# Cryptocurrencies in Emerging Markets: A Stablecoin Solution?

David Murakami[1] Ganesh Viswanath-Natraj[2]

[1]University of Oxford, St Hilda's College

[2]University of Warwick, Warwick Business School

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# Research Questions

- What are the macroeconomic effects for a small open EME of circulating cryptocurrencies, such as Bitcoin, as legal tender?
  - Welfare implications?
  - Effects on monetary policy efficacy?
  - Buffer to global financial shocks?
  - Implication for exchange rate regimes?

# Motivation

- El Salvador became the first country to adopt Bitcoin as legal tender in September, 2021.
- Digital currencies address emerging market challenges of financial inclusion and the high remittance costs.
- **Store of Value**: Bitcoin daily price changes is an order of magnitude higher than fiat currency exchange rates. High volatility in a medium of exchange corresponds to high volatility in the macroeconomy.
- **Stablecoin solution**: A potential solution to the volatility inherent to Bitcoin is to instead adopt a global stablecoin, which can transform cross-border payments, make it easier for migrants to send remittances to emerging countries, and bring financial inclusion benefits for the unbanked population.

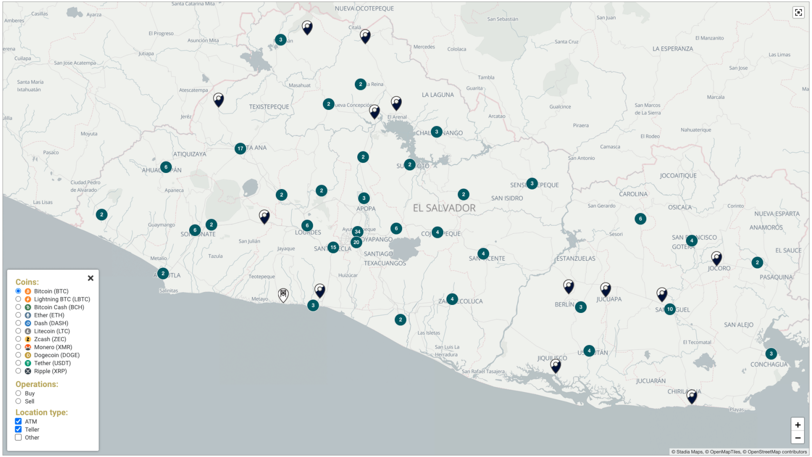
# Roadmap of Talk

- Background: El Salvador Bitcoin Experiment and Stablecoin Solution
- Small Open Economy Model: allow for domestic, foreign and digital currency.
  1. Households: Segmentation with digital currency held by unbanked: financial inclusion.
  2. Banks: Hold deposits in domestic, foreign currency and digital currency deposits.
  3. Digital currency deposits are subject to price volatility
  4. Propagation of "Bitcoin price shocks" to households, firm output and bank lending.
- Model Results
  1. Global financial cycle
  2. Fixed versus Flexible exchange rates
  3. Welfare analysis

