blue bars indicate confidence intervals.

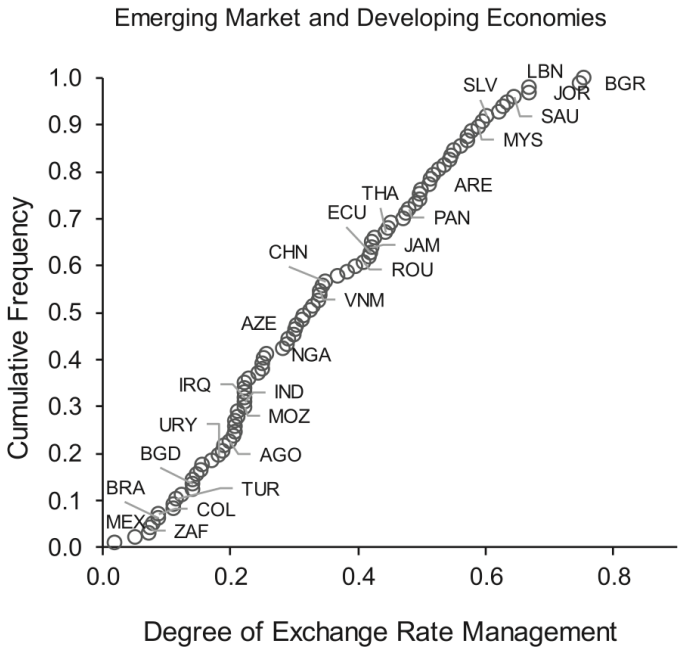


Figure A14. Degree of Exchange Rate Management. This figure displays the index for the degree of exchange rate management by emerging market economies, calculated by Adler et al. (2024)

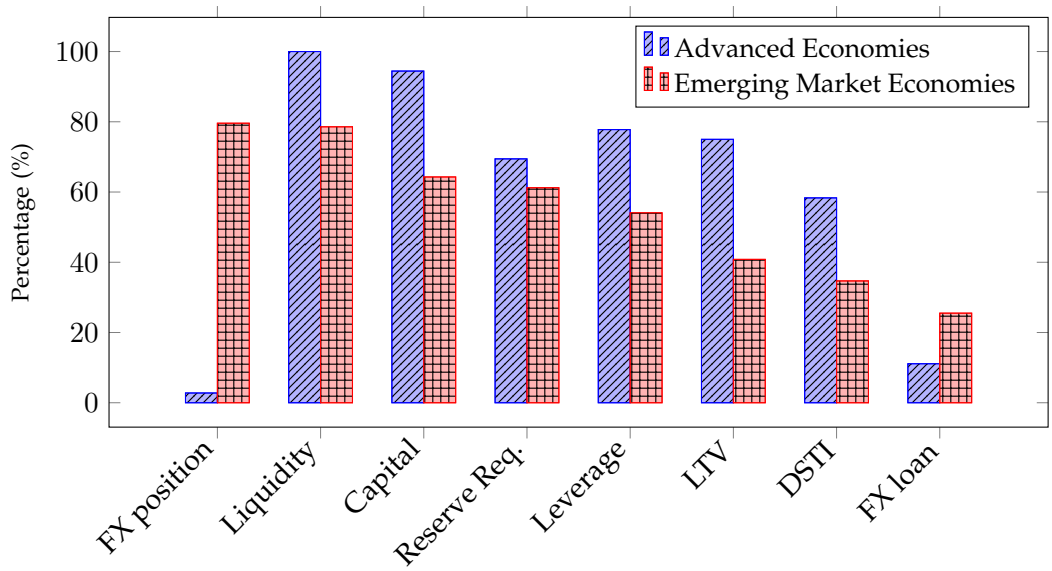


Figure A15. The Use of Macroprudential Tools Across Across Countries. This figure displays the share of economies, segmented into Advanced Economies and Emerging Market Economies, that had used a specified prudential tool by December 2021, according to data sourced from the IMF Macroprudential Policy database (iMaPP).

B Tables

Table A1. Comparison of Financial Dollarization in Emerging and Developing Economies

This table compares the average proportions of loans, bank liabilities, and deposits denominated in foreign currencies to the total assets of banking systems in selected emerging and developing countries over the past two decades. The data derive from the Financial Soundness Indicators provided by the International Monetary Fund (IMF) and are supplemented with figures sourced directly from the financial regulatory authorities of the respective countries.

