# Cryptocurrencies in Emerging Markets: A Stablecoin Solution?*

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**Abstract**

In this paper we rationalize cryptocurrency adoption in a small open economy model. Digital dollarization, which is when households use stablecoins pegged to the USD for transactions, increases the net welfare of households. Alternatively, risky cryptocurrency adoption, such as El Salvador's 2021 experiment to make Bitcoin legal tender, result in net welfare losses. This outcome is consistent with the observed low take-up of Bitcoin as legal tender in the data. The welfare benefits derived from cryptocurrency adoption are increasing in the magnitude of macroeconomic shocks, providing motivation for the growing use of stablecoins in emerging markets as a safeguard against high inflation and macroeconomic instability.

**Keywords**: stablecoins, digital dollarization, bitcoin, cryptocurrency, monetary policy

**JEL Classifications**: F31, G14, G15, G18, G23

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# 1 Introduction

Emerging markets economies (EMEs) are increasingly adopting cryptocurrencies to hedge against macroeconomic instability. For example, a number of economies, such as Turkey and Argentina, have used stablecoins, blockchain-based currencies typically pegged to the USD, as a store of value. Using stablecoins, a type of digital dollarization, is typically in response to high inflation and domestic policy uncertainty.[1] Recent survey evidence conducted by Mastercard reveal that up to a third of households in Latin America have used stablecoins for retail payments.[2] In addition to digital dollarization, El Salvador adopted Bitcoin as legal tender in September 2021. While the policy aimed to increase financial inclusion, reduce remittance costs, and encourage foreign direct investment, there was limited take-up of the currency based on survey data (Alvarez, Argente, and Van Patten 2023).

In this paper, we study cryptocurrency adoption in a workhorse small open economy (SOE) New Keynesian dynamic stochastic general equilibrium (DSGE) model. Our model investigates how cryptocurrencies can bring macroeconomic benefits as a vehicle for consumption smoothing for the unbanked population. Our model framework answers open questions on cryptocurrency adoption in emerging markets: what welfare effects this has; whether monetary policy becomes more or less effective; and whether digital currencies buffer or amplify an economy from foreign financial shocks. In particular, we can rationalize why countries may choose to pursue digital dollarization in response to macroeconomic instability, and why risky cryptocurrency adoption leads to welfare losses, explaining the limited take-up of Bitcoin in El Salvador. We generalize our findings to SOEs with both floating and fixed exchange rates.

Our baseline SOE model features two types of households: those that hold both domestic (fiat) currency and cryptocurrencies, and those that only hold money and cryptocurrencies.[3] The model also contains a banking sector, which intermediates funding between households and firms. Additionally, we allow banks to raise funds from foreign (global) inter-bank markets. The spread between foreign interest rates and domestic interest rates generates the existence of cross-border interbank borrowing into the domestic economy, as investors search for higher yields.[4] Within this framework, we form a simple process for the adjustment of cryptocurrency deposits due to

1. In January 2022, Turkish residents sold Lira for the Tether stablecoin. See: https://www.ft.com/content/02194361-a5b9-4bf0-9147-f36ba7759cf1. Concerns about the devaluation of the Argentinan Peso after a government resignation led to a surge in demand for stablecoins: https://www.coindesk.com/business/2022/07/04/argentines-take-refuge-in-stablecoins-after-economy-minister-resignation/

2. https://www.prnewswire.com/news-releases/latin-america-s-crypto-conquest-is-driven-by-consumers-needs-819718066.html. For more evidence, we refer readers to Appendix A.1.

3. Our baseline specification is an independent central bank. However, we can generalize our model to include fixed exchange rate regimes like El Salvador, in which the domestic currency is the USD.

4. The foreign interest rate can be proxied by the US Federal Funds Rate.

their valuation effects. The intuition is as follows. Households need to convert cryptocurrency to domestic currency at the time of consumption. Valuation effects in the cryptocurrency lead to a change in the purchasing power of household cryptocurrency deposits, which affects consumption, labor, and bank lending. A baseline calibration predicts that a 1 percent decline in cryptocurrency prices will cause a peak decline in unbanked consumption of approximately 0.1%, and banked consumption of approximately 0.015% (1.5 basis points).

We then turn to understanding the welfare effects of cryptocurrency adoption, and compute the relative welfare of an economy with cryptocurrencies to an economy with no cryptocurrency deposits, which we denote as "cryptocurrency autarky". When the volatility of the cryptocurrency prices is sufficiently high, the general equilibrium effects of volatile cryptocurrency deposits lead to an increase in the volatility of bank lending, firm wages, and an increase in the volatility of consumption and labor. The volatility costs cause a decline in aggregate welfare relative to the cryptocurrency autarky economy. Our welfare analysis sheds light on the welfare benefits of digital dollarization: For a sufficiently low volatility of the cryptocurrency price shock, we obtain net benefits relative to autarky. Thus, we conjecture that digital dollarization can provide an effective mechanism for consumption smoothing.

Finally, we compute the relative welfare of an economy with a cryptocurrency with respect to different external macroeconomic shocks, such as foreign monetary policy and inflation shocks. Our results suggest that the introduction of a cryptocurrency provides welfare benefits to both banked and unbanked households, and these benefits are increasing in the volatility of macroeconomic shocks. In an economy with cryptocurrency deposits, the unbanked households can better hedge interest rate risk by smoothing consumption using cryptocurrency rather than just real money balances.

While both banked and unbanked households benefit from cryptocurrency's role in consumption smoothing, we find that for large external shocks, banked households experience higher welfare gains due to the financial channel. Banked households, whose income is tied to bank equity, are more sensitive to foreign interest rate shocks, which increase the foreign debt burden and reduce bank net worth. However, access to cryptocurrency allows these households to diversify risks, weakening the impact of the financial channel on bank capital and mitigating the adverse effects of foreign monetary shocks. Our simulations show that in a cryptocurrency economy, banked households see improvements in net worth, deposits, and capital stock, while foreign currency borrowing as a share of total assets declines.

In summary, our findings suggest that cryptocurrency adoption can serve as a hedge against macroeconomic risk and inflation, supporting the notion that countries may adopt digital dollarization to protect against economic volatility.

The remainder of the paper is structured as follows. In Section 2, we summarize the contributions of our paper to the related literature. In Section 3, we describe our model and define the equilibrium conditions. Section 4 outlines the results of our baseline specification of a cryptocurrency price shock and conducts additional tests on differences between fixed and flexible exchange rate regimes and a welfare analysis. Section 5 concludes the paper.

## 2 Related literature

We contribute to the literature on the macroeconomic costs and benefits of dollarization (Schmitt-Grohé and Uribe 2001; Chang and Velasco 2002; Mendoza 2001). The costs of dollarization, as studied by Schmitt-Grohé and Uribe (2001), include the loss of monetary independence and the reduced ability to stabilize prices against asymmetric shocks. This is weighed against the benefit of lowering the likelihood of a "peso shock" and a large currency devaluation. Their welfare analysis finds that the net welfare costs of dollarization range from 0.1% to 0.3% when compared to alternative policy rules. Chang and Velasco (2002) shows how the welfare implications of dollarization can vary depending on government credibility, while Mendoza (2001) demonstrates how dollarization can improve welfare by reducing policy uncertainty and alleviating credit constraints, with benefits ranging from 4% to 9%.

Relative to the existing literature on dollarization, we make three key contributions. First, we analyze digital dollarization when the cryptocurrency itself is subject to price fluctuations, adding an additional cost to traditional dollarization. Unlike a stable currency peg, the cryptocurrency peg introduces devaluation risk, which, if sufficiently high, can lead to welfare costs that outweigh the benefits of macroeconomic hedging. Second, similar to traditional dollarization studies, we show that digital dollarization can act as a hedge against external macroeconomic shocks and, under reasonable assumptions about cryptocurrency price shocks, can have net positive welfare effects. Finally, we highlight the relative benefits of digital dollarization for banked versus unbanked households. We find that unbanked households are generally more sensitive to cryptocurrency price shocks, but both types of households can gain welfare from the inclusion of a stable digital currency. The welfare benefits, however, are typically greater for unbanked households due to the consumption-smoothing advantages. Interestingly, banked households may benefit more from holding cryptocurrency during periods of large external shocks, such as shocks to foreign risk premia.

Our work also relates to an emerging literature on the macroeconomic implications of global stablecoins and a Central Bank Digital Currency (CBDC) (Baughman and Flemming 2020; Benigno, Schilling, and Uhlig 2022; Benigno 2022; Ferrari Minesso, Mehl, and Stracca 2022; George, Xie, and Alba 2020; Skeie 2019; Ikeda 2020; Kumhof et al. 2021; Cong and Mayer 2021). Benigno, Schilling, and Uhlig (2022) model a two-country framework in which a global stablecoin is traded freely between both countries. They determine an equilibrium result of synchronization of interest rates across the two countries in which users are indifferent between holding the global cryptocurrency and the domestic currency. Baughman and Flemming (2020) model the welfare effects of basket-based stablecoins that is a convex weighting of sovereign currencies. They find, in equilibrium, there is low demand for the global stablecoin, and modest welfare effects relative to a dollarization case of 2%. Skeie (2019) studies an equilibrium in which the cryptocurrency is susceptible to bank runs. Ferrari Minesso, Mehl, and Stracca (2022) set up a two-country model with a CBDC issued by the home country. They find productivity spillovers are amplified in the presence of a CBDC, and that it reduces the effectiveness of the foreign country's monetary policy. Cong and Mayer (2021) model the political economy of currency competition with countries choosing between adopting a CBDC and a private cryptocurrency. They show that EMEs with weak fundamentals can derive net welfare benefits from cryptocurrency adoption as an alternative to adopting a CBDC or the US dollar.

Finally, we contribute to a policy discussion on the cost and benefits of cryptocurrency adoption. Ikeda (2020) models digital dollarization in a two-country economy in which goods are priced in foreign currency. Domestic monetary policy transmission is weakened when prices are denominated in a foreign currency, in line with the dominant currency pricing model developed in Gopinath et al. (2020). The channel of monetary policy transmission in Ikeda (2020) is expenditure switching; in our paper, we offer an alternative channel through having cryptocurrency deposits that are insulated from changes in the policy rate. Oefele, Baur, and Smales (2024) find empirical evidence that emerging markets trade more in stablecoins as a hedge against macroeconomic risk, with countries like Turkey typically increasing stablecoin trading during periods of higher inflation.

Turning to risky cryptocurrency adoption, Alvarez, Argente, and Van Patten (2023) document survey evidence on the Bitcoin Chivo wallet and analyze the determinants of Bitcoin adoption. They find that the unbanked population is not sufficiently incentivized to adopt the payment system. Goldbach and Nitsch (2024) shows that El Salvador's policies had negative effects on capital flows. Subacci (2021) argues that while Bitcoin enables value transfer without intermediation, the risk of a sudden drop in its price means that migrants and their families back home can never be sure about the amount transferred.[5] Economists at the IMF (Adrian and Weeks-Brown 2021) have opposed El Salvador's Bitcoin law, noting substantial risks to macro-financial stabil-

5. See, for example, https://www.project-syndicate.org/commentary/risks-of-el-salvador-adopting-Bitcoin-by-paola-subacchi-2021-06.

ity, financial integrity, consumer protection, and the environment. They also cite the ineffectiveness of monetary policy as central banks cannot set interest rates on a cryptocurrency, and as a result, domestic prices could become highly unstable. In addition, Plassaras (2013) analyzes regulatory concerns with the IMF being unable to provide financial support through emergency loan provisions if the financial crisis is due to legal tender in cryptocurrencies.

# 3 Model

Our model framework draws on elements from small open economy (SOE) models with financial frictions (Aoki, Benigno, and Kiyotaki 2016; Akinci and Queralto 2023; Gourinchas 2018; Ahmed, Akinci, and Queralto 2021) and exogenous terms of trade shocks (Kulish and Rees 2017; Drechsel and Tenreyro 2018). The source of financial frictions is based on an incentive compatibility constraint, where banks must hold sufficient value to prevent them from absconding with a fraction of foreign deposits, following Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). This friction is crucial in deviating from the uncovered interest parity (UIP) condition. We extend the framework in Aoki, Benigno, and Kiyotaki (2016) (henceforth ABK) by incorporating an additional set of unbanked households that lack access to domestic or international banking channels. These households rely solely on money and cryptocurrencies as mediums of exchange and savings vehicles. Cryptocurrency prices in our model are subject to exogenous shocks, akin to the terms of trade and commodity price shocks studied by Drechsel and Tenreyro (2018), with the key distinction being that cryptocurrency price shocks influence the saving and consumption behavior of unbanked households rather than the allocation of commodity-producing firms.

Our baseline model builds on the New Keynesian dynamic stochastic general equilibrium (DSGE) framework (Galí 2015), equipped with a banking sector and cross-border interbank borrowing as a funding source for domestic banks. We incorporate SOE features from Galí and Monacelli (2005), ABK, and Akinci and Queralto (2023). The model includes a banking sector capable of holding cryptocurrency balances and raising funds from both domestic households and international banks, albeit with foreign exchange risk and efficiency costs. For instance, an increase in foreign interest rates on cross-border interba

## 3.1 Households and workers

The representative household contains a continuum of individuals, each of which are of type $i \in \{b, h, u\}$. Bankers ($i = b$) and banked households (BHH) ($i = h$) share a perfect insurance scheme such that they each consume the same amount of real output.

However, unbanked households (UHH) $(i = u)$ are not part of this insurance scheme, and so their consumption volumes are different from bankers and the BHH.

The problem for the representative banked household is the following. They choose consumption, $C_t^h$, labor supply, $L_t^h$, equity holdings in firms, $K_t^h$, deposits held at the bank, $D_t$, which earn a nominal return of $R_t$,[6] and cryptocurrency deposits, $B_t^h$,[7] to maximize the present value discounted sum of their expected utility,

$$\max_{\{C_t^h, L_t^h, K_t^h, M_t^h, B_t^h, D_t\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ u(C_t^h, L_t^h) + \Upsilon(M_t^h, B_t^h) \right],$$

subject to their period budget constraint,

$$\begin{aligned} C_t^h + Q_t K_t^h + \chi_t^h + M_t^h + \chi_{M,t}^h + B_t^h + \chi_{DC,t}^h + D_t \\ = w_t^h L_t^h + R_t^k Q_{t-1} K_{t-1}^h + \frac{M_{t-1}^h + R_{t-1}^c B_{t-1}^h + R_{t-1} D_{t-1}}{\pi_t} + \Pi_t^P, \end{aligned} \tag{1}$$

where $Q_t$ is the equity price in terms of final goods; $\chi^h(K_t, K_t^h)$ are BHH portfolio management costs; $w_t^h$ are real wages of the BHH in terms of final goods; $\Pi_t^P$ are real profits earned by the household from the production of intermediate goods, production of investment goods, and banking; $R_t^k = (z_t^k + \lambda) Q_t / Q_{t-1}$ is the gross return on capital and $z_t^k$ is the rental rate of capital; $R_t = 1 + i_t$ is the gross nominal interest rate; $\pi_t = P_t / P_{t-1}$ is the gross domestic inflation rate, where $P_t$ is the domestic price level; parameter $\lambda$ is one minus the depreciation rate of capital; and $R_t^c$ denotes a nominal return earned on cryptocurrency deposits held in digital wallets. The nominal return is equal to the appreciation of cryptocurrency in domestic currency:

$$R_t^c = \frac{P_t^c}{P_{t-1}^c}. \tag{2}$$

The functional form of the subutility function $\Upsilon(\cdot)$ uses CRRA preferences over both money and cryptocurrency balances.