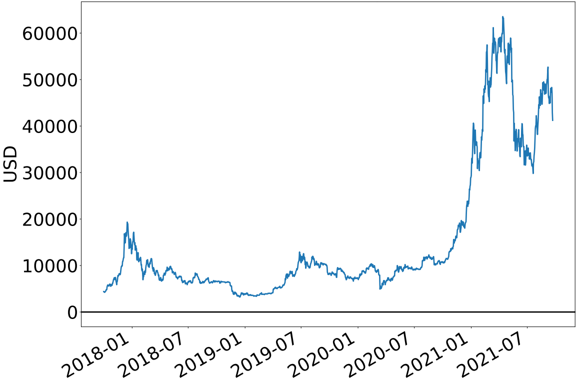
# El Salvador

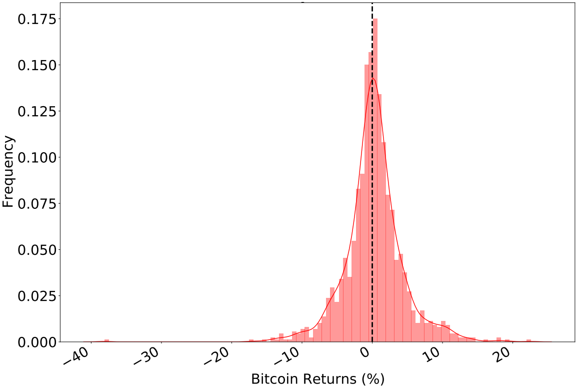
- El Salvador's recent law to make Bitcoin legal tender took effect on September 7th, 2021.
- Under the new regime, each individual can own a government sponsored Chivo digital wallet and is eligible for $30 US in Bitcoin. El Salvador has installed a number Bitcoin ATMs, allowing its citizens to convert the cryptocurrency into US Dollars.
- Banks are also pursuing regulations to encourage the use of Bitcoin wallet services in banking.
- Reasons for digital currency adoption:
  1. **Financial inclusion**: two thirds of El Salvador's population is without bank account.
  2. **Remittance costs**. Remittances total 25 percent of GDP. However, Hanke et al (2021) find Bitcoin wallet fees $\approx$ bank fees of approximately 5 per cent.
  3. **FDI flows**: "Bitcoin Beach project" in El Zonte.

# Map of El Salvador Bitcoin-Dollar ATMs



# Bitcoin Price and Histogram of Returns



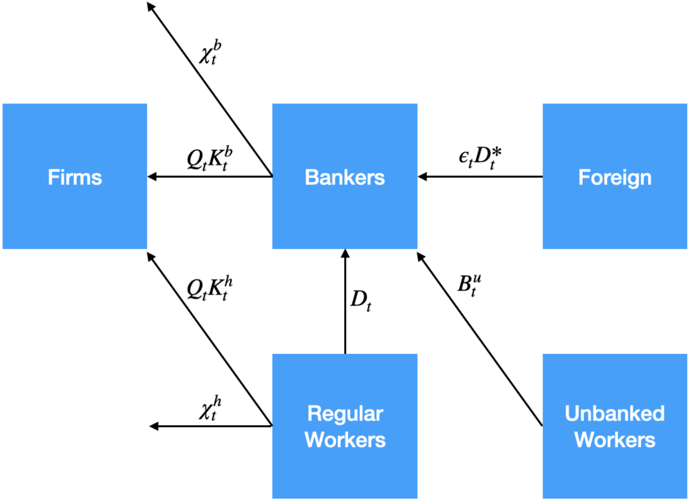



# Solution: Stablecoins and Mobile Payments

- 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.
- Replacing Bitcoin with a stablecoin is a solution to the volatility problem. Much of the existing infrastructure (eg. Chivo wallet and Bitcoin-ATMs) is in place for this transition.
- However we caveat that for stablecoins to be legal tender, they need to be appropriately regulated to be fully collateralized at all times.
- An alternative that can be used instead of a stablecoin is a mobile payment platform. In Kenya, the biggest phone company developed M-Pesa, a texting-based system for storing and sending money.

# Model

# Model Schematic



# Domestic Currency (Regular) Households

- Setup based on Aoki, Benigno, and Kiyotaki (2016).
- The representative household contains a continuum of individuals, each of which are of type $i \in \{b, h, u\}$.
  - Bankers ($i = b$) and regular workers ($i = h$) share a perfect insurance scheme.
  - However, unbanked workers ($i = u$) are not part of the insurance scheme.
- The problem for regular workers is the following:

$$\max_{C_t^h, L_t^h, K_t^h, D_t} \mathbb{E}_t \left[ \sum_{s=0}^{\infty} \beta^s \ln \left( C_{t+s}^h - \frac{\zeta_0^h}{1+\zeta^h} (L_{t+s}^h)^{1+\zeta^h} \right) \right], \tag{1}$$

subject to their period budget constraint,

$$C_t^h + Q_t K_t^h + \chi_t^h + D_t = w_t^h L_t^h + \Pi_t^P + (z_t^k + \lambda Q_t) K_{t-1}^h + \frac{R_{t-1}}{\Pi_t} D_{t-1}. \tag{2}$$