	Financial dollarization		
Country	Loans (%)	Liabilities (%)	Deposits (%)
Armenia	61.28	63.94	64.16
Argentina	12.72	16.74	16.49
Brazil	14.36		0.00
Chile	14.60	21.22	12.02
Colombia	6.45	10.71	0.00
Indonesia	16.46	19.24	17.54
Israel	25.86	35.45	20.59
India	8.44	7.49	
South Korea	13.22	14.29	2.64
Lebanon	75.80	64.76	60.65
Mexico	10.85	15.72	7.89
Malaysia	4.36	12.98	3.71
Pakistan	11.53	12.96	7.91
Paraguay	41.87	45.74	46.60
Peru	39.48	48.84	44.93
Romania	57.77	36.82	34.55
Russia	27.75	27.83	27.41
Turkiye	26.98	41.63	39.27
Uruguay	61.48	70.02	76.63
Ukraine	48.23	50.31	38.40
South Africa	8.83	5.98	3.24

Table A2. Comparative Overview of the Turkish Banking Industry's Balance Sheet

This table presents a detailed comparison of the Turkish banking sector's balance sheet composition at two distinct time points: July 2010, a year following the global financial crisis, and April 2017, a year before the Turkish debt crisis of 2018. It details both local currency and foreign currency components across different asset and liability categories, showing their proportions relative to total values. Liquid assets include cash, required reserves, and receivables from the central bank, money markets, and banks. The table also displays the total assets and liabilities in billions of dollars, providing a clear view of the sector's financial standing and its evolution during the specified period. Additionally, the FX position section highlights the on-balance sheet and total net FX positions, along with regulatory capital and net position percentages, indicating the banking sector's exposure to foreign currency risks and its regulatory compliance status at the respective time points.

	July 2010			April 2017		
	LC	FC	Total	LC	FC	Total
Assets (relative to total assets)						
Liquid assets	3.6	6.9	10.5	2.7	11.6	14.3
Loans	36.3	13.6	49.9	44.2	20.0	64.2
Securities	26.5	5.7	32.2	9.0	4.3	13.3
Other assets	6.4	1.1	7.5	6.4	1.9	8.2
Total assets	72.7	27.3	100.0	62.3	37.7	100.0
Total assets (in bn $)	405.6	152.1	557.8	460.2	278.4	738.6
Liabilities (relative to total liabilities)						
Deposits	45.0	19.6	64.6	30.6	24.9	55.5
Non-deposit liabilities	11.6	11.4	23.0	12.3	21.3	33.6
Shareholders' equity	12.3	0.1	12.4	10.8	0.1	10.9
Total liabilities	68.9	31.1	100.0	53.7	46.3	100.0
Total liabilities (in bn $)	384.1	173.7	557.8	396.8	341.7	738.6
Foreign currency general position						
On-balance sheet net FX position (in bn $)			-21.5			-63.3
Total net FX position (in bn $)			-0.3			-0.3
Regulatory capital (in bn $)			63.4			92.0
Regulatory net position (%)			-0.5			-0.3

Table A3. Descriptive Statistics

This table presents key descriptive statistics for various banking metrics, including prices and quantities of deposit and loan products, and overall bank balance sheet composition, from October 2009 to April 2017. The data are split into two sections: Panel A, which covers metrics in local currency, and Panel B, which details metrics in foreign currency. For each variable within these panels, the table includes the mean, 10th percentile, median, and 90th percentile values.