As mentioned, banked households can directly purchase equity in domestic firms, but with an efficiency cost – relative to a banker purchasing equity – given by the fol-

6. Technically, the household chooses nominal deposits, $D_t^n$, which are deflated by the domestic consumer price index, $P_t$:

$$D_t = \frac{D_t^n}{P_t}.$$

7. Specifically, we define

$$B_t = P_t^c B_t^N,$$

where $P_t^c$ is the real price level of cryptocurrencies and $B_t^N$ are cryptocurrency holdings denominated in units of the cryptocurrency token (e.g., Bitcoin).

lowing expression:

$$\chi_t^h = \frac{\varkappa^h}{2}\left(\frac{K_t^h}{K_t}\right)^2 K_t, \tag{3}$$

where $K_t$ is the aggregate capital stock and parameter $\varkappa^h$ is an efficiency cost arising from banked households financing firms directly. For notational convenience, define $\lambda_t^i$ as the marginal utility of consumption of household $i$, then denote $\Lambda_{t,t+1}^i$ as the stochastic discount factor (SDF) of type $i$ households given by

$$\Lambda_{t,t+1}^i = \beta \mathbb{E}_t \frac{\lambda_{t+1}^i}{\lambda_t^i}. \tag{4}$$

The unbanked also supply their labor to firms for a wage, however they engage in intertemporal savings by holding real money balances, $M_t$, and cryptocurrency. In other words, they do not have access to deposit facilities at banks. Their problem is:

$$\max_{\{C_t^u, L_t^u, M_t, B_t^u\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_t^u, L_t^u) + \Upsilon(M_t^u, B_t^u)\right],$$

subject to the period budget constraint,

$$C_t^u + B_t^u + \chi_{M,t}^u + \chi_{DC,t}^h + M_t = w_t^u L_t^u + \frac{R_{t-1}^c B_{t-1}^u + M_{t-1}}{\pi_t}. \tag{5}$$

For details on functional forms and first order conditions (FOCs), please refer to Appendix A.2.1.

## 3.2 Banks

The interaction between workers and bankers within the representative household is as follows. We normalize the composition of workers and bankers such that their combined population is a unit density. Let $\sigma$ denote the continuation probability of a banker remaining in employment through to the next period, such that she may retire with probability $1 - \sigma$ in each period. The number of bankers retiring in each period is matched by the number of workers transitioning into banking, and thus the population of workers and bankers is stable. A retiring banker transfers her franchise value – or remaining net worth – as a dividend to the household, and new bankers receive fraction $\gamma$ of total assets from the household as initial funds.

Banked households cannot access foreign savings directly, and foreign households cannot directly hold domestic capital. All interactions between domestic equity markets and foreign households must be intermediated by the domestic banking sector.

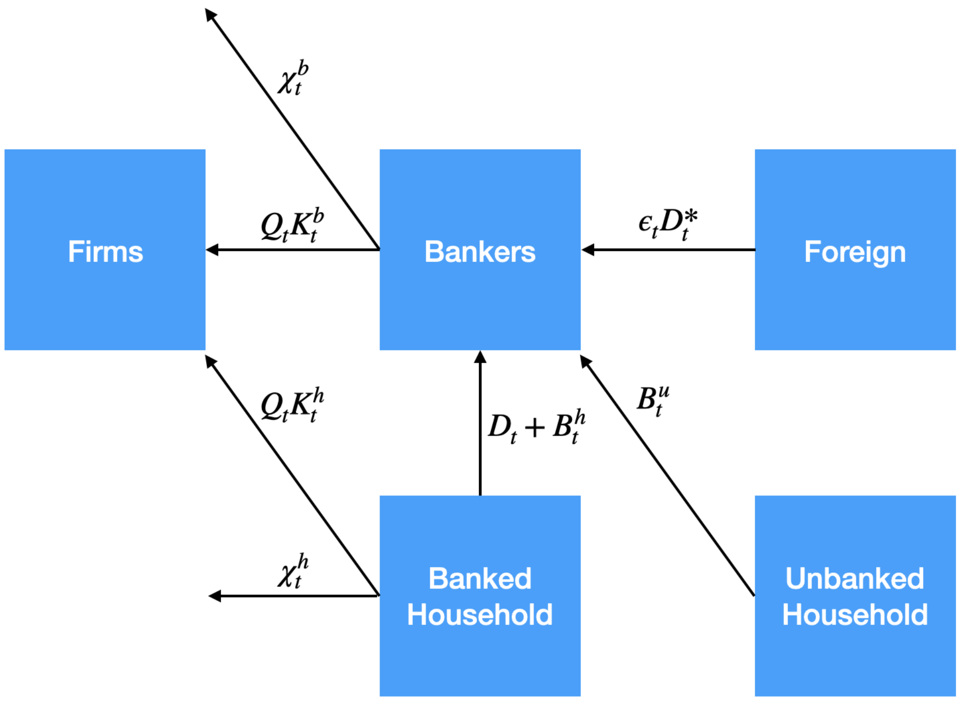



Figure 1: Graphical illustration of the model

This of course implies that the domestic banks are exposed to foreign exchange rate risk. Figure 1 provides an overview of agents and flows in this model.

A banker will finance her capital investments, of market value $Q_t k_t^b$, by receiving deposit funds from banked households in domestic currency, $d_t$, cryptocurrency deposits, $b_t$, and from foreign households in foreign currency converted to domestic currency units, $\epsilon_t d_t^*$. The banker faces exchange rate risk, and the real exchange rate is defined as

$$\epsilon_t = \frac{E_t P_t^*}{P_t}, \tag{6}$$

where $E_t$ is the nominal exchange rate defined as the quantity of domestic currency units per one unit of foreign currency.[8] While bankers can invest in domestic firms costlessly – unlike workers – they incur an efficiency cost from taking in deposits from foreign households, defined by the following expression:

$$\chi_t^b = \frac{\varkappa^b}{2} x_t^2 Q_t k_t^b, \tag{7}$$

where $\varkappa^b > 0$ is a foreign borrowing cost parameter and $Q_t k_t^b$ is the asset holding of a banker.[9] $x_t$ is the fraction of a banker's assets financed by foreign borrowing and is

8. Thus, an increase (decrease) in $\epsilon_t$ and $E_t$ is a domestic currency depreciation (appreciation).
9. The quadratic adjustment costs $\chi_t^h$ and $\chi_t^b$ can also be thought of as a method to close the model, as explained in Schmitt-Grohé and Uribe (2003).

defined as:

$$x_t = \frac{\epsilon_t d_t^*}{Q_t k_t^b}. \tag{8}$$

Additionally, as the banker offers cryptocurrency wallet services to households,[10] we define $x_t^c$ as a banker's cryptocurrency deposit leverage ratio:

$$x_t^c = \frac{b_t}{Q_t k_t^b}. \tag{9}$$

Bankers aim to build up their own net worth or franchise value, $n_t$, until retirement. As mentioned, when a banker retires she brings her net worth back to the household in the form of a dividend.[11] Thus, a banker will seek to maximize her bank's franchise value, $\mathbb{V}_t^b$, which is the expected present discount value of future dividends:

$$\mathbb{V}_t^b = \mathbb{E}_t \sum_{s=1}^{\infty} \Lambda_{t,t+s}^h \sigma^{s-1}(1-\sigma)n_{t+s}, \tag{10}$$

where $n_{t+s}$ is the net worth of the bank when the banker retires at date $t+s$ with probability $\sigma^{s-1}(1-\sigma)$. So, a banker will choose quantities $k_t^b$, $d_t$, and $d_t^*$ to maximize expression (10).[12]

A financial friction in line with Gertler and Kiyotaki (2010) is used to limit the banker's ability to raise funds, whereby the banker faces a moral hazard problem: the banker can either abscond with the funds she has raised from domestic and foreign depositors, or the banker can operate honestly and pay out her obligations. Absconding is costly, however, and so the banker can only divert a fraction, $\Theta$, of assets she has accumulated:

$$\Theta(x_t, x_t^c) = \frac{\theta_0}{\exp(\theta x_t + \theta^c x_t^c)}, \tag{11}$$

where we assume that $\{\theta_0, \theta, \theta^c\} > 0$. Thus, following Gertler and Kiyotaki (2010), we assume that as the banker raises a greater proportion of her funds from international

10. See, for example, the central bank of El Salvador publishing draft regulations on banks handling Bitcoin deposits.

11. As done in Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), this retirement assumption is made so as to avoid banks being able to accumulate retained earnings, evading any financing constraints or obligations to creditors.

12. Note that we make the simplifying assumption that each individual banker exogenously accepts cryptocurrency deposits, $b_t$, directly in proportion to the population of bankers and total cryptocurrency holdings. In other words, in aggregate, the total sum of individual cryptocurrency deposits at each $j$-th bank, $b_t(j)$, is equal to aggregate cryptocurrency deposits, $B_t$:

$$\sum_{j=1}^{\infty} b_t(j) = B_t.$$

financial markets and cryptocurrency deposits, she can abscond a smaller proportion of her assets.

The caveat to absconding, in addition to only being able to take a fraction of assets away, is that it takes time – i.e., it takes a full period for the banker to abscond. Thus, the banker must decide to abscond in period $t$, in addition to announcing what value of $d_t$ she will choose, prior to realizing next period's rental rate of capital. If a banker chooses to abscond in period $t$, its creditors will force the bank to shut down in period $t+1$, causing the banker's franchise value to become zero.

Therefore, the banker will choose to abscond in period $t$ if and only if the return to absconding is greater than the franchise value of the bank at the end of period $t$, $\mathbb{V}_t^b$. It is assumed that the depositors act rationally, and that no rational depositor will supply funds to the bank if she clearly has an incentive to abscond. In other words, the bankers face the following incentive constraint:

$$\mathbb{V}_t^b \geq \Theta(x_t, x_t^c) Q_t k_t^b, \tag{12}$$

where we assume that the banker will not abscond in the case of the constraint holding with equality.

Bankers face the following balance sheet constraint:

$$\left(1 + \frac{\varkappa^b}{2} x_t^2\right) Q_t k_t^b = d_t + \epsilon_t d_t^* + n_t + b_t. \tag{13}$$

Additionally, we can write the flow of funds constraint for a banker as

$$n_t = R_t^k Q_{t-1} k_{t-1}^b - \frac{R_{t-1}}{\pi_t} d_{t-1} - \frac{R_{t-1}^*}{\pi_t^*} \epsilon_t d_{t-1}^* - \frac{R_{t-1}^c}{\pi_t} b_{t-1}, \tag{14}$$

noting that for the case of a new banker, the net worth is the startup fund given by the household (fraction $\gamma$ of the household's assets).

### 3.2.1 Banker's problem and financial market wedges

Since $\mathbb{V}_t^b$ is the franchise value of the bank, which we can interpret as a "market value", we can divide $\mathbb{V}_t^b$ by the bank's net worth to obtain a Tobin's Q ratio for the bank denoted by $\psi_t$:

$$\psi_t \equiv \frac{\mathbb{V}_t^b}{n_t}. \tag{15}$$

Additionally, defining $\phi_t$ as the leverage ratio of a bank,

$$\phi_t = \frac{Q_t k_t^b}{n_t}, \tag{16}$$

we can write the banker's problem as the following:

$$\psi_t = \max_{\phi_t, x_t} \left\{ \mu_t \phi_t + \left(1 - \frac{\varkappa^b}{2} x_t^2 \phi_t\right) \upsilon_t + \mu_t^* \phi_t x_t + \mu_t^c x_t^c \phi_t \right\}, \tag{17}$$

subject to

$$\psi_t = \Theta(x_t, x_t^c)\phi_t, \tag{18}$$

where $\Omega_{t,t+1}$ is the stochastic discount factor of the banker;[13] $\mu_t$ is the excess return on capital over home deposits; $\mu_t^c$ is the cost advantage of cryptocurrency holdings over home deposits; $\mu_t^*$ is the cost advantage of foreign currency debt over home deposits or the deviation from real uncovered interest parity (UIP); and $\upsilon_t$ is the marginal cost of deposits:

$$\mu_t = \mathbb{E}_t \Omega_{t,t+1} \left( R_{t+1}^k - \frac{R_t}{\pi_{t+1}} \right), \tag{19}$$

$$\mu_t^c = \mathbb{E}_t \Omega_{t,t+1} \left( \frac{R_t}{\pi_{t+1}} - \frac{R_t^c}{\pi_{t+1}} \right), \tag{20}$$

$$\mu_t^* = \mathbb{E}_t \Omega_{t,t+1} \left( \frac{R_t}{\pi_{t+1}} - \frac{\epsilon_{t+1}}{\epsilon_t} \frac{R_t^*}{\pi_{t+1}^*} \right), \tag{21}$$

$$\upsilon_t = \mathbb{E}_t \Omega_{t,t+1} \frac{R_t}{\pi_{t+1}}, \tag{22}$$

$$\Omega_{t,t+1} = \Lambda_{t,t+1}^h (1 - \sigma + \sigma \psi_{t+1}). \tag{23}$$

Solving the banker's problem yields an optimal leverage ratio and share of foreign deposits:

$$\phi_t = \frac{\upsilon_t}{\Theta(x_t, x_t^c) - \mu_t - \mu_t^* x_t - \mu_t^c x_t^c + \frac{\varkappa^b}{2} x_t^2 \upsilon_t}, \tag{24}$$

$$x_t = \frac{\theta \mu_t^* - \varkappa^b \upsilon_t}{\theta \varkappa^b \upsilon_t} + \sqrt{\left( \frac{\mu_t^*}{\varkappa^b \upsilon_t} \right)^2 + 2 \frac{\mu_t^c}{\varkappa^b \upsilon_t} x_t^c + \left( \frac{1}{\theta} \right)^2 + 2 \frac{\mu_t}{\varkappa^b \upsilon_t}}. \tag{25}$$

For a complete description of the solution to the banker's problem, please refer to Appendix A.2.2.

13. Note that we assume that the stochastic discount factor of the banker is a function of the stochastic discount factor of the banked households. This is because we assume that unbanked households do not hold domestic currency denominated deposits.

## 3.3 Firms

### 3.3.1 Final good firms

Firms and production in the model are standard, following a New Keynesian Dixit-Stiglitz setup. Final goods are produced by perfectly competitive firms using intermediate goods as inputs into production:

$$Y_t = \left( \int_0^1 Y_t(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}},$$

where $Y_t(i), i \in [0,1]$, are differentiated intermediate goods and $\eta > 0$ is an elasticity of demand parameter.

### 3.3.2 Intermediate good producers

Each differentiated intermediate good is produced by a constant returns to scale technology given as follows:

$$Y_t(i) = A_t \left( \frac{K_{t-1}(i)}{\alpha_K} \right)^{\alpha_K} \left( \frac{IM_t(i)}{\alpha_M} \right)^{\alpha_M} \left( \frac{L_t^h(i)}{\alpha_h} \right)^{\alpha_h} \left( \frac{L_t^u(i)}{\alpha_u} \right)^{\alpha_u},$$

where $K_t(i)$, $IM_t(i)$, $L_t^h(i)$, and $L_t^u(i)$ are capital, imports, BHH labor, and UHH labor inputs into production, respectively, by intermediate good producer $i$, and $A_t$ denotes an aggregate total factor productivity (TFP) process which is assumed to follow a stationary AR(1) process. $\alpha_K$, $\alpha_M$, $\alpha_h$, and $\alpha_u$ are input shares for capital, imports, banked households, and unbanked households, respectively, and are each assumed to be bound between 0 and 1 such that the share of inputs sum to unity giving a constant returns to scale production technology.

From the intermediate firm's cost minimization problem, real marginal cost is defined as:[14]

$$mc_t = \frac{1}{A_t} (z_t^k)^{\alpha_K} \epsilon_t^{\alpha_M} (w_t^h)^{\alpha_h} (w_t^u)^{\alpha_u}, \tag{29}$$

14. From the FOCs, we also yield the following expenditure shares:

$$\frac{\epsilon_t IM_t}{z_t^k K_{t-1}} = \frac{\alpha_M}{\alpha_K}, \tag{26}$$

$$\frac{w_t^h L_t^h}{z_t^k K_{t-1}} = \frac{\alpha_h}{\alpha_K}, \tag{27}$$

$$\frac{w_t^u L_t^u}{z_t^k K_{t-1}} = \frac{\alpha_u}{\alpha_K}. \tag{28}$$

and where we also find that in the symmetric equilibrium,

$$Y_t = A_t \left(\frac{K_{t-1}}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t^h}{\alpha_h}\right)^{\alpha_h} \left(\frac{L_t^u}{\alpha_u}\right)^{\alpha_u}. \tag{30}$$

where $K_{t-1}$, $M_t$, $L_t^h$ and $L_t^u$ are aggregate capital, imports, BHH labor, and UHH labor inputs used in production during period $t$, respectively.