# Unbanked Households

- Unbanked workers also supply labor to firms for a wage. Their only savings vehicle is cryptocurrency.
- Their problem is:

$$\max_{C_t^u, L_t^u, B_t^u} \mathbb{E}_t \left[ \sum_{s=0}^{\infty} \beta^s \left\{ \ln \left( C_{t+s}^u - \frac{\zeta_0^u}{1+\zeta^u} (L_{t+s}^u)^{1+\zeta^u} \right) + \nu_u \ln \left( 1 + B_{t+s}^u \right) \right\} \right], \tag{3}$$

subject to period budget constraint,

$$C_t^u + B_t^u = w_t^u L_t^u + \frac{R_{t-1}^c}{\Pi_t} B_{t-1}^u, \tag{4}$$

where $B_t^u$ are real cryptocurrency holdings in terms of domestic quantities for unbanked workers, and $R_t^c$ is the nominal return on cryptocurrency holdings:

$$R_t^c = \frac{P_t^c}{P_{t-1}^c}. \tag{5}$$

# Bankers

- Bankers seek to maximize franchise value, $\mathbb{V}_t^b$:

$$\mathbb{V}_t^b = \mathbb{E}_t \left[ \sum_{s=1}^{\infty} \Lambda_{t,t+s}^h \sigma^{s-1} (1-\sigma) n_{t+s} \right]. \tag{6}$$

- As in Gertler and Kiyotaki (2010), a financial friction (moral hazard) is used to limit the banker's ability to raise funds.
- Banker can abscond with a fraction, $\Theta_t$, of assets.
- Thus, the bankers face the following incentive compatibility constraint:

$$\mathbb{V}_t^b \geq \Theta(x_t, x_t^c) Q_t k_t^b, \tag{7}$$

# Bank Balance Sheet and Flow of Funds

- Bank balance sheet contains deposits, cryptocurrency deposits, foreign debt, and net worth:

| Assets | Liabilities + Equity |
|---|---|
| Loans $Q_t k_t^b$ | Deposits $d_t$ |
| Management costs $\chi_t^b$ | Bitcoin deposits $b_t$ |
| | Foreign debt $\epsilon_t d_t^*$ |
| | Net worth $n_t$ |

$$\left(1 + \frac{\varkappa^b}{2} x_t^2\right) Q_t k_t^b = d_t + \epsilon_t d_t^* + n_t + B_t. \tag{8}$$

- We can also write the flow of funds of an individual banker as:

$$n_t = (z_t^k + \lambda Q_t) k_{t-1}^b - \frac{R_{t-1}}{\Pi_t} d_{t-1} - \frac{R_{t-1}^*}{\Pi_t^*} \epsilon_t d_{t-1}^* - \frac{R_{t-1}^c}{\Pi_t} b_{t-1}. \tag{9}$$

# Wedges and Deviation from UIP

$$\mu_t = \mathbb{E}_t \left[ \Omega_{t,t+1} \left\{ \frac{z^k_{t+1} + \lambda Q_{t+1}}{Q_t} - (1 + \tau^K_t) \frac{R_t}{\Pi_{t+1}} \right\} \right], \tag{10}$$

$$\mu^c_t = \mathbb{E}_t \left[ \Omega_{t,t+1} \left\{ (1 - \tau^c_t) \frac{R_t}{\Pi_{t+1}} - \frac{R^c_t}{\Pi_{t+1}} \right\} \right], \tag{11}$$

$$\mu^*_t = \mathbb{E}_t \left[ \Omega_{t,t+1} \left\{ (1 - \tau^{D^*}_t) \frac{R_t}{\Pi_{t+1}} - \frac{\epsilon_{t+1}}{\epsilon_t} \frac{R^*_t}{\Pi^*_{t+1}} \right\} \right], \tag{12}$$

$$\upsilon_t = \mathbb{E}_t \left[ \Omega_{t,t+1} \frac{R_t}{\Pi_{t+1}} \right], \tag{13}$$

- $\Omega_{t,t+1}$ is the stochastic discount factor of the banker; $\mu_t$ is the excess return on capital over home deposits; $\mu^c_t$ is the cost advantage of cryptocurrency holdings over home deposits; and $\mu^*_t$ is the cost advantage of foreign currency debt over home deposits or the deviation from real uncovered interest parity (UIP).