	A. Local currency items				B. Foreign currency items			
	Mean	p10	p50	p90	Mean	p10	p50	p90
Household deposits								
Checking: Amounts (bn. liras)	2.89	0.33	2.14	6.83	2.61	0.28	2.10	6.21
Checking: Market share (%)	0.56	0.06	0.56	1.29	0.51	0.06	0.37	1.30
Term: Amounts (bn. liras)	21.00	5.46	20.71	36.89	10.81	1.50	8.91	25.46
Term: Market share (%)	4.29	0.99	4.52	7.31	2.09	0.35	1.64	4.17
Term: Price (%)	9.64	7.93	9.67	11.32	2.41	1.65	2.31	3.38
Firm deposits								
Checking: Amounts (bn. liras)	2.64	0.40	2.27	5.45	2.37	0.24	1.90	5.35
Checking: Market share (%)	1.02	0.16	0.98	1.90	0.88	0.09	0.80	1.77
Term: Amounts (bn. liras)	7.74	1.19	7.00	14.66	7.80	0.65	6.25	16.52
Term: Market share (%)	3.03	0.42	2.91	5.65	2.97	0.28	3.03	5.99
Term: Price (%)	9.84	7.56	9.86	12.04	2.54	1.66	2.38	3.76
Mortgages								
Amount (billions)	0.22	0.01	0.16	0.48				
Market share (%)	9.42	0.49	8.60	18.29				
Interest rate (%)	11.35	9.31	11.29	13.52				
Borrowers' PD (%)	0.76	0.37	0.60	1.41				
Consumer loans								
Amount (billions)	0.09	0.01	0.05	0.21				
Market share (%)	8.25	0.70	6.69	17.65				
Interest rate (%)	16.67	13.79	16.88	19.15				
Borrowers' PD (%)	7.90	2.33	6.19	16.44				
Corporate loans								
Amount (billions)	0.65	0.19	0.58	1.19	0.32	0.09	0.30	0.55
Market share (%)	4.35	1.25	3.77	8.05	2.19	0.70	2.21	3.42
Interest rate (%)	14.86	11.83	14.93	17.72	4.73	3.61	4.40	6.70
Borrowers' PD (%)	4.46	2.75	4.07	6.84				
Assets (rel. to total assets)								
Reserves	1.34	0.31	0.80	3.41	3.67	1.42	3.96	5.57
Securities holdings	15.82	6.94	13.75	27.7				
Loans (stock)	57.78	44.23	58.73	68.23	21.39	15.49	21.81	26.98
FX swap position (net)					10.56	18.85	10.33	2.78
Liabilities (rel. to total liabilities)								
Deposits	36.81	28.77	36.92	45.00	21.95	13.19	21.51	30.47
Interbank borrowing	9.55	3.59	9.08	16.81	18.74	8.74	16.85	31.93
Residual funding (net)	19.07	10.91	18.45	29.58	-6.11	-19.78	-7.79	10.09
Banks' PD (%)	1.91	1.28	1.86	2.67				
Cross-border borrowing rate (%)	1.83	1.18	1.73	2.59				

Table A4. Interest-rate Discount on Dollar-denominated Loans

This table presents the regression results referenced Equation 2. Panel A details results using the UIP-adjusted credit spread as the dependent variable, defined in Equation 1 with z_t representing expected exchange rate depreciation derived from survey data. Conversely, Panel B employs the CIP-adjusted credit spread, substituting survey data with forward exchange rate expectations. Loan-level controls include loan size and maturity. All models incorporate fixed effects for bank-year-quarter. Columns (1) and (4) analyze the full sample, while the remaining columns focus on a subsample of firms that issued new loans in both currencies within the same quarter. Robust standard errors are shown in parentheses.

	A. UIP-adjusted credit spread			B. CIP-adjusted credit spread		
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign currency dummy	-5.77	-6.41	-6.41	-0.35	-1.03	-1.04
	(0.18)	(0.19)	(0.19)	(0.08)	(0.07)	(0.08)
Loan controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	No	Yes	Yes	No
Bank-year-quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm-year-quarter FEs	No	No	Yes	No	No	Yes
Observations	11,434,830	662,394	662,394	11,434,830	662,394	662,394
adj. R-squared	0.56	0.53	0.53	0.11	0.10	0.10

Table A5. Run-prone behavior: Uninsured deposit funding vs. wholesale dollar funding

This table presents the regression results as referenced in Equation 3, analyzing quarterly data at the bank level. Column (1) examines the changes in the percentage of uninsured deposits, while Column (2) explores changes in wholesale dollar funding. Both columns include bank-specific and time-specific fixed effects to control for invariant characteristics over time and across banks. Robust standard errors are shown in parentheses.