Inherent to each intermediate firm $i$'s problem – in addition to selecting input quantities to minimize costs – is the choice of $P_t(i)$. Under Rotemberg pricing and in the symmetric equilibrium, we can write an expression for the evolution of inflation:[15]

$$(\pi_t - 1)\pi_t = \frac{1}{\kappa}(\eta mc_t + 1 - \eta) + \mathbb{E}_t \Lambda_{t,t+1}^h \frac{Y_{t+1}}{Y_t}(\pi_{t+1} - 1)\pi_{t+1}. \tag{31}$$

### 3.3.3 Investment good firms

We assume that investment goods are produced by perfectly competitive firms, and that the aggregate capital stock grows according to the following law of motion:

$$K_t = \lambda K_{t-1} + I_t, \tag{32}$$

and recall that $\lambda = 1 - \delta$, where $\delta \in (0, 1)$ is the depreciation rate. Total investment costs are given by:

$$I_t \left[1 + \Phi\left(\frac{I_t}{\bar{I}}\right)\right],$$

where $\Phi(\cdot)$ are investment adjustment costs similar to those in Christiano, Eichenbaum, and Evans (2005),[16] and are defined as:

$$\Phi\left(\frac{I_t}{\bar{I}}\right) = \frac{\kappa_I}{2}\left(\frac{I_t}{\bar{I}} - 1\right)^2,$$

with $\Phi(1) = \Phi'(1) = 0$ and $\Phi''(\cdot) > 0$. The investment adjustment cost parameter $\kappa_I = \Phi''(1)$ is chosen so that the price elasticity of investment is consistent with instrumental variable estimates in Eberly (1997).

Thus, the representative investment good firm wishes to maximize its profits,

$$\max_{I_t} \left\{ Q_t I_t - I_t - \Phi\left(\frac{I_t}{\bar{I}}\right) I_t \right\}.$$

15. A standard expression for the New Keynesian Phillips Curve (NKPC) can be written by log linearising (31) about the non-inflationary steady state.

16. The key difference is that here $\Phi(I_t/\bar{I})$ as opposed to $\Phi(I_t/I_{t-1})$ as in Christiano, Eichenbaum, and Evans (2005).

Differentiating with respect to $I_t$ gives the following FOC:

$$Q_t = 1 + \Phi\left(\frac{I_t}{\bar{I}}\right) + \left(\frac{I_t}{\bar{I}}\right)\Phi'\left(\frac{I_t}{\bar{I}}\right). \tag{33}$$

## 3.4 Foreign exchange

In this subsection we describe the role of foreign output, inflation, and interest rates. In what follows, starred variables denote the corresponding foreign version of a variable.

Our model follows standard producer pricing, where we assume that exports are a function of foreign output and are given by:

$$EX_t = \left(\frac{P_t}{E_t P_t^*}\right)^{-\varphi} Y_t^* = \epsilon_t^{\varphi} Y_t^*, \tag{34}$$

where $\varphi$ is the price elasticity of foreign demand. An alternative setup would be allowing firms set export prices in foreign currency to maximize revenues, but we simplify by setting exports exogenously, as in Aoki, Benigno, and Kiyotaki (2016).[17]

To pin down the relationship between the nominal and real exchange rate, we first take logarithms of the definition for the real exchange rate, and then take first-differences:

$$\ln \epsilon_t - \ln \epsilon_{t-1} = \ln E_t - \ln E_{t-1} + \ln P_t^* - \ln P_{t-1}^* - (\ln P_t - \ln P_{t-1}).$$

This is simplified as:

$$\Delta \ln \epsilon_t = \Delta \ln E_t + \hat{\pi}_t^* - \hat{\pi}_t. \tag{35}$$

The nominal exchange is jointly determined by the purchasing power parity condition in equation (35) and the regime for the nominal exchange rate in the following subsection 3.5.

## 3.5 Exchange rate regime and monetary policy

In the baseline specification, the domestic central bank is assumed to operate an inertial Taylor Rule:

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\frac{1-\omega_E}{\omega_E}} \left(\frac{E_t}{\bar{E}}\right)^{\frac{\omega_E}{1-\omega_E}}\right]^{1-\rho_R} \exp(\varepsilon_t^R), \tag{36}$$

17. For a model allowing domestic firms to price exports in foreign currency, see Cesa-Bianchi, Ferrero, and Li (2024).Though exogenously setting exports simplifies our approach, global pricing would reduce the impact of the expenditure switching channel, as exports would be priced in foreign currency. Instead, our model focuses on the financial channel of exchange rates, specifically the effects of exchange rate movements on foreign currency liabilities of bank balance sheets, net worth, lending, and asset prices, as studied in Aoki, Benigno, and Kiyotaki (2016).

where the central bank responds to inflation and fluctuations in the nominal exchange rate away from steady state target $\bar{E}$, and $\varepsilon_t^R$ is a monetary policy shock. This particular formulation of the Taylor Rule in (36) is based on Galí and Monacelli (2016) and Akinci and Queralto (2023), where $\omega_E \in [0, 1]$ is a sensitivity parameter depicting how strongly the central bank reacts to exchange rate fluctuations and the inflation rate.

The independent central bank is consistent with emerging markets that have sovereign monetary policy that targets inflation and minimizes fluctuations in the exchange rate. For example, Brazil has an inflation targeting mandate and uses FX interventions to mitigate exchange rate fluctuations and provide liquidity during periods of stress in financial markets (Sandri 2023).

The Taylor Rule represents a strict inflation targeting regime as $\omega_E \to 0$, and an exchange rate peg as $\omega_E \to 1$. It allows hybrid regimes of managed exchange rates for values of $\omega_E \in (0, 1)$. When $\omega_E \to 0$, it includes a very high weight on inflation, and a (approximately) zero weight on exchange rate deviations from its steady state target. This regime is equivalent to a strict inflation targeting regime. In contrast, when $\omega_E \to 1$, the central bank puts a (approximately) zero weight on inflation and a very high weight on exchange rate deviations. Therefore for moderate interest rate changes in response to economic shocks, the resulting change in the exchange rate is infinitesimally small, approximating a fixed exchange rate regime.[18]

### 3.6 Cryptocurrency price process

**Stablecoin and Digital Dollarization.** We model the adoption of stablecoins in emerging markets. The stablecoin price process is a stationary AR(1) process. Stablecoins are typically pegged to the USD. In the model framework, this is equivalent to the real stablecoin price tracking the real exchange rate $\epsilon$.[19] We allow for the stablecoin price to fluctuate around the real exchange rate, given by the cryptocurrency price shock $\varepsilon_t^{Pc}$. We rationalize a symmetric distribution of peg deviations as empirically the distribution of stablecoin prices is two-sided.[20]

$$\ln\left(\frac{P_t^c}{\epsilon_t}\right) = \rho_c \ln\left(\frac{P_{t-1}^c}{\epsilon_t}\right) + \varepsilon_t^{Pc}. \tag{37}$$

**Risky cryptocurrency.** In this case, we model the adoption of risky cryptocurrencies like El Salvador's policy to make Bitcoin legal tender. The cryptocurrency price process

18. To capture dollarized economies like El Salvador that do not have an independent central bank, we replace the interest rate rule with an exchange rate fix at $E = 1$. This rule quantitatively provides equivalent welfare and steady state values to the Taylor rule with $\omega_E \to 1$.

19. In practice, the stablecoin tracks the nominal exchange rate. However, as $P_t^c$ is the real cryptocurrency price in units of the domestic good, the real cryptocurrency price is tracking the real exchange rate.

20. Appendix A.1 shows the two-sided distribution of stablecoin prices USDT and USCC.

is a stationary AR(1) process as before, however $\bar{P}^c$ is exogenously set and is not dependent on the nominal exchange rate (in the case of a stablecoin). This reflects the fact that Bitcoin and risky cryptocurrencies are typically disconnected from the macroeconomy (Benigno and Rosa 2023).

$$\ln\left(\frac{P_t^c}{\bar{P}^c}\right) = \rho_c \ln\left(\frac{P_{t-1}^c}{\bar{P}^c}\right) + \varepsilon_t^{P^c}. \tag{38}$$

Our baseline specification in our empirical analysis will employ the digital dollarization regime with stablecoins, however we note that our key results extend to a regime with a risky cryptocurrency.

### 3.7 Macroeconomic shocks

In addition to domestic interest rate and cryptocurrency price shocks, we consider shocks to the foreign interest rate, foreign output, foreign inflation and domestic productivity. All variables are given by a series of stationary AR(1) processes:

$$\ln\left(\frac{R_t^*}{\bar{R}^*}\right) = \rho_{R^*} \ln\left(\frac{R_{t-1}^*}{\bar{R}^*}\right) + \varepsilon_t^{R^*}, \tag{39}$$

$$\ln\left(\frac{Y_t^*}{\bar{Y}^*}\right) = \rho_{Y^*} \ln\left(\frac{Y_{t-1}^*}{\bar{Y}^*}\right) + \varepsilon_t^{Y^*}, \tag{40}$$

$$\ln\left(\frac{\pi_t^*}{\bar{\pi}^*}\right) = \rho_{\pi^*} \ln\left(\frac{\pi_{t-1}^*}{\bar{\pi}^*}\right) + \varepsilon_t^{\pi^*}. \tag{41}$$

$$\ln\left(\frac{A_t}{\bar{A}}\right) = \rho_A \ln\left(\frac{A_{t-1}}{\bar{A}}\right) + \varepsilon_t^{A}, \tag{42}$$

$$\tag{43}$$

### 3.8 Market equilibrium

Aggregate capital is the sum of capital (equity) owned by banked households and bankers:

$$K_t = K_t^h + K_t^b. \tag{44}$$

Likewise, aggregate consumption and labor supply by regular and unbanked households are given as:

$$C_t = C_t^h + C_t^u, \tag{45}$$

$$L_t = L_t^h + L_t^u. \tag{46}$$

The aggregate resource constraint of the domestic economy is

$$Y_t = C_t + \left[1 + \Phi\left(\frac{I_t}{\bar{I}}\right)\right] I_t + EX_t + \frac{\kappa}{2}(\pi_t - 1)^2 Y_t + \chi_t^h + \chi_t^b + \chi_{M,t}^h + \chi_{M,t}^u, \tag{47}$$

which states that output must be consumed, invested, exported, and used to pay for adjustments.[21]

The law of motion of aggregate net foreign debt is given as:

$$D_t^* = \frac{R_{t-1}^*}{\pi_t^*} D_{t-1}^* + IM_t - \frac{1}{\epsilon_t} EX_t, \tag{48}$$

The foreign debt equation of motion links the stock of foreign debt, $D^*$, to the previous period debt, which accrues interest, and the flow of new debt which is equal to the current account deficit $IM - EX$. Assuming Balance of Payments equilibrium, the current account deficit is equal to the capital account surplus, which is the new flow of capital financing by foreigners. The aggregate net worth of the bankers is:

$$\begin{aligned} N_t = \sigma & \left( R_t^k Q_{t-1} K_{t-1}^b - \frac{R_{t-1}}{\pi_t} D_{t-1} - \epsilon_t \frac{R_{t-1}^*}{\pi_t^*} D_{t-1}^* - \frac{R_{t-1}^c}{\pi_t} B_{t-1} \right) \\ & + \gamma (z_t^k + \lambda Q_t) K_{t-1}, \end{aligned} \tag{49}$$

and the aggregate balance sheet of the banking sector is given by:

$$Q_t K_t^b \left(1 + \frac{\varkappa^b}{2} x_t^2\right) = \left(1 + \frac{\varkappa^b}{2} x_t^2\right) \phi_t N_t, \tag{50}$$

$$Q_t K_t^b \left(1 + \frac{\varkappa^b}{2} x_t^2\right) = N_t + D_t + \epsilon_t D_t^* + B_t, \tag{51}$$

$$x_t = \frac{\epsilon_t D_t^*}{Q_t K_t^b}, \tag{52}$$

$$x_t^c = \frac{B_t}{Q_t K_t^b}. \tag{53}$$

We can see that (50) is an identity based on (16), and (51) is an aggregate version of the balance sheet identity, (13). Meanwhile, as all banks are identical, (52) and (53) are the corresponding aggregate versions of (8) and (9), respectively. When unbanked and banked households both use cryptocurrency deposits, their aggregate balance is held by the banker:

21. We note that GDP is given as:

$$Y_t^{GDP} = Y_t - \epsilon_t IM_t.$$

$$B_t = B_t^u + B_t^h. \tag{54}$$

A competitive equilibrium is a set of 10 prices, $\{ E_t, mc_t, Q_t, R_t, R_t^c, w_t^h, w_t^u, z_t^k, \epsilon_t, \pi_t \}$; 20 quantity variables, $\{ B_t, B_t^h, B_t^u, C_t, C_t^h, C_t^u, D_t, D_t^*, EX_t, I_t, K_t, K_t^b, K_t^h, L_t, L_t^h, L_t^u, M_t^h, M_t^u, N_t, Y_t \}$; eight bank variables, $\{ x_t, x_t^c, \psi_t, \phi_t, \upsilon_t, \mu_t, \mu_t^c, \mu_t^* \}$; three foreign variables, $\{ R_t^*, Y_t^*, \pi_t^* \}$; and two exogenous variables, $\{ A_t, P_t^c \}$, which satisfy 43 equations.

## 3.9 Calibration

We calibrate the parameters in our model using relatively standard values found in the New Keynesian macroeconomics literature. We choose El Salvador as a representative small open economy to calibrate the model parameters. The model frequency is quarterly. The baseline calibration of the domestic household block, banking, and firm sector is based on ABK (Table 1).

**Money and cryptocurrency balances.** The preference parameter $\nu_{0,i}^M$ in the economy without cryptocurrency, which we refer to as 'autarky,' is calibrated to target a ratio of real money balances to GDP of 10.5%. This is based on estimates of the cash-to-GDP ratio provided by Abad, Nuño, and Thomas (2024). These estimates are derived from the amount of banknotes in circulation, and similar estimates are found for emerging market economies in Shirai and Sugandi (2019). [22]

When transitioning to the cryptocurrency economy, we assume that investors we maintain the share of physical cash in the economy at 10.5% of GDP. Specifically, we set $\frac{M_{\text{autarky}}}{GDP} = \frac{M_{\text{dc}}}{GDP}$. While this is a simplifying assumption, it ensures comparability between the two economies in terms of the level of cash relative to GDP. The coefficient of relative risk aversion for both money and cryptocurrency, $\nu_i^M$ and $\nu_i^{DC}$, is set to 2, based on the lower bound of estimates for CRRA in the finance literature (Elminejad, Havranek, and Irsova 2022). A limitation of our calibration is the lack of a precise counterfactual for the share of cryptocurrency in the economy. For our baseline, we calibrate the cryptocurrency preference parameter, $\nu_{0,i}^{DC}$, to ensure that the share of cryptocurrency balances matches the share of real money balances in the cryptocurrency economy. With greater usage of stablecoins and cryptocurrencies over time, these parameters could be re-calibrated based on observable data on cryptocurrency balances in the economy.

22. Measures of broad money to GDP are typically much higher. For example, the World Bank reports a 60% broad money to GDP ratio. However, this is an upper bound since broad money often includes interest-bearing term deposits. Therefore, for our baseline, we use the cash-in-circulation measure, which is more consistent with the definition used in the model.

**Interest rates.** Interest rates of the domestic country are calibrated to be 5% annualized, based on an average of interest rates from 2000 to 2020 in El Salvador from the IMF's *International Financial Statistics*. The foreign interest rate is calibrated to an annualized rate of 2 percent, based on US historical data.

**Bank parameters.** For the banking parameters, the severity of the banker's moral hazard, management costs of foreign borrowing, and the fraction of household assets brought on by new bankers – $\theta_0$, $\varkappa^b$, and $\gamma$, respectively – are selected so that the bank leverage multiple, $\phi$, is roughly equal to 4 in steady state and the spread between the rate of return on bank assets and deposits is 2 percent. The banker's continuation probability, $\sigma$, is set so that the annualized dividend payout of the banker is equal to $4(1 - \sigma) = 24$ percent of the bank's net worth.

We assume bankers treat cryptocurrency deposits and the foreign deposits as symmetric with respect to the fraction of funds a banker can abscond with. Therefore, the elasticity of cryptocurrency financed leverage, $\theta^c$, is set at 0.1, which is equivalent to the elasticity of foreign deposits to leverage. The moral hazard parameters are also assumed to be symmetric, $\theta_0 = \theta_0^c = 0.401$. The cryptocurrency sub-utility parameters for the banked and unbanked households are calibrated to yield a steady state cryptocurrency deposits that is equal to 20% of labor income in the steady state, and this matches data from the World Bank which has an aggregate savings rate of 20 percent for El Salvador.[23]

The firm's capital share is one third and the import share is 0.18 following standard values in the literature. We calibrate the share of unbanked households, $\alpha_u$, to match the labor share of the unbanked population in El Salvador. The total labor share is equal to $\alpha_h + \alpha_u = 0.52$. Based on data from the World Bank, the share of the unbanked population in 2020 is two thirds, giving $\alpha_u = \frac{2}{3} \times (0.52) = 0.3466$ and $\alpha_h = 0.1734$.[24] In the baseline specification we choose $\omega_E = 0.5$, which is in between a perfect fix ($\omega_E \to 1$) and a perfect float ($\omega_E \to 0$), and can be thought of as a managed float. We find our results are qualitatively similar for fixed and flexible exchange rate regimes, as we show in Appendix 3.5.