# Firms

Firms and production in the model are standard.

- Final goods are produced by perfectly competitive firms using intermediate goods as inputs into production.
- Final good firms also export output to foreign economy.

# Monetary Policy

- The domestic central bank is assumed to operate an inertial Taylor Rule:

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R} \left[\left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\frac{1-\omega_E}{\omega_E}} \left(\frac{E_t}{\bar{E}}\right)^{\frac{\omega_E}{1-\omega_E}}\right]^{1-\rho_R} \exp(\varepsilon_t^R). \tag{14}$$

- $\omega_E \in [0,1]$ with:
  - $\omega_E \to 0$: strict inflation targeting
  - $\omega_E \to 1$: exchange rate peg

# Cryptocurrency Market Clearing and Exogenous Processes

- Cryptocurrency market clearing (baseline case):

$$B_t^u = B_t. \tag{15}$$

- Stationary AR(1) processes for TFP and cryptocurrency prices are given as:

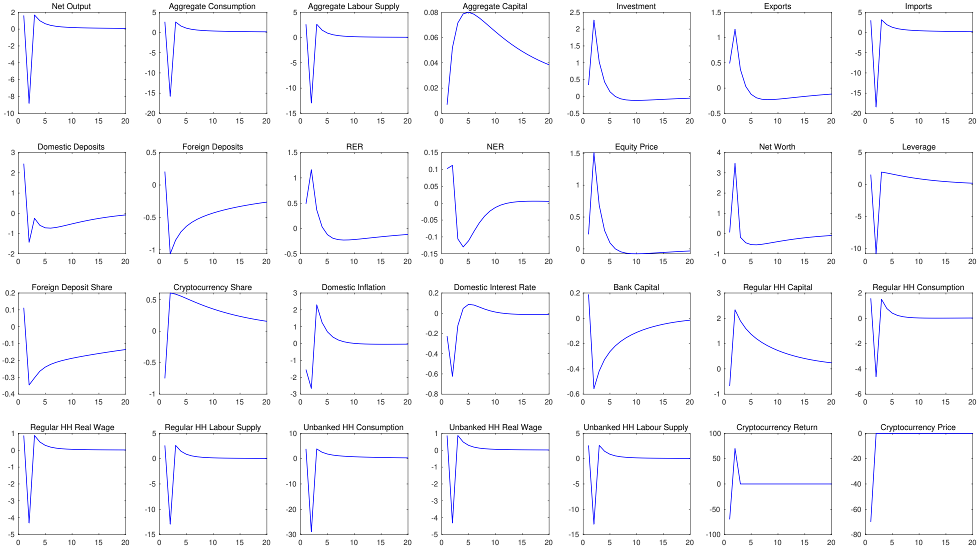
$$\ln\left(\frac{A_t}{\bar{A}}\right) = \rho_A \ln\left(\frac{A_{t-1}}{\bar{A}}\right) + \varepsilon_t^A, \tag{16}$$

$$\ln\left(\frac{P_t^c}{\bar{P}^c}\right) = \rho_{P^c} \ln\left(\frac{P_{t-1}^c}{\bar{P}^c}\right) + \varepsilon_t^{P^c}. \tag{17}$$

- We also specify AR(1) processes for foreign output, inflation, and interest rates.