	%Δ Uninsured deposits	%Δ Wholesale dollar funding
	(1)	(2)
Bank probability of default	1.42	-3.16
	(1.57)	(1.31)
Bank FEs	Yes	Yes
Year-quarter FEs	Yes	Yes
Observations	693	693
adj. R-squared	0.11	0.23

Table A6. The transmission of the local monetary policy on LC lending markets

This table presents the estimated effects of local monetary policy changes on local currency (LC) lending rates, with columns (1) and (2) derived from the parameter estimates in Equation 3 and Equation 4, respectively. The analysis restricts the sample to loans denominated in local currency. Here, $\Delta r_{t-\tau}$ denotes the shift in the local monetary policy rate from $(t-\tau)$ to t, while $\Delta r^{US}t$ represents changes in the Wu-Xia Shadow Federal Funds Rate, used as a measure of global liquidity conditions. The variable "Wholesale USD Funding Share" is the proportion of a bank's assets funded via cross-border dollar borrowings from non-resident banks. Both regression specifications include firm fixed effects and bank-time fixed effects to control for unobserved heterogeneity. Additionally, the table quantifies the differential impact of a cumulative 100 basis points increase in the local policy rate over the past three months on loan rates, comparing banks at the 90th percentile versus those at the 10th percentile of the wholesale dollar funding share. Parentheses contain robust standard errors.

	(1)	(2)
$\sum_{\tau=0}^{3}\gamma_\tau \times \left(\Delta r_{t-\tau} \times \text{Wholesale USD Funding Share}_{j(l),t-\tau}\right)$	-1.36	-1.56
	(0.00)	(0.00)
$\sum_{\tau=0}^{3}\gamma_\tau \times \left(\Delta r_{t-\tau} \times \text{Wholesale USD Funding Share}_{j(l),t-\tau} \times \Delta r_t^{USD}\right)$		2.01
		(0.00)
90^{th} vs. 10^{th} percentile of Global Funding Share	-31.93	-47.78
Additional controls	Yes	Yes
Bank-year-quarter FEs	Yes	Yes
Firm FEs	Yes	Yes
Observations	361,976	361,976
adj. R-squared	0.05	0.10

Table A7. Demand Estimates: Household and Commercial Deposits

This table is divided into two panels and two sections. Section I reports demand estimates for household deposits (Panel A) and commercial deposits (Panel B). The dependent variable in each model is the logarithm of the market share of the product. We use monthly data from 2010 to 2017 to estimate each demand model. Bank controls include time-varying attributes such as the number of branches, the average number of employees per branch, and the number of ATMs. Each specification includes bank-specific and currency-time fixed effects. Robust standard errors are indicated in parentheses. Section II presents the own-rate elasticities for local and foreign currency deposit products for household (Panel A) and commercial (Panel B) deposits. This section provides the median and standard deviation (in parentheses) of the elasticities, as implied by the estimates presented in Section I.

	A. Household deposits		B. Commercial deposits	
	(1)	(2)	(3)	(4)
I. Preferences				
Interest rate	54.81	51.86	32.87	21.41
	(0.78)	(0.80)	(0.56)	(0.57)
Transaction dummy	3.00	2.94	2.15	1.42
	(0.08)	(0.07)	(0.06)	(0.05)
Lagged deposit market share		6.09		19.93
		(0.64)		(0.41)
II. Own-rate elasticities				
Local currency deposit products		4.72		1.99
		(0.68)		(0.35)
Foreign currency deposit products		1.16		0.49
		(0.33)		(0.16)
Observations	3312	3312	3312	3312
adj. R-squared	0.91	0.92	0.91	0.95
Bank controls	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes
Currency-time FEs	Yes	Yes	Yes	Yes

Table A8. Preferences of Depositors and Borrowers for Dollar-denominated Products

This table presents the parameter estimates from Equation 24, with separate results for household deposits (Panel A), commercial deposits (Panel B), and commercial loans (Panel C). The "FC dummy" is an indicator variable for foreign currency denomination, and ΔFX_t represents the change in the foreign exchange rate. Standard errors are shown in parentheses.