**Macroeconomic shocks.** Turning to the calibration of macroeconomic shocks, productivity and foreign output shocks are assumed to have quarterly standard deviations of 1.3% and 2%, respectively. Meanwhile, innovations to foreign inflation, foreign and domestic interest rates have a standard deviation of 0.25% quarterly. We calibrate cryptocurrency price innovations to a quarterly standard deviation of a 1%, which is much

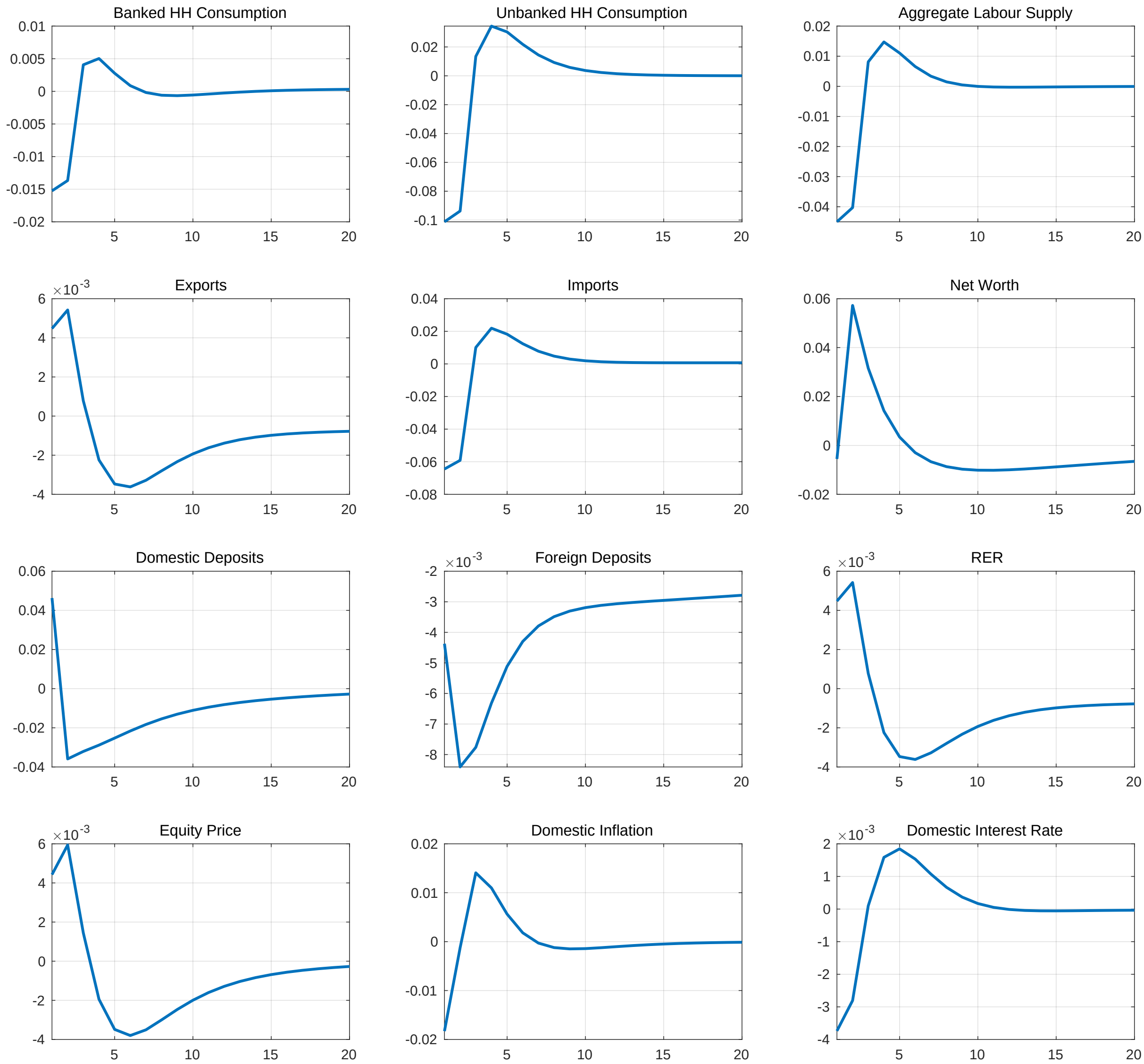
23. Data reference: https://data.worldbank.org/indicator/NY.GNS.ICTR.ZS?locations=SV.
24. https://datatopics.worldbank.org/g20fidata/country/el-salvador

lower than volatility estimates for Bitcoin. Using data from *Cryptocompare* between January 2017 to September 2021 we observe that the average quarterly volatility for Bitcoin was 70% throughout the sample period. In contrast, our calibration is a higher volatility than stablecoins like USDC and Tether which have an average quarterly volatility of between 0.1 and 0.2 percent (quarterly) volatility, respectively. We assume cryptocurrency price shocks are independent to other shocks, consistent with an empirical literature documenting a disconnect between bitcoin returns and macroeconomic fundamentals (Benigno and Rosa 2023; Umar et al. 2021; Pyo and Lee 2020; Marmora 2022). We assume a serial correlation coefficient of 0.85 (quarterly) for all our exogenous shock processes except for the cryptocurrency price process which we assume to be a transitory shock.

Table 1: Baseline calibration

| Parameter | Value | Description |
|---|---|---|
| $\beta$ | 0.9876 | Household discount factor |
| $\zeta$ | 1/3 | Inverse-Frisch elasticity of labor supply |
| $\zeta_0$ | 7.883 | Labor supply capacity |
| $\nu_{0,h}^{M}$ | 0.002 | Scale term of real money balances (BHH) |
| $\nu_{h}^{M}$ | 2 | Inverse-EIS of real money balances (BHH) |
| $\nu_{0,u}^{M}$ | 0.005 | Scale term of real money balances (UHH) |
| $\nu_{u}^{M}$ | 2 | Inverse-EIS of real money balances (UHH) |
| $\nu_{0,h}^{DC}$ | 0.002 | Scale term of cryptocurrency balances (BHH) |
| $\nu_{h}^{DC}$ | 2 | Inverse-EIS of cryptocurrency balances (BHH) |
| $\nu_{0,u}^{DC}$ | 0.005 | Scale term of cryptocurrency balances (UHH) |
| $\nu_{u}^{DC}$ | 2 | Inverse-EIS of cryptocurrency balances (UHH) |
| $\kappa_M$ | 2 | Money adjustment cost parameter |
| $\kappa_{DC}$ | 2 | Cryptocurrency adjustment cost parameter |
| $\varkappa^h$ | 0.0197 | BHH direct finance cost |
| $\theta$ | 0.1 | Elasticity of foreign financed leverage |
| $\theta^c$ | 0.1 | Elasticity of cryptocurrency financed leverage |
| $\theta_0$ | 0.401 | Bank moral hazard severity |
| $\sigma$ | 0.94 | Banker survival probability |
| $\gamma$ | 0.0045 | Fraction of total assets brought by new banks |
| $\varkappa^b$ | 0.0197 | Bank management cost of foreign borrowing |
| $\alpha_K$ | 0.3 | Production share of capital |
| $\alpha_M$ | 0.18 | Production share of imports |
| $\alpha_h$ | 0.1734 | Production share of BHH |
| $\alpha_c$ | 0.3466 | Production share of UHH |
| $\lambda$ | 0.98 | One minus the depreciation rate ($\delta = 0.02$) |
| $\kappa_I$ | 0.66 | Investment adjustment cost parameter |
| $\omega_E$ | $[0,1]$ | Monetary policy exchange rate sensitivity parameter |
| $\rho_A$ | 0.85 | TFP AR(1) coefficient |
| $\rho_R$ | 0.8 | Monetary policy inertia |
| $\rho_{R^*}$ | 0.85 | Foreign interest rate AR(1) coefficient |
| $\rho_{Y^*}$ | 0.85 | Foreign output AR(1) coefficient |
| $\rho_{\Pi^*}$ | 0.85 | Foreign inflation AR(1) coefficient |
| $\rho_c$ | 0.7 | Stablecoin price AR(1) coefficient |

Figure 2: Cryptocurrency price shock (baseline specification)




Note: Figure plots impulse responses of model variables with respect to a 1 standard deviation innovation to cryptocurrency prices. Time periods are measured in quarters, and responses are measured as a percent deviation from steady state. Domestic Inflation, Domestic Interest Rate and Cryptocurrency Return are annualized.

# 4 Results

## 4.1 Baseline specification

We trace the effects of a negative 1 percent standard deviation shock to cryptocurrency prices over 20 periods in Figure 2. A cryptocurrency disinflationary shock reduces holdings of cryptocurrency and a decline in the savings of unbanked households. This causes unbanked households to cut down their consumption. Through GHH preferences, the decline in consumption reduces labor supply by unbanked households and a decline in the real wage. The general level of prices declines, and is accompanied with a peak decline in unbanked consumption of approximately 0.1%, and banked household consumption of 0.015% (1.5 basis points). Banked households also experience an initial decline in consumption. Their effects are muted relative to unbanked households as they do not hold cryptocurrency directly. Instead, their consumption losses are due to the general equilibrium effects of a decline in wages, labor supply, and income that both sets of households experience. Turning to the banking sector, the decline in the value of their cryptocurrency liabilities causes an increase in net worth of bankers. There is a reallocation toward holding more domestic and foreign deposits. The positive effect of net worth causes a rise in asset prices and investment, but this is not enough to offset the decline in consumption, wages, and output due to the valuation of household savings. The central bank responds to the decline in prices by lowering interest rates. This triggers a nominal and real exchange rate depreciation, which increases net exports.

## 4.2 Welfare analysis

To assess the potential costs and benefits of introducing cryptocurrency, we explore its effect on welfare of the banked and unbanked households. First, we setup a simple comparison of the household utility in the deterministic steady state with the cryptocurrency economy and crypto-autarky economy. We include the sub-utility functions for holdings of money and cryptocurrency balances, $\Upsilon(M_t^i, B_t^i)$.[25] The welfare gains of digital dollarization, when the stablecoin is not subject to price shocks ($\sigma_c = 0$) in the deterministic steady state are:

$$
\begin{aligned}
\text{BHH:}\ & \ln\left(C^h - \zeta_{0,h}\frac{(L^h)^{1+\zeta_h}}{1+\zeta_h}\right)\Bigg|_{\text{crypto}} - \ln\left(C^h - \zeta_{0,h}\frac{(L^h)^{1+\zeta_h}}{1+\zeta_h}\right)\Bigg|_{\text{no crypto}} \\
& + \Upsilon(M_t^h, B_t^h)\big|_{\text{crypto}} - \Upsilon(M_t^h, B_t^h)\big|_{\text{no crypto}} \\
& = 1.08\%,
\end{aligned}
$$

25. Note that for the no crypto economy, $B_t^i = 0$.

$$
\begin{aligned}
\text{UHH:}\ & \ln\left(C^u - \zeta_0^u \frac{(L^u)^{1+\zeta^u}}{1+\zeta^u}\right)\Bigg|_{\text{crypto}} - \ln\left(C^u - \zeta_0^u \frac{(L^u)^{1+\zeta^u}}{1+\zeta^u}\right)\Bigg|_{\text{no crypto}} \\
& \quad + \Upsilon(M_t^u, B_t^u)\Big|_{\text{crypto}} - \Upsilon(M_t^u, B_t^u)\Big|_{\text{no crypto}} \\
& = 1.36\%.
\end{aligned}
$$

Absent of shocks, this simple comparison indicates that both sets of households are better off in the crypto economy, however the unbanked are made better off.

We next repeat this exercise but we subject the economies to shocks, following the calibration strategy outlined in Section 3.9. To see how welfare scales with respect to volatility of cryptocurrency prices, Figure 3 plots the welfare gain for each household type over the no-cryptocurrency autarky economy for different levels of cryptocurrency price volatility. Welfare for the unbanked household is declining in cryptocurrency price volatility but relatively stable for the banked. Thus, the synthetic aggregate household welfare is decreasing in cryptocurrency price volatility. Introducing cryptocurrencies to the economy with higher price volatility leads to slightly lower welfare losses for the banked households, at the expense of higher welfare losses for the unbanked.

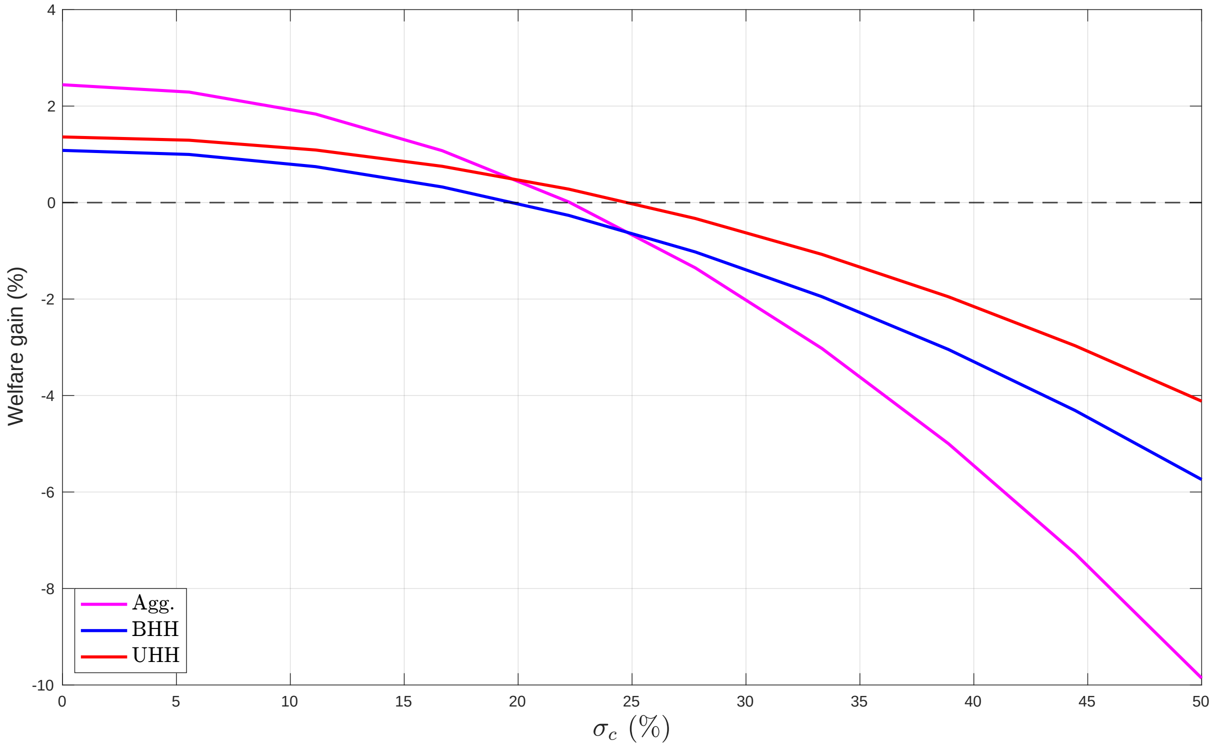
For unbanked households, we numerically determine a cutoff level of volatility $\sigma_c$ of approximately 25% (quarterly), above which unbanked households experience net welfare losses relative to an economy with no cryptocurrency. Similarly, the cutoff volatility above which banked households experience net welfare losses is 20% (quarterly) Our analysis suggests for small levels of volatility of the cryptocurrency, the household benefits from holding a fraction of their income as savings, which helps stabilize consumption in the event of adverse shocks. For banked households, we find that the relative welfare gains in the baseline equilibrium is always lower than the relative welfare gains for unbanked households.

At a high level of volatility – for example, Bitcoin's average quarterly volatility of 70% between January 2017 to September 2021 – there are net welfare losses for both types of households as costs of a volatile store of value exceed the benefits of financial inclusion and consumption smoothing benefits. Stablecoins have a much lower volatility than Bitcoin. This can rationalize the low take-up of Bitcoin as legal tender based on survey data in El Salvador (Alvarez, Argente, and Van Patten 2023).

To further understand the mechanisms through which we obtain welfare effects for banked and unbanked households, we conduct simulations of both the baseline and autarky economies in Figure 4. We simulate the economy under all macroeconomic shocks and present results for key variables, including consumption, output, labor, inflation, and the domestic interest rate.

