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Stablecoins and fiat currencies

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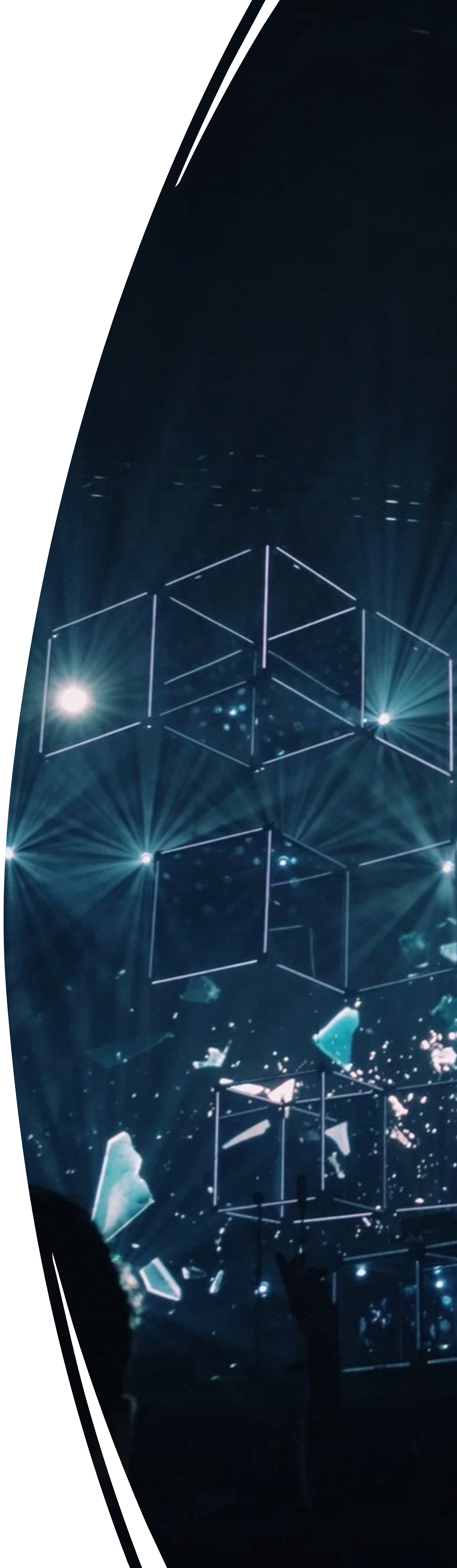

Capital Control in the Era of Stablecoins*

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Abstract

Stablecoins are cryptocurrencies designed to peg the U.S. dollar, providing foreign household investors with an alternative liquidity to the U.S. dollar, especially those households residing in countries under capital controls. In this paper, we propose a consumption- based asset pricing model to study the role of stablecoins. Our findings show two major benefits of the introduction of stablecoins to a country where foreign exchange intervention is in place, namely a higher level of saving and investment as well as improved household welfare. Additionally, we conduct empirical tests to validate the conditions used in our model, finding that the expected return on stablecoins is statistically indifferent to fiat currencies, and that stablecoin returns are more volatile than the average of dollar-based exchange rates. That said, while developed-country fiat currencies are generally less volatile than stablecoins, for emerging-economy fiat currencies the opposite is true. In short, we argue that this explains the stronger demand for stablecoins in emerging economies than in developed countries.

Keywords: Cryptocurrency, Stablecoin, Exchange Rates, Dollar Factor, Tokenomics.
JEL Classification: E50, E58, F31, F38, G15

1 Introduction

Stablecoins are cryptocurrencies designed to peg a stable value with respect to a fiat currency, typically the U.S. dollar (Kozhan and Viswanath-Natraj, 2021). As with other cryptocur- rencies functioning in a decentralized system, stablecoins also have advantages in that their demand and supply are not determined by authorities such as central banks. This new class of cryptocurrencies reflects strong demand for stability in investment assets without the intervention of the authorities. In contrast to other cryptocurrencies, stablecoins are often coupled with some form of collateral as a stabilizing mechanism to regularize their volatility. This stability feature creates an alternative investment opportunity to fiat currencies.

Although some studies question the stability claimed for the stablecoin design (Bullmann et al., 2019; Lyons and Viswanath-Natraj, 2020; Hoang and Baur, 2021; Grobys et al., 2021), this does not negate the fundamental distinction between decentralized stablecoins and centralized fiat money, although the actual degree of decentralization varies from one stablecoin to another depending on the accepted collateral assets. For investors constrained by capital controls imposed by governments, stablecoins may serve as a substitute for safe assets denominated in foreign currency, despite their often being riskier than simply holding the foreign currency. In practice, it is difficult to conclude that fiat currencies are always less volatile than stablecoins. Several central banks are found to intervene in foreign-exchange markets even when domestic macroeconomic risk is relatively low. Even global policymakers such as the IMF are still searching for better guidelines to regulate foreign exchange intervention (Lafarguette and Veyrune, 2021). Hence, from the investor?s perspective one may prefer stablecoins over fiat money when unanticipated policy risk outweighs the risk inherent in the decentralized cryptocurrency system.