	A. Retail deposits	B. Commercial deposits	C. Commercial loans
	(1)	(2)	(3)
FC dummy	2.65	1.13	-1.38
	(0.04)	(0.03)	(0.03)
ΔFX_t	-1.92	-1.29	1.03
	(0.21)	(0.14)	(0.16)
FC dummy $\times$ ΔFX_t	2.60	1.79	-1.42
	(0.31)	(0.41)	(0.22)
Observations	182	182	184
adj. R-squared	0.97	0.96	0.96

Table A9. Loan Demand and Borrower Default Estimates

This table presents loan demand and borrower default estimates across three categories of loans: mortgages, consumer loans, and corporate loans. Panel A displays the parameter estimates from Equation 25, categorizing results by loan type into mortgages (Column 1), consumer loans (Column 2), and corporate loans (Column 3). Panel B similarly offers insights into default rates, with parameter estimates from Equation 26, organized similarly by loan type. The analysis utilizes monthly data spanning from 2010 to 2017 to construct each model. Bank controls considered include dynamic attributes such as branch count, employee per branch average, and ATM numbers. Each model accounts for bank-specific fixed effects to control for individual bank characteristics. For corporate loans, the models additionally adjust for currency-time fixed effects to account for potential currency valuation impacts on loan performance. Robust standard errors are indicated in parentheses.

	A. Demand estimates			B. Default estimates		
	Mortgages	Consumer loans	Corporate loans	Mortgages	Consumer loans	Corporate loans
	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate	-17.33	-73.15	-8.73	17.86	26.92	-1.50
	(78.19)	(9.68)	(1.51)	(10.98)	(6.48)	(5.28)
Observations	837	837	1674	837	837	837
adj. R-squared	0.87	0.62	0.90	0.83	0.67	0.75
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	No	Yes	Yes	Yes
Currency-time FEs	No	No	Yes	No	No	No

Table A10. Demand Estimates: Local currency-denominated Government Bonds

This table presents the parameter estimate for the elasticity of substitution between local currency and foreign currency in wholesale funding markets, based on the Equation 28. Standard errors, shown in parentheses, indicate the precision of the estimates. Robust standard errors are shown in parentheses..

	A. Non-bank residents	B. Non-residents
	(1)	(2)
$y_t(m)$	-7.32	9.84
	(3.29)	(4.09)
Observations	480	480
adj. R-squared	0.78	0.80
Bond characteristics	Yes	Yes
Outside characteristics	Yes	Yes
Trend controls	Yes	Yes
Maturity FEs	Yes	Yes

Table A11. Elasticity of Substitution Between LC and FC Wholesale Funding

This table displays the estimated parameters derived from Equation 28, incorporating time fixed effects. Parentheses include the standard errors.

	log(relative funding ratio)
log(price ratio)	29.76
	(6.21)
Observations	729
adj. R-squared	0.16
Time fixed effects	Yes

Table A12. Descriptive statistics: Observed vs. Alternative Equilibria

This table presents descriptive statistics for prices and quantities of key balance sheet items over the period 2010–2017 (Panel A) and shows the average change under alternative equilibria relative to observed values, controlling for bank-time fixed effects (Panel B).

	A. Observed equilibria				B. Change relative to observed equilibria
	Mean	p10	p50	p90	Est. (SE)
Banks' probability of default (%)	1.54	1.01	1.51	2.23	9.92 (1.05)
Interest rates on global funding (%)	2.02	1.40	1.95	2.64	7.31 (0.79)
Interest rates on loans (%)					
Mortgages	10.57	8.13	10.5	12.95	1.68 (0.16)
Consumer loans	15.22	12.92	14.59	18.16	2.45 (0.31)
LC corporate loans	13.58	10.75	13.28	16.44	2.12 (0.13)
FC corporate loans	5.09	4.23	5.00	6.04	4.93 (0.20)
Interest rates on deposits (pp.)					
LC retail deposits	8.86	6.80	8.72	11.08	2.24 (0.11)
LC commercial deposits	8.94	6.80	8.94	11.61	1.59 (0.14)
FC retail deposits	2.66	2.19	2.59	3.29	3.23 (0.10)
FC commercial deposits	2.76	2.20	2.71	3.49	3.56 (0.18)
Default probability of mortgages (%)	0.72	0.39	0.61	1.15	1.89 (0.28)
Default probability of consumer loans (%)	4.98	1.53	3.37	11.64	3.57 (0.47)
Default probability of corporate loans (%)	3.78	2.54	3.73	5.29	1.22 (0.09)
Assets (billions)					
LC loan originations	1.02	0.27	1.03	1.73	-0.23 (0.03)
FC loan originations	0.31	0.14	0.30	0.48	-0.05 (0.00)
LC reserves	0.72	0.13	0.37	1.82	0.27 (0.06)
FC reserves	3.78	0.68	3.45	7.34	0.75 (0.13)
LC bond holdings	15.46	2.23	10.59	31.93	-2.90 (0.85)
FX swap (net) position (billions)	6.89	1.26	5.29	15.87	-5.72 (0.97)
Liabilities (billions)					
LC deposits	31.84	7.48	36.64	54.17	11.50 (1.53)
FC deposits	19.13	2.72	19.43	34.72	3.99 (0.70)
LC central bank funding	8.34	1.52	4.28	19.99	-7.71 (0.84)
FC global bank funding	16.59	1.64	15.03	36.74	-9.93 (0.87)
Equity value (billions)	73.50	17.46	77.01	122.63	-47.48 (2.71)