The simulations clearly demonstrate a rightward shift in household consumption

Figure 3: Welfare gains and cryptocurrency price volatility



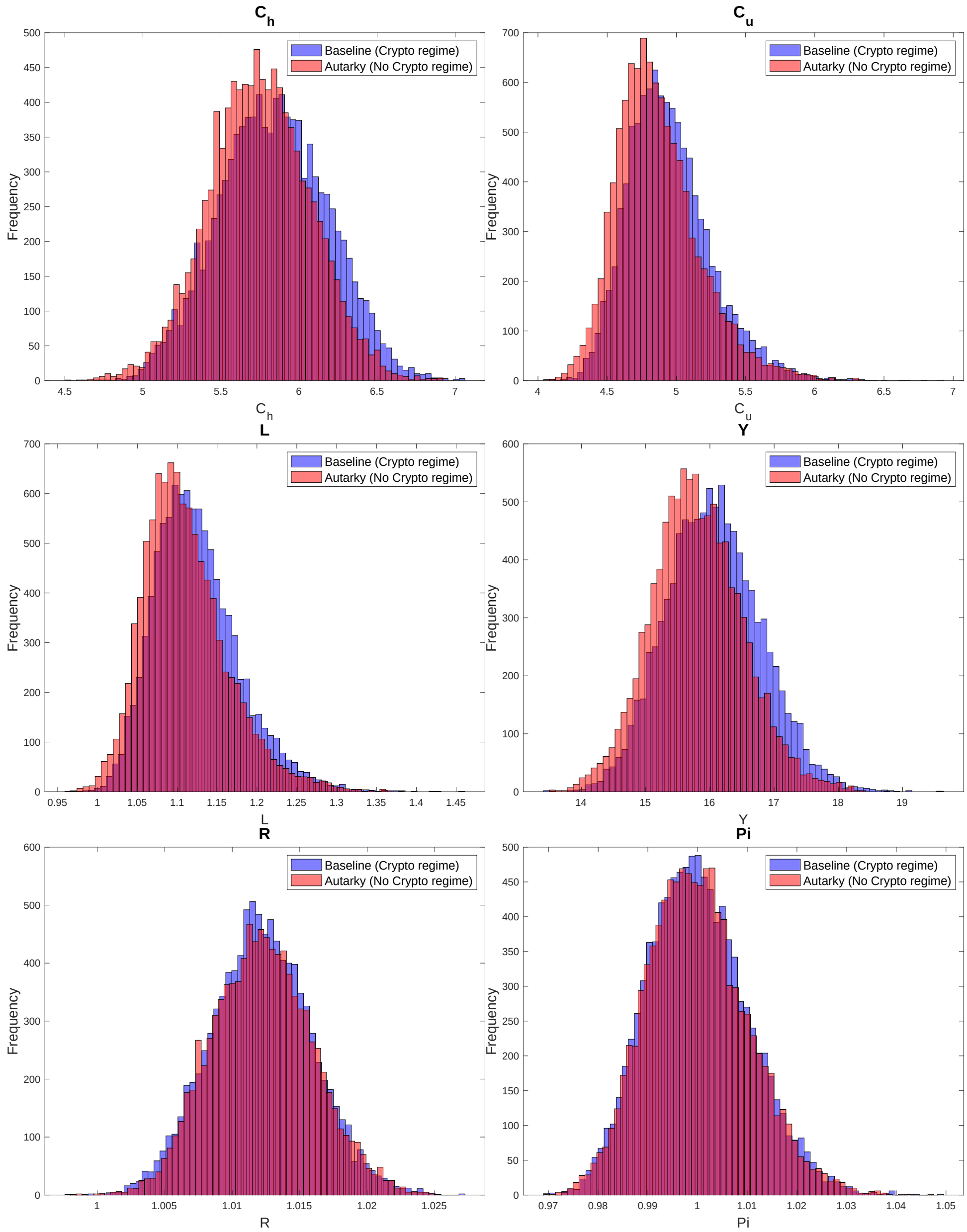

Note: Figure plots welfare gains for three different types of households: unbanked, banked and a representative household that aggregates consumption of unbanked and banked households. Welfare gains are calculated for varying levels of cryptocurrency price volatility. Welfare gains are with respect to an economy with no cryptocurrency deposits. The first moment of welfare is calculated using a second order log-linear approximation to the steady state.

for both banked and unbanked households in the economy. Output and labor are also higher in the cryptocurrency economy. While the distribution of the domestic interest rate remains similar, we observe that the distribution of inflation is less dispersed following the adoption of cryptocurrency.

Regarding the mechanisms driving these results, the existence of an additional financial asset facilitates consumption smoothing for households. Specifically, in response to adverse income shocks or negative demand shocks—such as those stemming from monetary policy, households can draw down on their savings more effectively. In the absence of sufficient money balances, this additional asset provides a buffer.

For banked households, the introduction of cryptocurrency also allows for increased consumption during adverse shocks, though to a lesser extent. This is because banked households already have access to interest-bearing deposits, which they can use to mitigate the effects of income shocks. However, the presence of cryptocurrency offers an additional tool for buffering against economic volatility.

Figure 4: **Simulations of consumption, output, labor, inflation and domestic interest rate: baseline (cryptocurrency) and autarky regimes**




Note: Plot of simulations with 10,000 periods of banked and unbanked consumption, aggregate output, labor, inflation and domestic interest rate. Simulations are subject to all macroeconomic shocks in the baseline calibration, and cryptocurrency price shocks set at 1% volatility (quarterly).

Another potential channel through which digital dollarization can be welfare improving is through providing a hedge to macroeconomic volatility, to which we now turn.

### 4.3 Welfare effects of monetary policy, risk premia

In Figure 5, we plot welfare level for different household types, compared to the autarky level, under varying levels of volatility of a foreign interest rate and foreign inflation shock. Solid lines indicate a cryptocurrency volatility of zero percent, and dotted lines indicate a volatility of 10 percent (quarterly). The welfare level for both households is increasing in the variance of macroeconomic shocks, however the welfare gains of diversification attenuate with higher levels of the cryptocurrency volatility.

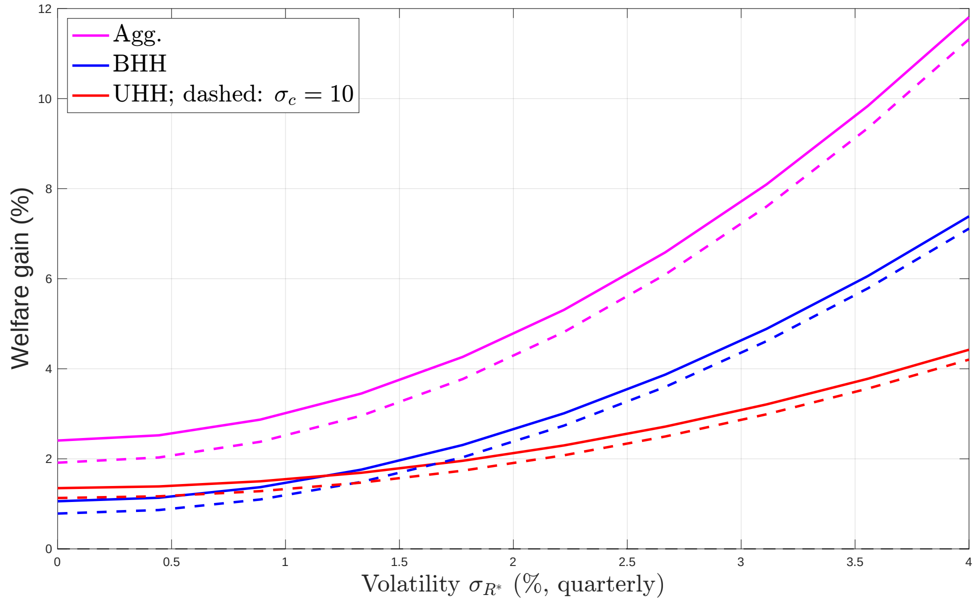
While the consumption smoothing channel is applicable to explain part of the welfare gains in the cryptocurrency economy, an interesting finding is that under high foreign interest rate and inflation shocks, banked households can achieve higher welfare gains than unbanked households. To understand this effect, we explore the mechanisms through which foreign interest rate shocks propagate, as discussed in Aoki, Benigno, and Kiyotaki (2016). A key mechanism is the financial channel, which disproportionately affects banked households. Since these households receive income through bank equity, shocks to the banking sector have a more significant impact on their welfare. When a foreign interest rate shock occurs, the cost advantage of banks borrowing in foreign currency diminishes. To increase the attractiveness of domestic assets, uncovered interest rate parity requires the domestic currency to depreciate, which increases the foreign debt burden and therefore reduces the bank's net worth.

However, when banked households have access to cryptocurrency, they can better diversify the risks posed by foreign monetary policy shocks. Similar to our analysis of macroeconomic variables, we present simulations of banking variables such as net worth, domestic and foreign currency deposits, and bank capital in Figure 6. In the cryptocurrency economy, we observe a rightward shift in the distribution of net worth, bank deposits, and the capital stock owned by banks. Additionally, there is a leftward shift in the share of foreign deposits as a proportion of total assets. This is intuitive, as contractionary monetary shocks lead to a small increase in foreign currency borrowing through the financial channel. Our results suggest that in a cryptocurrency economy, the impact of contractionary foreign monetary shocks on foreign currency deposits and net worth is reduced, weakening the financial channel's impact on bank capital. This diversification through cryptocurrency deposits ultimately helps mitigate the adverse effects of foreign interest rate shocks on the welfare of banked households.

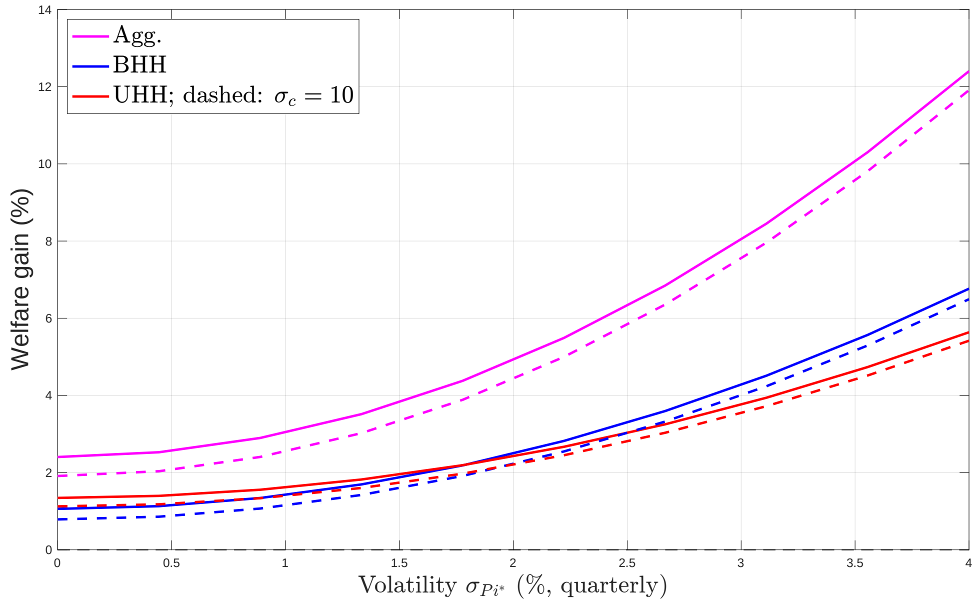
In summary, the welfare effects we observe in a cryptocurrency economy suggest that cryptocurrencies provide a hedge against macroeconomic risk. This aligns with recent empirical literature documenting the disconnect between cryptocurrency returns and macroeconomic fundamentals (Benigno and Rosa 2023; Umar et al. 2021; Pyo and Lee 2020; Marmora 2022). For example, this literature finds that Bitcoin returns are largely unaffected by FOMC and macroeconomic announcements, positioning cryp-

Figure 5: Welfare gains and domestic monetary policy, foreign risk premia and exchange rate regime

(a) Foreign risk premia



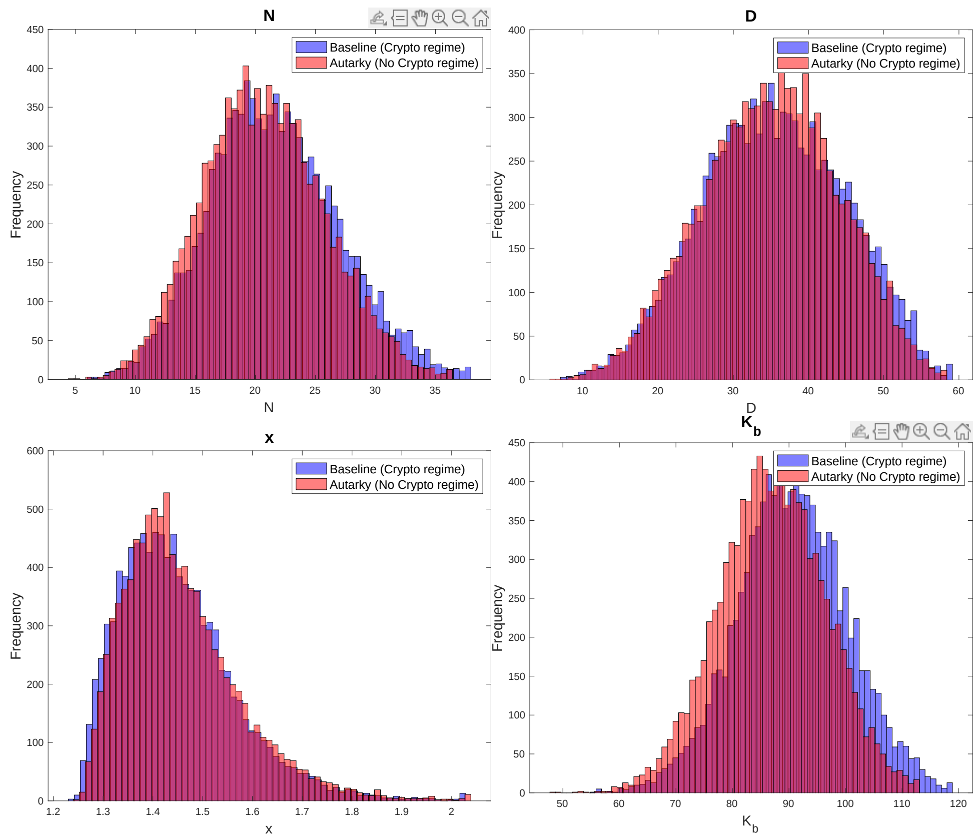

(b) Foreign inflation




Note: Figure plots welfare gains for three different types of households: unbanked, banked and a representative household that aggregates consumption of unbanked and banked households. We compute welfare gains for different levels of volatility of foreign interest rates (upper panel) and foreign inflation (lower panel). Welfare gains are with respect to an economy with no cryptocurrency deposits. Solid lines indicate welfare gains that are computed for a level of zero cryptocurrency price volatility. Dashed lines indicate welfare gains are computed for a positive level of cryptocurrency price volatility, $\sigma_c = 10$ percent (quarterly). The first moment of welfare is calculated using a second order log-linear approximation to the steady state.

tocurrencies as a potential hedge against macroeconomic uncertainty and inflation risk, particularly in emerging markets. These findings further support the observation that countries may pursue digital dollarization as a strategy to hedge against macroeconomic risk and high inflation.

Figure 6: **Simulations of banking variables: baseline (cryptocurrency) and autarky regimes**




Note: Plot of simulations with 10,000 periods of banking variables: net worth, fraction of assets financed by foreign borrowing (x) and capital owned by the banking sector. Simulations are subject to all macroeconomic shocks in the baseline calibration, and cryptocurrency price shocks set at 1% volatility (quarterly).

# 5 Conclusion

In this paper we study the macroeconomic costs and benefits of cryptocurrency adoption by introducing a SOE model that features two types of households: those that hold domestic currency deposits and those that strictly hold cryptocurrency.

Our framework is motivated to explain two empirical facts. First, there is a widespread adoption of stablecoins in emerging markets, such as Turkey and Argentina, in response to macroeconomic instability and high inflation. Second, countries like El Salvador have adopted Bitcoin, a risky cryptocurrency as legal tender, but have limited adoption based on survey data.

To explain these facts, we form a simple process for the cryptocurrency price. In the case of digital dollarization, the cryptocurrency price pegs to a foreign currency (eg. USD) exchange rate, and a risky cryptocurrency follows a stochastic price process with extrinsic volatility.