This paper proposes a consumption-based asset-pricing model to rationalize the rapidly growing market share of stablecoins since their introduction. The financial market is imperfect because of capital controls imposed on risk-free assets by governments. Although stablecoins are expected to have the same mechanisms for price and return as fiat currencies, their standard deviation would naturally be much larger. Nevertheless, household investors might still be willing to take such risks, given capital control prevents them from achieving first-best allocations. In this model, we demonstrate two benefits of introducing stablecoins to household investors, namely higher levels of savings and investments as well as welfare improvements.

Next, we provide empirical evidence for our comparison of the dynamics of stablecoin versus currency returns. We seek to validate the assumptions we make in the proposed model. The findings can be summarized in two dimensions. First, we cannot reject the null hypoth- esis that stablecoins and fiat currencies have the same level of expected return. As stablecoins are often pegged to the U.S. dollar, we compare them with the dollar factor (Verdelhan, 2018), which is calculated as the cross-sectional average among the 22 currencies studied in this paper. Second, we test the variance ratio between the two return distributions. Our findings indicate differentiated implications for investors residing in different countries. Half of the fiat currencies studied in this paper are more volatile than stablecoins, while the other half are more stable. We note that not all households would be unconditionally and equally interested in stablecoin investments. The demand for stablecoins exhibits cross-country variations depending on the policy risk associated with the corresponding fiat currency. Aligned with a practitioner report[1], our empirical results show higher fiat currency volatility in emerging economies than in developed countries.

Our study is related to the literature that attempts to understand the interaction of policymakers and decentralized financial assets. The most relevant study is Cong and Mayer (2021) , who propose a model to rationalize different attitudes on the part of the authorities to the adoption of central-bank digital currency or even existing cryptocurrency. Our work attempts to explain cross-country variations in the demand for stablecoins. In addition, Klages-Mundt et al. (2020) propose several economic models to capture different sources of risk emerging from regulatory actions as well as from cryptocurrency design. Catalini et al. (2021); Arner et al. (2020) argue that stablecoins could be eventually replaced by central-bank digital currencies.

The paper is organized as follows. Section 2 presents consumption-based asset pricing models. In Section 3, we provide the data sources, set out the regression models, and discuss the

[1] See 'The 2020 Geography of Cryptocurrency Report' by *Chainanalysis*.

empirical results. Finally, Section 4 provides concluding remarks.

2 Model

In this section, we present a consumption-based asset pricing model with a capital-control constraint. Without loss of generality, we illustrate the model from the perspective of India. As participants in an open economy, Indian household investors have a demand for foreign currency. We first depict an incomplete economy without a risky asset, namely stablecoin, in order to identify the dead-weight loss in equilibrium. Then, we build on this benchmark model to demonstrate how the introduction of a new stablecoin asset helps the economy to recover first-best equilibrium.

First, we construct a simple economy in which only risk-free assets are available to the household investor. This setup describes a scenario before the cryptocurrency era where the only way to invest in currency as an asset is through the government, either by saving or exchange with foreign currencies. This might not be the case for developed economies like the United States or the European Union, where foreign currencies are traded in free markets that are accessible to household investors. We write

$$
\begin{aligned}
\max_{\{\xi\}} \quad & u(C_0) + \beta u(C_1) \\
s.t. \quad & \\
C_0 &\leq e_0 - \xi P^f \\
C_1 &\leq e_1 + \xi P^f R \\
\xi &\leq \overline{\xi},
\end{aligned}
\tag{1}
$$

where β is the intertemporal discount factor, e_t is the endowment, R is the interest rate, and ξ is the total financial asset, namely the risk-free asset with the price denoted as P^f. The investor's choice of the amount of the financial asset to hold is bounded above by $\overline{\xi} > 0$, which denotes the government?s intervention on the supply of foreign currency, say the U.S.

dollar.

If the constraint is slack, for instance $\xi \leq \overline{\xi} = \infty$, the financial market would be complete and the optimal ξ^* would be determined by the optimization problem with the budget constraints only. Consequently, we make the following assumption so that $\overline{\xi}$ has an effective impact on the investor's optimal choice of ξ.

Assumption 1. *If the government of India imposes sufficiently strong control on the supply of the U.S. dollar, the constraint $\xi \leq \overline{\xi}$ will affect the investor?s optimal holding of the financial asset, as follows:*

$$-u'(C_0)|_{\xi=\overline{\xi}} P^f + \beta \mathbb{E}_0 u'(C_1)|_{\xi=\overline{\xi}} P^f R > 0. \tag{2}$$

This assumption implies that the investor would strictly prefer to save more given government intervention. In other words, letting ξ^* represent the investor's frictionless level of investment, we have $\xi^* > \overline{\xi}$.