Table A13. Banking Sector Fragility and Welfare: Observed vs. Alternative Equilibria

	Banking Sector Fragility	Depositor Surplus	Borrower Surplus	Banking Sector Equity
Alternative Equilibrium	13.24 (1.38)	26.09 (3.87)	-0.71 (0.09)	-31.38 (3.87)
Baseline average	1.76	111.83	6.55	54.72
Market fixed effects	Yes	Yes	Yes	Yes
Observations adj. R-squared	837 0.58	837 0.98	837 0.97	837 0.68

Table A14. Comparing Equilibria Under Actual Policy vs. Counterfactual Policies

	Counterfactual No. 1		Counterfactual No. 2		Counterfactual No. 3	
	Est.	SE	Est.	SE	Est.	SE
Panel A. Bank-level outcomes						
Banks' probability of default (%)	-1.33	(0.48)	0.86	(0.38)	0.79	(0.35)
Interest rates on global funding (%)	-2.66	(0.43)	2.73	(0.29)	0.44	(0.28)
Interest rates on loans (%)						
Mortgages	-0.25	(0.12)	0.42	(0.10)	0.76	(0.10)
Consumer loans	-0.11	(0.08)	-0.02	(0.07)	-0.02	(0.06)
LC corporate loans	-0.01	(0.04)	0.19	(0.03)	0.29	(0.03)
FC corporate loans	0.77	(0.05)	-0.66	(0.05)	0.21	(0.04)
Interest rates on deposits (pp.)						
LC retail deposits	-0.01	(0.04)	0.20	(0.04)	0.48	(0.03)
LC commercial deposits	-0.17	(0.07)	0.55	(0.06)	0.59	(0.06)
FC retail deposits	0.22	(0.04)	-0.03	(0.04)	0.35	(0.03)
FC commercial deposits	0.54	(0.07)	-0.22	0.06	0.48	(0.05)
Default probability of mortgages (%)	-0.18	(0.24)	-0.28	(0.21)	0.40	(0.20)
Default probability of consumer loans (%)	-0.04	(0.15)	-0.49	(0.12)	-0.50	(0.11)
Default probability of corporate loans (%)	0.19	(0.03)	-0.46	(0.03)	-0.36	(0.03)
Assets (billions)						
LC loan originations	-0.01	(0.01)	0.02	(0.01)	0.01	(0.01)
FC loan originations	-0.01	(0.00)	0.00	(0.00)	-0.01	(0.00)
LC reserves	0.01	(0.02)	0.03	(0.02)	0.00	(0.01)
FC reserves	0.18	(0.06)	0.07	(0.05)	0.25	(0.05)
LC bond holdings	-0.02	(0.23)	0.34	(0.23)	0.23	(0.20)
FX swap (net) position (billions)	-1.18	(0.43)	1.55	(0.36)	0.44	(0.34)
Liabilities (billions)						
LC deposits	-0.27	(0.69)	-0.30	(0.60)	-0.26	(0.55)
FC deposits	0.89	(0.32)	0.49	(0.29)	1.52	(0.26)
LC central bank funding	1.16	(0.21)	-0.38	(0.16)	0.24	(0.15)
FC global bank funding	-1.63	(0.31)	0.65	(0.28)	-1.02	(0.25)
Equity value (billions)	-0.83	(0.88)	-7.17	(0.77)	-11.11	(0.69)
Panel B. Market-level outcomes						
Banking sector equity value (billions)	-0.28	(0.16)	-3.56	(0.13)	-5.73	(0.12)
Depositors' surplus (billions)	-0.08	(0.13)	0.68	(0.12)	2.26	(0.10)
Borrowers' surplus (billions)	-0.09	(0.01)	0.11	(0.01)	0.02	(0.01)
Spot exchange rate	0.05	(0.01)	-0.10	(0.01)	-0.08	(0.01)
LC government bond yields	-0.37	(0.04)	0.60	(0.04)	0.45	(0.03)