We evaluate the relative welfare of an economy with the digital currency to an economy without cryptocurrency, which we label the autarky economy. Our results suggest that stablecoin adoption, which we refer to as digital dollarization, increases net welfare as it is a more efficient store of value for unbanked households, enabling them to smooth consumption. In contrast, risky cryptocurrencies like Bitcoin brings net welfare losses through the general equilibrium effects of more volatile consumption, bank lending, and firm labor demand.

Next, we conduct a welfare analysis with respect to foreign macroeconomic shocks to foreign currency risk premia and inflation. The welfare gains of both types of households in an economy with cryptocurrencies are increasing in the volatility of macroeconomic shocks, suggesting it is a useful hedge against macroeconomic uncertainty.

Our work has important policy implications. First, it provides a rationale for the increasing use of stablecoins in emerging markets as a hedge against macroeconomic instability and high inflation, as evident in the case studies of Turkey and Argentina's stablecoin adoption. Second, we show that risky cryptocurrency adoption leads to a welfare loss due to the valuation effects of the cryptocurrency on household savings and bank balance sheets. This explains the relatively limited adoption of Bitcoin's use in transactions in El Salvador since it became legal tender in late 2021.

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# A Appendix

## A.1 Digital Dollarization and El Salvador

### A.1.1 Stablecoins

Stablecoins are a class of blockchain-based cryptocurrencies pegged to the US Dollar. Tether and USDC, the largest stablecoins by market cap as of September 2021, account for approximately 90 percent of the stablecoin market. Stablecoins have faced scrutiny from regulators due to concerns on the potential of run-risk and speculative attacks. This is in part due to stablecoins being backed by illiquid assets that make it difficult for the issuer to meet mass redemption. Estimates of volatility based on quarterly returns of Tether/USD and USDC/USD are 0.18 percent and 0.12 percent, respectively, from January 2020 to September 2021. Stablecoins need to be appropriately regulated to be fully collateralized at all times.[26] Regulations may require stablecoin issuers to be required to meet strict capital requirements to ensure full collateralization. This includes stablecoin deposits backed by government schemes such as deposit insurance, liquidity support by the central bank, and redemption fees in response to peg discounts – as discussed in Routledge and Zetlin-Jones (2021) – are policies that can be used to ensure stability of the peg.

### A.1.2 Stablecoin adoption in emerging market currencies

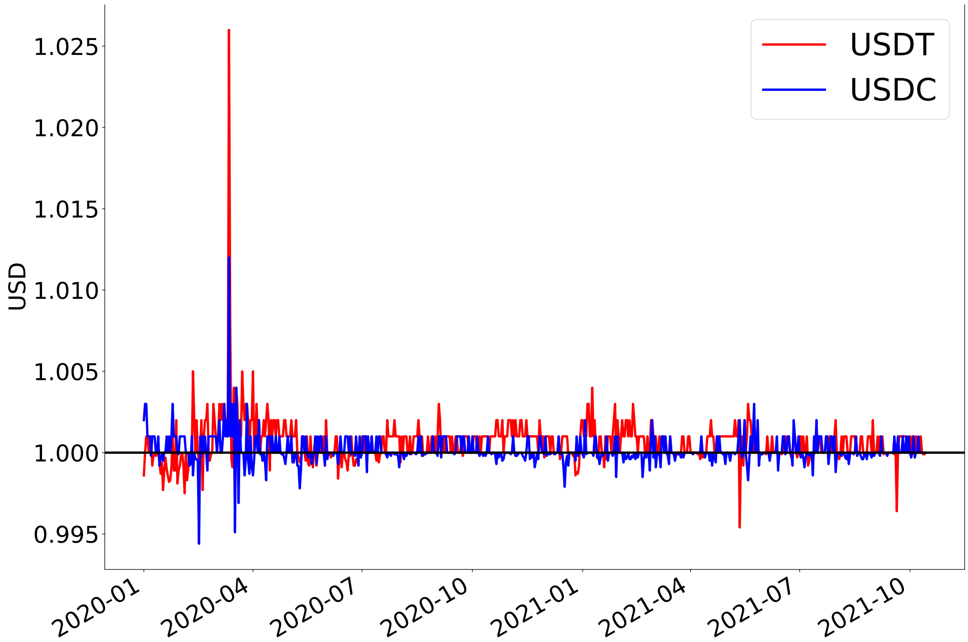
To motivate our link to digital dollarization, we find high inflation countries like Turkey and Argentina have a large amount of stablecoin/USD trading during periods of macroeconomic instability and trend exchange rate devaluation. In particular, both countries face macroeconomic instability and high (annualized) inflation rates of over 50 per cent for Turkey and over 200 per cent for Argentina, as of writing in 2024. In Figure 8 we plot trading volume for the Turkish Lira and Argentine peso against stablecoin Tether on Binance, the largest and most liquid cryptocurrency exchange. For example, trading in Binance in the TRY/USDT pair peaked at over 600 Million USDT.[27]

26. For example, statements provided by Tether show that the stablecoin is backed at most of 75.6 percent by liquid assets, which include commercial paper, fiduciary deposits, T-bills, and cash reserves. Quarterly statement released by Tether Ltd on breakdown of reserves. Statement issued on May 13th, 2021 on Tether's twitter account. Available at https://twitter.com/Tether_to/status/1392811872810934276

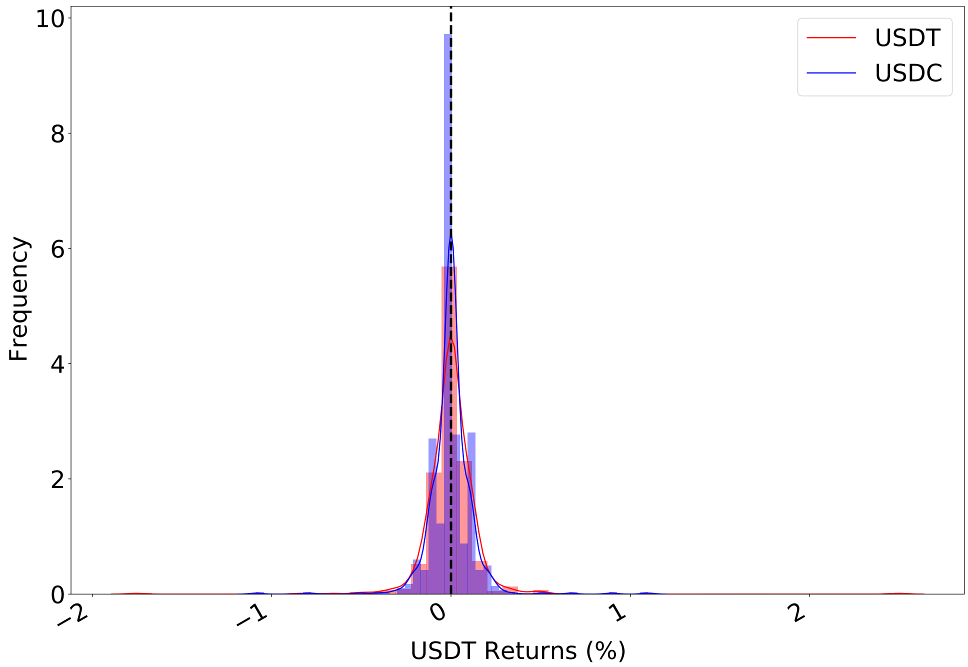
27. For the TRY/USDT pair Binance is the largest trading venue. For ARS/USDT trading, there are other cryptocurrency exchanges like Bitso which have similar levels of trading to Binance.

Figure 7: Stablecoin prices and returns

(a) Stablecoin prices

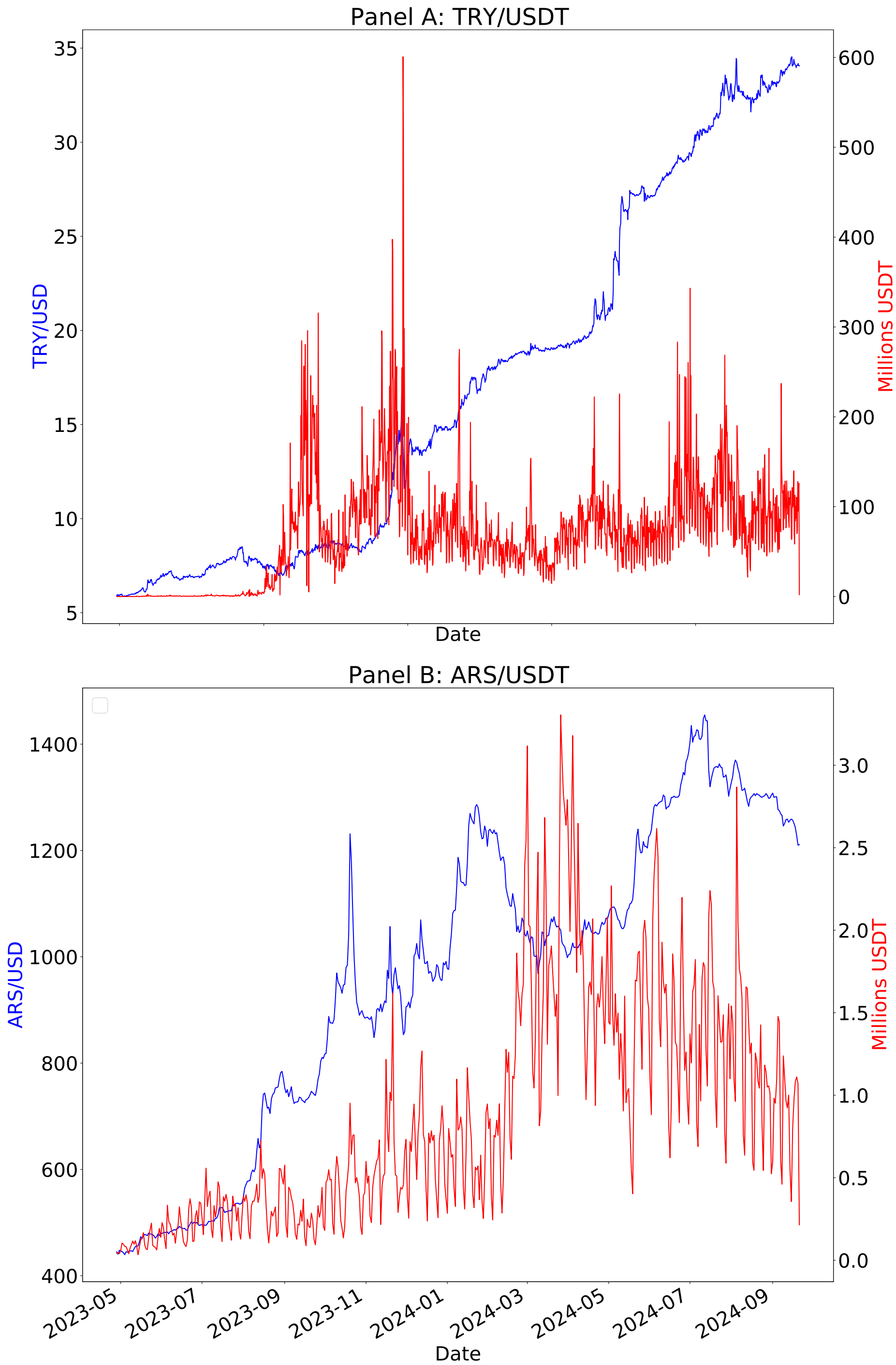



(b) Stablecoin returns (daily)




Note: Figure 7a: Stablecoins Tether, USDC, and DAI prices from January 2020 to September 2021. Figure 7b: Histogram of daily returns. Source: Cryptocompare.

Figure 8: Stablecoin markets in Turkish Lira and Argentine Peso




Note: Stablecoin trading in TRY/USDT and ARS/USDT markets on Binance cryptocurrency exchange. Figure 7b: Histogram of daily returns. Source: Coinapi.

### A.1.3 Risky cryptocurrency adoption: El Salvador

El Salvador's law to make Bitcoin legal tender took effect on September 7th, 2021.[28] Each individual can own a government sponsored Chivo digital wallet and is eligible for $30 US in Bitcoin. El Salvador has installed a number Bitcoin ATMs, allowing its citizens to convert the cryptocurrency into US dollars. Within the first day of the Bitcoin law, Bitcoin fell by approximately 10 percent, from $52,000 US to $47,000 US by day's end. Moody's downgraded government debt due to the risk of poor governance and the Bitcoin law.[29]

Proposed benefits of the policy include financial inclusion[30], reducing remittance costs[31], and increasing foreign direct investment inflows[33] For consumers, firms, and banks, the choice of legal tender depends on the network characteristics of the currency and whether it achieves the properties of money as an effective store of value, medium of exchange, and unit of account. The main cost with adopting Bitcoin is that it does not satisfy the store of value function of money, with volatility exceeding fiat-exchange rate movements by an order of magnitude. From January 2017 to September 2021, we observe a maximum daily return of 19.4 percent and a peak negative daily return of -38.4 percent. The volatility of quarterly returns of BTC/USD is 70 percent over the same period.[34]

28. https://www.npr.org/2021/09/07/1034838909/bitcoin-el-salvador-legal-tender-official-currency-cryptocurrency?t=1634944255426

29. https://www.coindesk.com/markets/2021/07/31/moodys-lowers-el-salvador-rating-maintains-negative-outlook-partly-due-to-Bitcoin-law/.

30. Estimates from the World Bank put up to two thirds of El Salvador's population without a bank account.https://datatopics.worldbank.org/g20fidata/country/el-salvador.

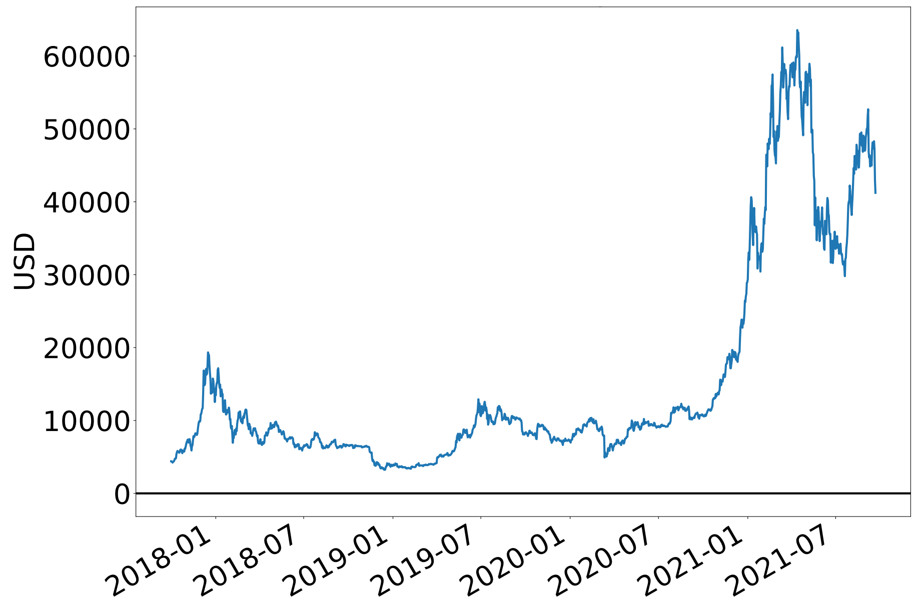
31. El Salvador is one of the most dependent countries on remittances which total 25 percent of GDP., reducing remittance costs,[32] Hanke, Hanlon, Chakravarthi, et al. (2021) quantifies remittance fees of Bitcoin relative to conventional banking methods. The authors estimate remittance fees for using banking services at 4 percent, and Bitcoin are estimated at a minimum of 5 percent, with the addition of network fees and other costs of safety and security of the payment network.