# Model Simulations

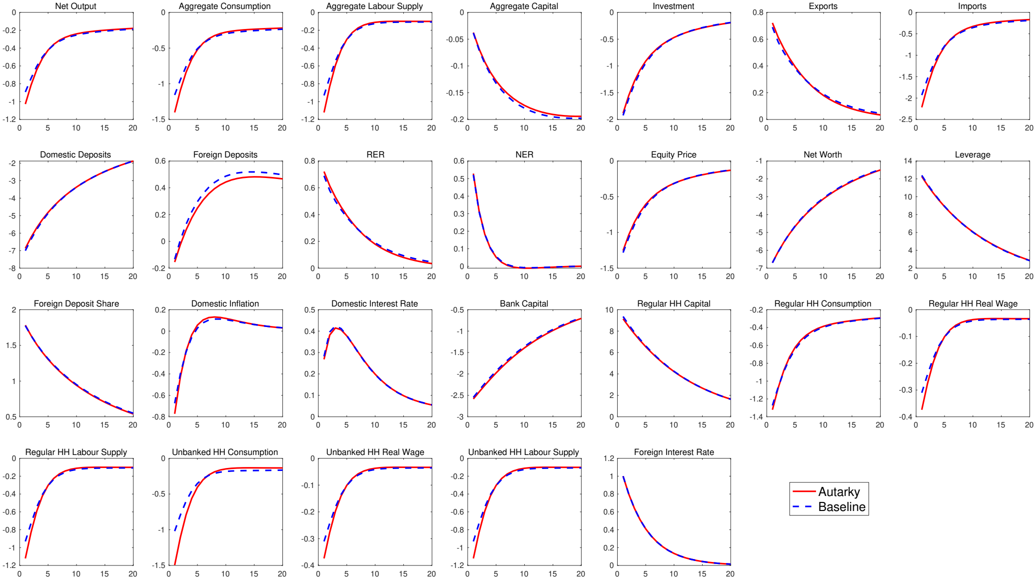
# $P_t^c$ Unit St.Dev Shock



# $P^c$ Shock Summary

- $P^c \downarrow$ shock reduces holdings of cryptocurrency and a decline in the savings and consumption of unbanked households.
- Through GHH preferences, the decline in consumption reduces labor supply by unbanked workers and a decline in the real wage.
- Peak decline in net output of approximately 8 percent.
- Regular households also experience consumption losses but more-so due to the general equilibrium effects of a decline in wages, labor supply, and income.
- For bankers, decline in the value of their cryptocurrency liabilities causes an increase in net worth. There is a reallocation toward holding more domestic and foreign deposits.
- $N \uparrow$ 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.
- Central bank responds to the decline in prices by lowering interest rates, triggering a nominal and real exchange rate depreciation.