C Synthetic FX Forward Creation

An FX swap agreement is a contract that facilitates the exchange of liquid assets (account money) in different currencies via the spot leg, while simultaneously hedging the resulting changes in foreign currency positions through the forward leg. Figure A16 illustrates the fund flows involved in a dollar/lira swap as an example. Initially, in the spot leg of the contract, the domestic bank borrows $S_t\tilde{X}_t^s$ local currency units from, and lends $\tilde{X}_t^s$ dollars to, a non-resident currency trader, where S_t is the current FX spot rate. Upon expiration of the contract in the forward leg, the domestic bank repays $F_t\tilde{X}_t^s$ local currency units to the non-resident currency trader, who in turn returns $\tilde{X}_t^s$ dollars to the domestic bank, where F_t represents the FX forward rate established at the start of the contract. The transaction ensures liquidity in the required denomination while maintaining the original foreign currency positions of both parties involved in the contract. It is crucial to note that an FX swap agreement does not alter the foreign currency position of any participating entity. Therefore, FX swaps can be considered a form of FX risk-free collateralized borrowing or lending.

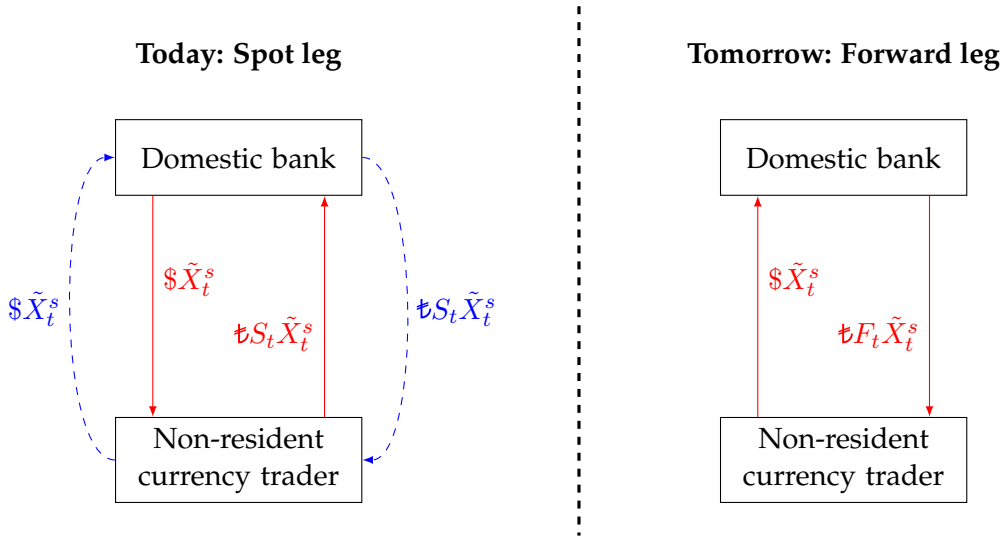


Figure A16. Synthetic FX Forward Creation. This figure displays fund flows involved in the synthetic creation of an FX forward contract through a combination of FX spot and FX swap transactions. Red solid lines are flows associated with the FX swap contract; dashed blue lines are for the FX spot market transaction. On the left side of the diagram, labeled "Today: Spot leg," a domestic bank and a non-resident currency trader execute a spot transaction where the trader buys the local currency (₺) from the bank. Simultaneously, they enter into an FX swap agreement where the trader returns an equivalent amount of local currency back to the bank. On the right side of the diagram, labeled "Tomorrow: Forward leg," the future settlement involves the trader repurchasing the currency at a predetermined rate (F_t), as agreed in the swap. By using these two types of financial instruments together—spot and swap—the parties effectively synthetically create a forward contract.

However, market participants, such as domestic banks in our empirical model, can close their existing exchange rate exposure by combining FX swap and spot transactions, effectively creating a synthetic forward foreign currency position. In this scenario, the spot leg of the FX swap and the spot transaction in the opposite direction cancel each other out. As a result, the remaining forward leg of the swap functions equivalently to a standalone forward transaction.