33. In 2019, the coastal town of El Zonte adopted Bitcoin as a local currency. The project gave $50 US in Bitcoin to each local family, encouraging the cryptocurrency's adoption by local vendors. The project led to Bitcoin being used to pay for utility bills, health care, food, and other services. https://www.reuters.com/technology/bitcoin-beach-tourists-residents-hail-el-salvadors-adoption-cryptocurrency-2021-09-07/

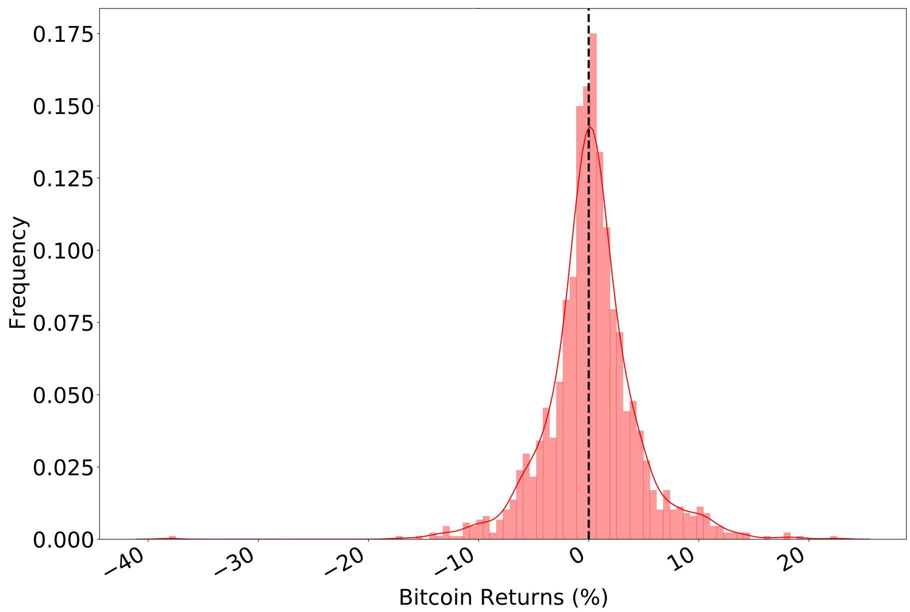
34. A poll conducted by the Central American University finds that approximately 67 percent of El Salvadorian participants did not believe that Bitcoin should be legal tender, and more than 70 percent believed the law should be repealed. Significant public pessimism on the Bitcoin law is justified due to the excess volatility of Bitcoin.

Figure 9: Bitcoin prices and returns

(a) Bitcoin prices




(b) Bitcoin returns (daily)




Note: Figure 9a: Bitcoin prices from January 2018 to September 2019. Figure 9b: Histogram of daily returns. Source: Cryptocompare.

## A.2 Model extended solutions

### A.2.1 Household optimization problem

The household utility function for agent $i \in \{h, u\}$ is given by the following Greenwood-Hercowitz-Huffman (GHH) functional form:

$$u(C_t^i, L_t^i) = \ln\left(C_t^i - \frac{\zeta_0}{1+\zeta}(L_t^i)^{1+\zeta}\right),$$

and the subutility function from holding money and cryptocurrency balances is

$$\Upsilon(M_t^i, B_t^i) = \nu_{0,i}^M \frac{(M_t^i)^{1-\nu_i^M} - 1}{1-\nu_i^M} + \nu_{0,i}^{DC} \frac{(B_t^i)^{1-\nu_i^{DC}} - 1}{1-\nu_i^{DC}}.$$

The parameters $\beta$, $\zeta_0$, $\zeta$, $\nu_{0,i}^M$, $\nu_i^M$, $\nu_{0,i}^{DC}$ and $\nu_i^{DC}$ are the household's discount factor, relative disutility from labor supply, the inverse-Frisch elasticity of labor supply, relative utility from holding real money balances, inverse-elasticity of intertemporal substitution of real money balances, relative utility of holding cryptocurrency holdings, and the inverse-elasticity of intertemporal substitution of cryptocurrency balances. The households' preferences are of the GHH form in order to shutoff the income effect to induce pro-cyclical labor supply.

Additionally, we use the following quadratic adjustment costs for real money balances and digital currencies:

$$\chi_{M,t}^i = \frac{\kappa_M}{2}\left(M_t^i - \bar{M}^i\right)^2,$$
$$\chi_{DC,t}^i = \frac{\kappa_{DC}}{2}\left(B_t^i - \bar{B}^i\right)^2.$$

The first-order conditions (FOCs) for labor, savings in equity, deposits, and cryptocurrency balances which emerge from the banked household's problem are:

$$w_t^h = \zeta_0^h (L_t^h)^{\zeta_h}, \tag{55}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1}^h R_{t+1}^k, \tag{56}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1}^h \frac{R_t}{\pi_{t+1}}, \tag{57}$$

$$\mathbb{E}_t \frac{\Lambda_{t,t+1}^h}{\pi_{t+1}} = 1 + \kappa_M (M_t^h - \bar{M}^h) - \nu_{0,h}^M \frac{C_t^h - \frac{\zeta_0}{1+\zeta}(L_t^h)^{1+\zeta}}{(M_t^h)^{\nu_h^M}}, \tag{58}$$

$$\mathbb{E}_t \Lambda_{t,t+1}^h \frac{R_t^c}{\pi_{t+1}} = 1 + \kappa_{DC}(B_t^h - \bar{B}^h) - \nu_{0,h}^{DC} \frac{C_t^h + \frac{\zeta_0}{1+\zeta}(L_t^h)^{1+\zeta}}{(B_t^h)^{\nu_h^{DC}}}. \tag{59}$$

The FOCs for labor supply, real money balances, and cryptocurrency balances for the unbanked household are:

$$w_t^u = \zeta_0^u (L_t^u)^{\zeta^u}, \tag{60}$$

$$\mathbb{E}_t \frac{\Lambda_{t,t+1}^u}{\pi_{t+1}} = 1 + \kappa_M (M_t^u - \bar{M}^u) - \nu_{0,u}^M \frac{C_t^u + \frac{\zeta_0}{1+\zeta}(L_t^u)^{1+\zeta}}{(M_t^u)^{\nu_u^M}}, \tag{61}$$

$$\mathbb{E}_t \Lambda_{t,t+1}^u \frac{R_t^c}{\pi_{t+1}} = 1 + \kappa_{DC} (B_t^u - \bar{B}^u) - \nu_{0,u}^{DC} \frac{C_t^u + \frac{\zeta_0}{1+\zeta}(L_t^u)^{1+\zeta}}{(B_t^u)^{\nu_u^{DC}}}. \tag{62}$$

### A.2.2 Rewriting and solving the banker's problem

With the constraints of the banker established in Section 3.2, we can proceed to write the banker's problem as:

$$\max_{k_t^b, d_t, d_t^*} \mathbb{V}_t^b = \mathbb{E}_t \left[ \Lambda_{t,t+1}^h \left\{ (1-\sigma) n_{t+1} + \sigma \mathbb{V}_{t+1}^b \right\} \right],$$

subject to the incentive constraint (12) and the balance sheet constraint (13).

As discussed in Section 3.2.1, dividing $\mathbb{V}_t^b$ by $n_t$ yields a Tobin Q expression of the form:

$$\psi_t \equiv \frac{\mathbb{V}_t^b}{n_t} = \mathbb{E}_t \left[ \Lambda_{t,t+1}^h (1 - \sigma + \sigma \psi_{t+1}) \frac{n_{t+1}}{n_t} \right],$$

where the evolution of net worth, $n_{t+1}/n_t$, is attained by simply iterating banker's flow of funds constraint (14) forward by one period, and then divide through by $n_t$:

$$\begin{aligned} \frac{n_{t+1}}{n_t} &= \left( z_{t+1}^k + \lambda Q_{t+1} \right) \frac{k_t^b}{n_t} - \frac{R_t}{\pi_{t+1}} \frac{d_t}{n_t} - \frac{R_t^*}{\pi_{t+1}^*} \frac{\epsilon_{t+1} d_t^*}{n_t} - \frac{R_t^c}{\pi_{t+1}} \frac{b_t}{n_t} \\ &= \frac{\left( z_{t+1}^k + \lambda Q_{t+1} \right)}{Q_t} \phi_t - \frac{R_t}{\pi_{t+1}} \frac{d_t}{n_t} - \frac{R_t^*}{\pi_{t+1}^*} \frac{\epsilon_{t+1}}{\epsilon_t} \frac{\epsilon_t d_t^*}{n_t} - \frac{R_t^c}{\pi_{t+1}} \frac{b_t}{n_t}. \end{aligned}$$

Rearrange the balance sheet constraint (13) and use the fact that $\epsilon_t d_t^*/n_t = x_t \phi_t$ and $b_t/n_t = x_t^c \phi_t$, to yield the following:

$$\frac{d_t}{n_t} = \left( 1 + \frac{\varkappa^b}{2} x_t^2 \right) \phi_t - x_t \phi_t - x_t^c \phi_t - 1.$$

Substitute this value for $d_t/n_t$ into the expression for $n_{t+1}/n_t$, and we get:

$$\frac{n_{t+1}}{n_t} = \left( R_{t+1}^k - \frac{R_t}{\pi_{t+1}} \right) \phi_t + \left( 1 - \frac{\varkappa^b}{2} x_t^2 \phi_t \right) \frac{R_t}{\pi_{t+1}} + \left( \frac{R_t}{\pi_{t+1}} - \frac{R_t^*}{\pi_{t+1}^*} \frac{\epsilon_{t+1}}{\epsilon_t} \right) x_t \phi_t + \left( \frac{R_t}{\pi_{t+1}} - \frac{R_t^c}{\pi_{t+1}} \right) x_t^c \phi_t.$$

Substituting this expression into (15), yields the following:

$$
\begin{aligned}
\psi_t &= \mathbb{E}_t \Lambda^h_{t,t+1}(1-\sigma+\sigma\psi_{t+1}) \left\{ \begin{array}{c} \left(R^k_{t+1} - \frac{R_t}{\pi_{t+1}}\right)\phi_t \\ + \left(1 - \frac{\varkappa^b}{2} x_t^2 \phi_t\right) \frac{R_t}{\pi_{t+1}} \\ + \left[\frac{R_t}{\pi_{t+1}} - \frac{R^*_t}{\pi^*_{t+1}} \frac{\epsilon_{t+1}}{\epsilon_t}\right] x_t \phi_t \\ + \left[\frac{R_t}{\pi_{t+1}} - \frac{R^c_t}{\pi_{t+1}}\right] x^c_t \phi_t \end{array} \right\} \\
&= \mu_t \phi_t + \left(1 - \frac{\varkappa^b}{2} x_t^2 \phi_t\right) \upsilon_t + \mu^*_t x_t \phi_t + \mu^c_t x^c_t \phi_t,
\end{aligned}
$$

with $\mu_t$, $\mu_t$, $\mu^*_t$, $\mu^c_t$, $\upsilon_t$, and $\Omega_{t,t+1}$ as defined in Section 3.2.1.

With $\mu_t, \mu^*_t, \mu^c_t > 0$, the banker's incentive compatibility constraint binds with equality, and so we can write the Lagrangian as:

$$
\mathcal{L} = \psi_t + \lambda_t(\psi_t - \Theta(x_t, x^c_t)\phi_t),
$$

where $\lambda_t$ is the Lagrangian multiplier. The FOCs are:

$$
(1+\lambda_t)\left[\mu_t + \mu^*_t x_t + \mu^c_t x^c_t - \frac{\varkappa^b}{2} x_t^2 \upsilon_t\right] = \lambda_t \Theta(x_t, x^c_t), \tag{63}
$$

$$
(1+\lambda_t)\left[\varkappa^b x_t \upsilon_t - \mu^*_t\right] = \theta \lambda_t \Theta(x_t, x^c_t), \tag{64}
$$

$$
\psi_t = \phi_t \Theta(x_t, x^c_t). \tag{65}
$$

Use (65) and substitute into the banker's objective function to yield:

$$
\phi_t = \frac{\upsilon_t}{\Theta(x_t, x^c_t) - \mu_t - \mu^*_t x_t - \mu^c_t x^c_t + \frac{\varkappa^b}{2} x_t^2 \upsilon_t}. \tag{66}
$$

Then, combine (63) and (64) to write

$$
F\left(x_t, \frac{\mu_t}{\upsilon_t}, \frac{\mu^*_t}{\upsilon_t}, \frac{\mu^c_t}{\upsilon_t}\right) = -\frac{\theta\varkappa^b}{2} x_t^2 + \left(\theta \frac{\mu^*_t}{\upsilon_t} - \varkappa^b\right) x_t + \theta\left(\frac{\mu_t}{\upsilon_t} + \frac{\mu^c_t}{\upsilon_t} x^c_t\right) + \frac{\mu^*_t}{\upsilon_t}.
$$

Note that $\mu_t, \mu^*_t, \mu^c_t, \upsilon_t > 0$, and so $F(x_t = 0, \dots) > 0$, and thus we can write

$$
x_t = \frac{\theta\mu^*_t - \varkappa^b \upsilon_t}{\theta \varkappa^b \upsilon_t} + \sqrt{\left(\frac{\mu^*_t}{\varkappa^b \upsilon_t}\right)^2 + 2\frac{\mu^c_t}{\varkappa^b \upsilon_t} x^c_t + \left(\frac{1}{\theta}\right)^2 + 2\frac{\mu_t}{\varkappa^b \upsilon_t}}. \tag{67}
$$

These expressions are (24) and (25) in the main body of the text. This concludes the problem and optimal choices of the banker.

### A.2.3 Firms and production

Final good firms maximize their profits by selecting how much of each intermediate good to purchase, and so their problem is:

$$\max_{Y_t(i)} P_t Y_t - \int_0^1 P_t Y_t(i) di.$$

Thus, as in Blanchard and Kiyotaki (1987), following the FOC of the final good firm problem, intermediate good producers face a downward sloping demand curve for their products:

$$Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\eta} Y_t,$$

where $P_t(i)$ is the price for good $i$, and $P_t$ is the price index for the aggregate economy and is defined as:

$$P_t = \left(\int_0^1 P_t(i)^{1-\eta} di\right)^{\frac{1}{1-\eta}}.$$

The cost minimization problem for each intermediate good producer is:

$$\min_{K_{t-1}(i), M_t(i), L_t^h(i), L_t^u(i)} z_t^k K_{t-1}(i) + \epsilon_t IM_t(i) + w_t^h L_t^h(i) + w_t^u L_t^u(i),$$

subject to:

$$A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t^h(i)}{\alpha_h}\right)^{\alpha_h} \left(\frac{L_t^u(i)}{\alpha_u}\right)^{\alpha_u} \geq Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\eta} Y_t.$$

The Lagrangian for intermediate firm $i$'s problem is:

$$\begin{aligned}\mathcal{L} = {} & z_t^k K_{t-1}(i) + \epsilon_t M_t(i) + w_t^h L_t^h(i) + w_t^u L_t^u(i) \\ & - mc_t(i) \left\{ \begin{array}{c} A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t^h(i)}{\alpha_h}\right)^{\alpha_h} \left(\frac{L_t^u(i)}{\alpha_u}\right)^{\alpha_u} \\ - \left(\frac{P_t(i)}{P_t}\right)^{-\eta} Y_t \end{array} \right\},\end{aligned}$$

where $mc_t$ is the minimized unit cost of production or the real marginal cost. The FOCs to this problem are:

$$z_t^k = mc_t(i) A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K - 1} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t^h(i)}{\alpha_h}\right)^{\alpha_h} \left(\frac{L_t^u(i)}{\alpha_u}\right)^{\alpha_u},$$

$$
\begin{aligned}
\epsilon_t &= mc_t(i)A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M - 1} \left(\frac{L^h_t(i)}{\alpha_h}\right)^{\alpha_h} \left(\frac{L^u_t(i)}{\alpha_u}\right)^{\alpha_u}, \\
w^h_t &= mc_t(i)A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M} \left(\frac{L^h_t(i)}{\alpha_h}\right)^{\alpha_h - 1} \left(\frac{L^u_t(i)}{\alpha_u}\right)^{\alpha_u}, \\
w^u_t &= mc_t(i)A_t \left(\frac{K_{t-1}(i)}{\alpha_K}\right)^{\alpha_K} \left(\frac{IM_t(i)}{\alpha_M}\right)^{\alpha_M} \left(\frac{L^h_t(i)}{\alpha_h}\right)^{\alpha_h} \left(\frac{L^u_t(i)}{\alpha_u}\right)^{\alpha_u - 1},
\end{aligned}
$$

Under Rotemberg (1982) pricing, firm $i$ maximizes the net present value of profits,

$$
\mathbb{V}_t(i) = \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \Lambda^h_{t,t+s} \left[ \left( \frac{P_{t+s}(i)}{P_{t+s}} - mc_{t+s} \right) Y_{t+s}(i) - \frac{\kappa}{2} \left( \frac{P_{t+s}(i)}{P_{t-1+s}(i)} - 1 \right)^2 Y_{t+s} \right] \right\},
$$

by optimally choosing $P_t(i)$. Differentiating $\mathbb{V}_t(i)$ with respect to $P_t(i)$ yields the following FOC:

$$
\begin{aligned}
\kappa \left( \frac{P_t(i)}{P_{t-1}(i)} - 1 \right) \frac{Y_t}{P_{t-1}(i)} &= \frac{1}{P_t} \left( \frac{P_t(i)}{P_t} \right)^{-\eta} Y_t - \eta \left( \frac{P_t(i)}{P_t} - mc_t \right) \left( \frac{P_t(i)}{P_t} \right)^{-\eta - 1} \frac{Y_t}{P_t} \\
&\quad + \kappa \mathbb{E}_t \left[ \Lambda^h_{t,t+1} \left( \frac{P_{t+1}(i)}{P_t(i)} - 1 \right) Y_{t+1} \frac{P_{t+1}(i)}{P_t(i)^2} \right].
\end{aligned}
$$

## A.3 Equilibrium conditions

A competitive equilibrium is a set of 10 prices, $\{ E_t, mc_t, Q_t, R_t, R_t^c, w_t^h, w_t^u, z_t^k, \epsilon_t, \pi_t \}$; 20 quantity variables, $\{ B_t, B_t^h, B_t^u, C_t, C_t^h, C_t^u, D_t, D_t^*, EX_t, I_t, K_t, K_t^b, K_t^h, L_t, L_t^h, L_t^u, M_t^h, M_t^u, N_t, Y_t \}$; eight bank variables, $\{ x_t, x_t^c, \psi_t, \phi_t, v_t, \mu_t, \mu_t^c, \mu_t^* \}$; three foreign variables, $\{ R_t^*, Y_t^*, \pi_t^* \}$; and two exogenous variables, $\{ A_t, P_t^c \}$, which satisfy 43 equations. In addition to the baseline economy, we solve for the cryptocurrency autarky economy by setting cryptocurrency deposits to zero ($B = 0$), which in turn makes the share of the bank balance sheet in cryptocurrencies zero ($x^c = 0$). The first order condition with respect to cryptocurrency deposits is no longer needed, and so $R^c$ and $P^c$ are no longer required.