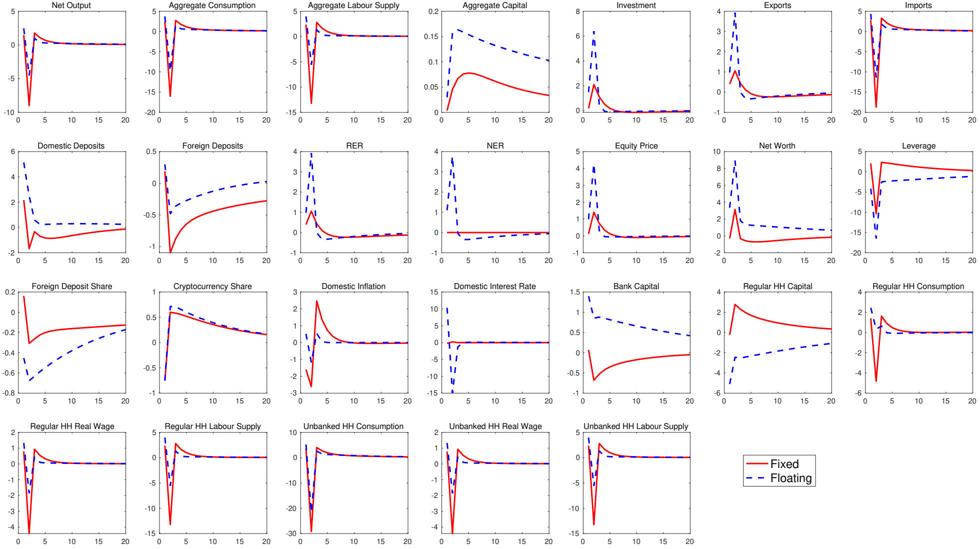
# Unit St.Dev Shock to $R_t^*$



# $R^*$ Shock Summary

- A foreign interest rate increase causes investors to pursue higher yields overseas, leading to a capital outflow, exchange rate depreciation, and a contraction of bank balance sheets.
- A decline in bank net worth and leverage leads to a fall in capital prices and contraction in loans to firms.
- This sees output and consumption consequently fall by approximately 1 percent in the baseline specification.
- Relative to the baseline calibration, the crypto autarky economy sees a larger peak decline in output.
- Implication: For an EME, such as El Salvador, the circulation of cryptocurrencies as legal tender helps to buffer the effect of global financial shocks.

# Unit St.Dev Shock to $P_t^c$: Fixed vs Float



# Fixed vs Floating Summary

- We simulate the response of an economy to a cryptocurrency price shock under two extreme cases of the Taylor rule: a fixed exchange rate peg is approximated by $\omega_E = 0.99$. A free floating exchange rate regime is approximated by $\omega_E = 0.01$.
- We find that flexible exchange rates provide a buffer through a nominal exchange rate depreciation.
- We observe a peak decline in output of 9 percent and 5 percent for the fixed and flexible exchange rate, respectively.
- Policy takeaway: For an EME, conditional on making cryptocurrencies legal tender, a floating exchange rate softens the effects of crypto asset price shocks.

# Welfare Analysis

- We calculate welfare by maximizing the value function for each type of household:

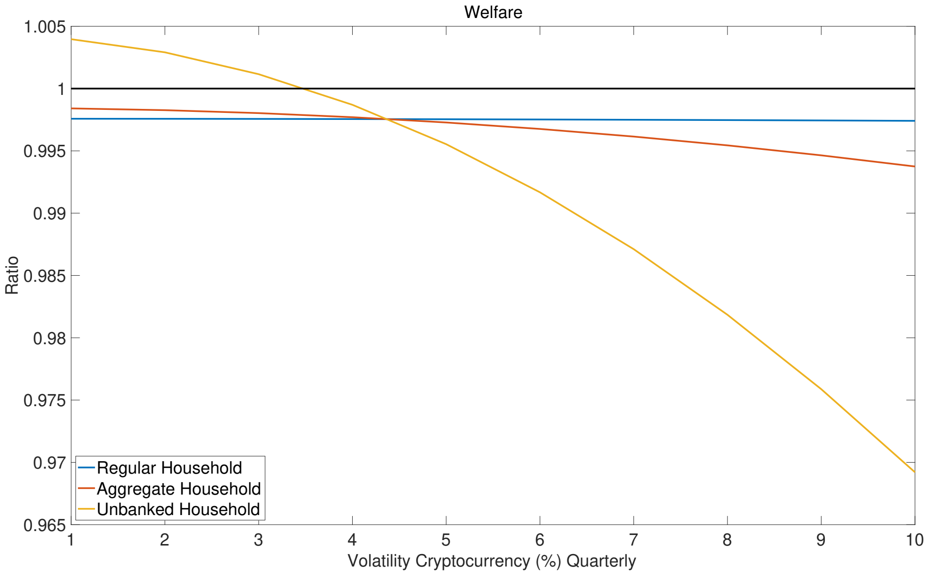
$$V_t^i = U(C_t^i, L_t^i) + \beta V_{t+1}^i, \quad i \in \{h, u, agg\}. \tag{18}$$

- We also compute a synthetic welfare for the aggregate household:

$$U^{\text{Aggregate}} = U^h(C_t^h, L_t^h) + U^u(C_t^u, L_t^u, B_t^u).$$

- Method: compute the first moment of welfare based on a second order log-linear approximation to the steady state. Compare to an autarky economy for each type of household.