**Households.**

$$w_t^h = \zeta_0 (L_t^h)^\zeta \tag{68}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1}^h R_{t+1}^k \tag{69}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1}^h \frac{R_t}{\pi_{t+1}} \tag{70}$$

$$1 + \kappa_{DC}(B_t^h - \bar{B}^h) = \mathbb{E}_t \Lambda_{t,t+1}^h \frac{R_t^c}{\pi_{t+1}} + \nu_{0,h}^{DC} \frac{C_t^h + \frac{\zeta_0}{1+\zeta}(L_t^h)^{1+\zeta}}{(B_t^h)^{\nu_h^{DC}}} \tag{71}$$

$$1 + \kappa_M(M_t^h - \bar{M}^h) = \mathbb{E}_t \frac{\Lambda_{t,t+1}^h}{\pi_{t+1}} + \nu_{0,h}^M \frac{C_t^h + \frac{\zeta_0}{1+\zeta}(L_t^h)^{1+\zeta}}{(M_t^h)^{\nu_h^M}} \tag{72}$$

$$C_t^u + B_t^u + \chi_{DC,t}^u + M_t + \chi_{M,t}^u = w_t^u L_t^u + \frac{R_{t-1}^c}{\pi_t} B_{t-1}^u + \frac{1}{\pi_t} M_{t-1} \tag{73}$$

$$w_t^u = \zeta_0 (L_t^u)^\zeta \tag{74}$$

$$1 + \kappa_{DC}(B_t^u - \bar{B}^u) = \mathbb{E}_t \Lambda_{t,t+1}^u \frac{R_t^c}{\pi_{t+1}} + \nu_{0,u}^{DC} \frac{C_t^u + \frac{\zeta_0}{1+\zeta}(L_t^u)^{1+\zeta}}{(B_t^u)^{\nu_u^{DC}}} \tag{75}$$

$$1 + \kappa_M(M_t^u - \bar{M}^u) = \mathbb{E}_t \frac{\Lambda_{t,t+1}^u}{\pi_{t+1}} + \nu_{0,u}^M \frac{C_t^u + \frac{\zeta_0}{1+\zeta}(L_t^u)^{1+\zeta}}{(M_t^u)^{\nu_u^M}} \tag{76}$$

**Banks.**

$$\mu_t = \mathbb{E}_t \Omega_{t,t+1} \left( R_{t+1}^k - \frac{R_t}{\pi_{t+1}} \right) \tag{77}$$

$$\mu_t^c = \mathbb{E}_t \Omega_{t,t+1} \left( \frac{R_t}{\pi_{t+1}} - \frac{R_t^c}{\pi_{t+1}} \right) \tag{78}$$

$$\mu_t^* = \mathbb{E}_t \Omega_{t,t+1} \left( \frac{R_t}{\pi_{t+1}} - \frac{\epsilon_{t+1}}{\epsilon_t} \frac{R_t^*}{\pi_{t+1}^*} \right) \tag{79}$$

$$v_t = \mathbb{E}_t \Omega_{t,t+1} \frac{R_t}{\pi_{t+1}} \tag{80}$$

$$\psi_t = \phi_t \Theta(x_t, x_t^c) \tag{81}$$

$$\phi_t = \frac{v_t}{\Theta(x_t, x_t^c) - \mu_t - \mu_t^* x_t - \mu_t^c x_t^c + \frac{\varkappa^b}{2} x_t^2 v_t} \tag{82}$$

$$x_t = \frac{\theta \mu_t^* - \varkappa^b v_t}{\theta \varkappa^b v_t} + \sqrt{\left(\frac{\mu_t^*}{\varkappa^b v_t}\right)^2 + 2\frac{\mu_t^c}{\varkappa^b v_t} x_t^c + \left(\frac{1}{\theta}\right)^2 + 2\frac{\mu_t}{\varkappa^b v_t}} \tag{83}$$

**Firms.**

$$mc_t = \frac{1}{A_t} (z_t^k)^{\alpha_K} \epsilon_t^{\alpha_M} (w_t^h)^{\alpha_h} (w_t^u)^{\alpha_u} \tag{84}$$

$$Y_t = A_t \left(\frac{K_{t-1}}{\alpha_K}\right)^{\alpha_K} \left(\frac{M_t}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t^h}{\alpha_h}\right)^{\alpha_h} \left(\frac{L_t^u}{\alpha_u}\right)^{\alpha_u} \tag{85}$$

$$\frac{\epsilon_t M_t}{z_t^k K_{t-1}} = \frac{\alpha_M}{\alpha_K} \tag{86}$$

$$\frac{w_t^h L_t^h}{z_t^k K_{t-1}} = \frac{\alpha_h}{\alpha_K} \tag{87}$$

$$\frac{w_t^u L_t^u}{z_t^k K_{t-1}} = \frac{\alpha_u}{\alpha_K} \tag{88}$$

$$(\pi_t - 1)\pi_t = \frac{1}{\kappa}(\eta mc_t + 1 - \eta) + \mathbb{E}_t \Lambda_{t,t+1}^h \frac{Y_{t+1}}{Y_t} (\pi_{t+1} - 1)\pi_{t+1} \tag{89}$$

$$K_t = \lambda K_{t-1} + I_t \tag{90}$$

$$Q_t = 1 + \Phi\left(\frac{I_t}{\bar{I}}\right) + \left(\frac{I_t}{\bar{I}}\right) \Phi'\left(\frac{I_t}{\bar{I}}\right) \tag{91}$$

**Foreign exchange.**

$$\epsilon_t = \frac{E_t P_t^*}{P_t} \tag{92}$$

$$EX_t = \epsilon_t^{\varphi} Y_t^* \tag{93}$$

$$\Delta \ln \epsilon_t = \Delta \ln E_t + \hat{\pi}_t^* - \hat{\pi}_t \tag{94}$$

$$\ln\left(\frac{R_t^*}{\bar{R}^*}\right) = \rho_{R^*} \ln\left(\frac{R_{t-1}^*}{\bar{R}^*}\right) + \varepsilon_t^{R^*} \tag{95}$$

$$\ln\left(\frac{Y_t^*}{\bar{Y}^*}\right) = \rho_{Y^*} \ln\left(\frac{Y_{t-1}^*}{\bar{Y}^*}\right) + \varepsilon_t^{Y^*} \tag{96}$$

$$\ln\left(\frac{\pi_t^*}{\bar{\pi}^*}\right) = \rho_{\pi^*} \ln\left(\frac{\pi_{t-1}^*}{\bar{\pi}^*}\right) + \varepsilon_t^{\pi^*} \tag{97}$$

**Central Bank**

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R} \left[ \left(\frac{\pi_t}{\bar{\pi}}\right)^{\frac{1-\omega_E}{\omega_E}} \left(\frac{E_t}{\bar{E}}\right)^{\frac{\omega_E}{1-\omega_E}} \right]^{1-\rho_R} \exp(\varepsilon_t^R) \tag{98}$$

**Market equilibrium.**

$$K_t = K_t^h + K_t^b \tag{99}$$

$$C_t = C_t^h + C_t^u \tag{100}$$

$$L_t = L_t^h + L_t^u \tag{101}$$

$$\begin{aligned} Y_t &= C_t + \left[1 + \Phi\left(\frac{I_t}{\bar{I}}\right)\right] I_t + EX_t + \frac{\kappa}{2}(\pi_t - 1)^2 Y_t + \chi_t^h + \chi_t^b \\ &\quad + \chi_{M,t}^h + \chi_{DC,t}^h + \chi_{M,t}^u + \chi_{DC,t}^u \end{aligned} \tag{102}$$

$$D_t^* = \frac{R_{t-1}^*}{\pi_t^*} D_{t-1}^* + M_t - \frac{1}{\epsilon_t} EX_t \tag{103}$$

$$\begin{aligned} N_t &= \sigma \left[ R_t^k Q_{t-1} K_{t-1}^b - \frac{R_{t-1}}{\pi_t} D_{t-1} - \epsilon_t \frac{R_{t-1}^*}{\pi_t^*} D_{t-1}^* - \frac{R_{t-1}^c}{\pi_t} B_{t-1} \right] \\ &\quad + \gamma R_{t-1}^k Q_{t-1} K_{t-1} \end{aligned} \tag{104}$$

$$Q_t K_t^b \left(1 + \frac{\varkappa^b}{2} x_t^2\right) = \left(1 + \frac{\varkappa^b}{2} x_t^2\right) \phi_t N_t \tag{105}$$

$$Q_t K_t^b \left(1 + \frac{\varkappa^b}{2} x_t^2\right) = N_t + D_t + \epsilon_t D_t^* + B_t, \tag{106}$$

$$x_t = \frac{\epsilon_t D_t^*}{Q_t K_t^b} \tag{107}$$

$$x_t^c = \frac{B_t}{Q_t K_t^b} \tag{108}$$

$$B_t = B_t^h + B_t^u \tag{109}$$

$$R_t^c = \frac{P_t^c}{P_{t-1}^c} \tag{110}$$

**Exogenous processes.**

$$\ln\left(\frac{A_t}{\bar{A}}\right) = \rho_A \ln\left(\frac{A_{t-1}}{\bar{A}}\right) + \varepsilon_t^A \tag{111}$$

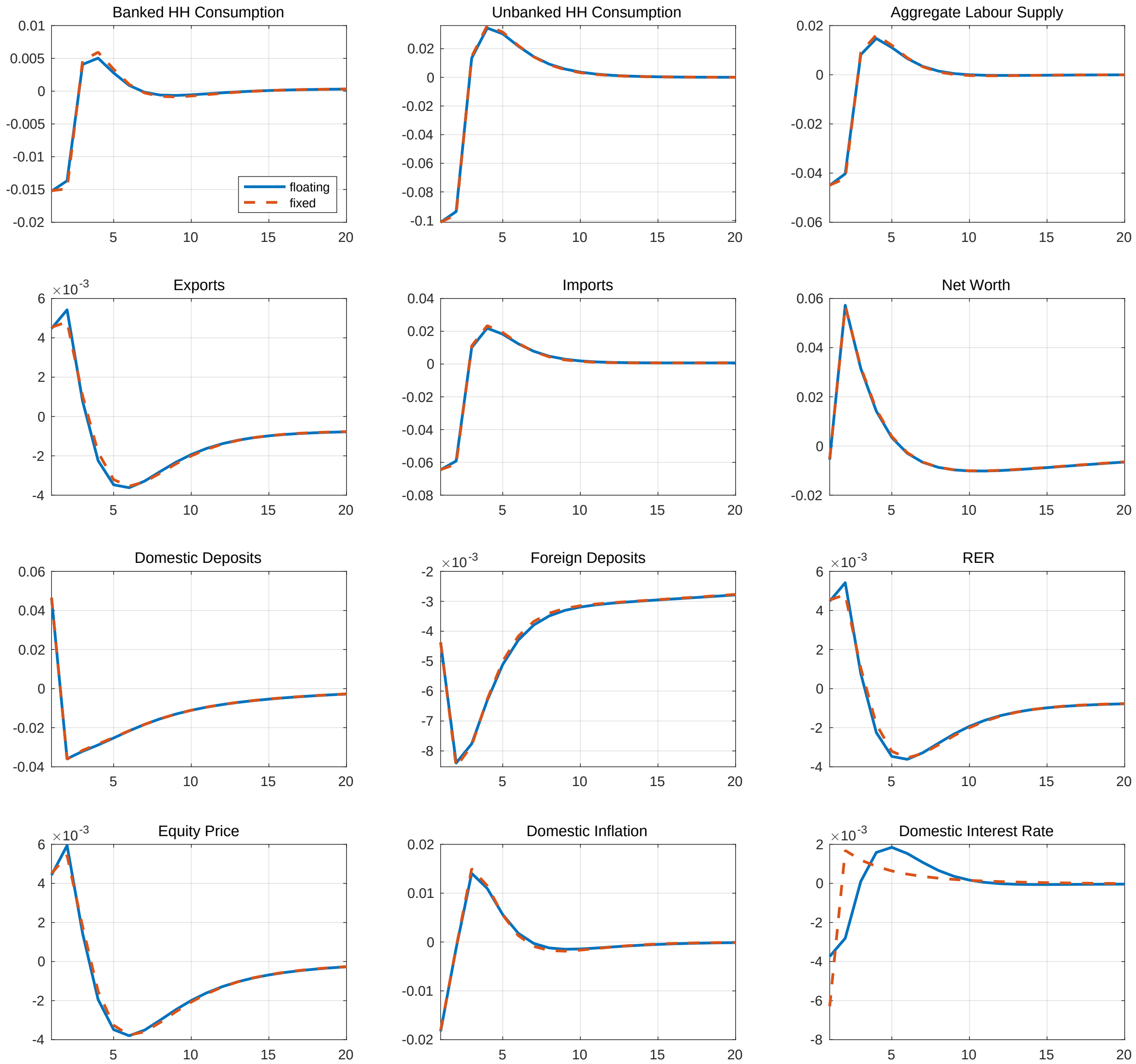
$$\ln\left(\frac{P_t^c}{\epsilon}\right) = \rho_{P^c} \ln\left(\frac{P_{t-1}^c}{\epsilon}\right) + \varepsilon_t^{P^c} \tag{112}$$

## A.4 Additional results: exchange rate regime

In this section we show our results on the effects of a cryptocurrency price shock are robust to the choice of exchange rate regime. We compare two extreme cases of the Taylor rule: a fixed exchange rate peg is approximated by $\omega_E = 0.99$ in which the central bank uses interest rates to target the nominal exchange rate. A free floating exchange rate regime is approximated by $\omega_E = 0.01$, in which the central bank uses interest rates to target the price level.

Figure 10 shows the results of the simulations in response to a standardized cryptocurrency price shock. Comparing the two regimes, we find flexible exchange rates provide a buffer through a nominal exchange rate depreciation. By allowing the interest rate to target the price level, exchange rates depreciate in the floating exchange rate regime. This helps stabilize prices through increasing import costs and the pass-through of inflation due to the assumption of producer currency pricing. Qualitatively, we observe similar declines in output, consumption, and investment in response to a cryptocurrency price shock.

Figure 10: Cryptocurrency price shock: Fixed versus flexible exchange rate regimes




Note: Figure plots impulse responses of model variables with respect to a 1 standard deviation cryptocurrency price shock. Time periods are measured in quarters, and responses are measured as a percent deviation from steady state. Domestic Inflation, Domestic Interest Rate, and Cryptocurrency Return are annualized. Solid line indicates a fixed exchange rate regime ($E = 1$) and dashed line indicates a flexible exchange rate regime ($\omega_E = 0.01$).