# Welfare and Cryptocurrency Price Volatility



# Concluding Remarks

- In this paper we study the macroeconomic costs and benefits of El Salvador's monetary experiment to make Bitcoin as legal tender.
- Using a small open economy model to understand the macroeconomic effects of Bitcoin adoption, we find:
  1. Bitcoin brings net welfare losses through the general equilibrium effects of more volatile consumption, bank lending and firm labor demand. In contrast, a digital currency with sufficiently low volatility, such as a stablecoin, can result in net welfare benefits.
  2. Holding deposits in cryptocurrency can attenuate the effect of domestic monetary policy on bank balance sheets. A loss of monetary policy sovereignty.
  3. Cryptocurrency adoption buffers against the effects of the global financial cycle.
  4. Floating exchange rates provide a buffer against cryptocurrency price shocks.

# Thank You!

# Market Equilibrium

- Aggregate variables:

$$K_t = K_t^h + K_t^b, \tag{19}$$
$$C_t = C_t^h + C_t^u, \tag{20}$$
$$L_t = L_t^h + L_t^u. \tag{21}$$

- The aggregate resource constraint of the domestic economy is

$$Y_t = C_t + \left[1 + \Phi\left(\frac{I_t}{\bar{I}}\right)\right] I_t + EX_t + \frac{\kappa}{2}(\Pi_t - 1)^2 Y_t + \chi_t^h + \chi_t^b. \tag{22}$$

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

$$D_t^* = \frac{R_{t-1}^*}{\Pi_t^*} D_{t-1}^* + M_t - \frac{1}{\epsilon_t} EX_t. \tag{23}$$

# Aggregate Bank Variables

- Aggregate net worth of the bankers is:

$$N_t = \sigma \left[ (z_t^k + \lambda Q_t) K_{t-1}^b - \frac{R_{t-1}}{\Pi_t} D_{t-1} - \epsilon_t \frac{R_{t-1}^*}{\Pi_t^*} D_{t-1}^* - \frac{R_{t-1}^c}{\Pi_t} B_{t-1} \right] \\ + \gamma (z_t^k + \lambda Q_t) K_{t-1}, \tag{24}$$

- Aggregate balance sheet of the banking sector:

$$Q_t K_t^b \left( 1 + \frac{\varkappa^b}{2} x_t^2 \right) = \left( 1 + \frac{\varkappa^b}{2} x_t^2 \right) \phi_t N_t, \tag{25}$$

$$Q_t K_t^b \left( 1 + \frac{\varkappa^b}{2} x_t^2 \right) = N_t + D_t + \epsilon_t D_t^* + B_t, \tag{26}$$

$$x_t = \frac{\epsilon_t D_t^*}{Q_t K_t^b}, \tag{27}$$

$$x_t^c = \frac{B_t}{Q_t K_t^b}. \tag{28}$$

# Calibration

| Parameter | Value | Description |
|---|---|---|
| $\beta$ | 0.9876 | Household discount factor |
| $\zeta^h = \zeta^u$ | $1/3$ | Labor supply parameter |
| $\zeta_0^h = \zeta_0^u$ | 7.883 | Inverse-Frisch elasticity |
| $\varkappa^h$ | 0.0197 | Regular worker direct finance cost |
| $\nu_u$ | 0.0028 | Cryptocurrency sub-utility parameter |
| $\theta$ | 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 |

# Calibration (cont.)

| Parameter | Value | Description |
|---|---|---|
| $\alpha_K$ | 0.3 | Production share of capital |
| $\alpha_M$ | 0.18 | Production share of imports |
| $\alpha_h$ | 0.1734 | Production share of regular workers |
| $\alpha_c$ | 0.3466 | Production share of unbanked workers |
| $\lambda$ | 0.98 | One minus the depreciation rate ($\delta = 0.02$) |
| $\omega_E$ | 0.5 | 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 |
| $\rho_{P^c}$ | 0 | Cryptocurrency price AR(1) coefficient |