Under Assumption 1, the investor's constrained optimal investment level would be binding at $\overline{\xi}$. Since holding foreign assets is expected to produce lower returns than in the complete market due to the presence of government intervention, the investor chooses to consume more in the current period and less in the future: $\overline{C}_0 > C_0^*$ and $\overline{C}_1 < C_1^*$.

Denote the difference expressed in the value function using a Taylor expansion

$$\Delta = V(\xi^*) - V(\overline{\xi}) = V'(\hat{\xi})(\xi^* - \overline{\xi}), \tag{3}$$

where $V(x) = u(C_0)|_{\xi=x} + \beta \mathbb{E}_0 u(C_1)|_{\xi=x}$ and $\hat{\xi} \in [\xi^*, \overline{\xi}]$. As the unconditional ξ^* is strictly higher than the equilibrium value under the intervention $\xi = \overline{\xi}$ by Assumption 1, we show in what follows that the equilibrium welfare of the constrained value function is at least as high as under unconstrained equilibrium, so that $\Delta \geq 0$.

Note that the value function for risk-averse households has the following properties: $V'(\cdot) > 0$ and $V''(\cdot) < 0$. Since the frictionless equilibrium ξ^* is obtained from the First-Order Condition, we also have $V'(\xi^*) = 0$. As the value of $\hat{\xi}$ in Equation (3) is higher than ξ^*

and the first-order derivative of the value function $V'(x) > 0$ is decreasing in x, we deduce that$V'(\hat{\xi}) > V'(\xi^*) = 0$. Therefore, we have proved that the welfare difference is strictly positive ($\Delta > 0$), implying that risk-averse investors are worse off when the government intervenes. Note that when the utility function is linear, $V''(\cdot) = 0$, Jensen's inequality is binding and so is the utility difference ($\Delta = 0$). This implies that risk-neutral investors are indifferent with or without the intervention because their intertemporal substitution can efficiently smooth consumption.

Now we extend the baseline model (1) by introducing a risky asset. As in Cochrane (2001), define the utility function of an investor residing in India as the current and future values of consumption in the following endowment economy:

$$\begin{aligned}
\max_{\{\xi_f,\xi_c\}} \quad & u(C_0) + \beta \mathbb{E}_0 u(C_1) \\
s.t. & \\
C_0 =& e_0 - [\xi_f P^f + \xi_c P^c] \\
C_1 =& e_1 + \xi_f P^f R + \xi_c P^c R^c \\
\xi_f \leq & \overline{\xi}
\end{aligned} \tag{4}$$

In this model, we assume the endowment and the risky asset return to be exogenous. The risky asset is the stablecoin while the risk-free asset is bank savings, naturally denominated in the local currency, in this case the Indian rupee.

Assumption 2. *By design, the stablecoin financial asset should peg the currency value. It is natural to assume that the initial stablecoin price is the same as the risk-free asset:*

$$P^f = P^c.$$

In addition, we assume that stablecoin returns are stochastic and have the same mean as the risk-free asset,

$$\mathbb{E}_0(R^c) = R,$$

while stablecoin returns have variance σ^2.

Without this assumption, the model becomes a standard portfolio choice problem between risk-free assets and any kind of risky assets, such as equity.

2.1 Model Equilibrium

In this section, we solve the baseline model (1) step by step. Following assumption 1, the optimal choice of ξ is binding at $\overline{\xi}$. Let $V(\xi) = u(e_0 - \xi P^f) + \beta \mathbb{E}_0 u(e_1 + \xi P^f R)$ be the value function. Under Assumption 1, the Mean Value Theorem implies that the value function $V(\cdot)$ is strictly increasing on $[0, \overline{\xi}]$. Therefore, we have $\arg\max_{\xi \in [0,\overline{\xi}]} V(\xi) = \overline{\xi}$. Hence, consumption values in the current and future periods are $\overline{C}_0 = e_0 - \overline{\xi} P^f$ and $\overline{C}_1 = e_1 + \overline{\xi} P^f R$ respectively, where the endowments e_0, e_1, price P^f, and return R of the risk-free asset are exogenous.

By specifying the negative exponential utility function $u(c) = -\exp\{-\gamma c\}$, with γ as the degree of risk aversion, Assumption 1 can now be reduced to

$$\overline{\xi} < \frac{\log\left(\beta R \mathbb{E}_0 \exp\{-\gamma e_1\}\right) + \gamma e_0}{\gamma P^f (R+1)}. \tag{5}$$

The proof of this assertion is given below. Rearranging inequality (5), Assumption 1 is equivalent to

$$\beta \mathbb{E}_0 \frac{u'(\overline{C}_1)}{u'(\overline{C}_0)} R > 1.$$

By plugging the marginal utility $u'(c) = -\gamma \exp\{-\gamma c\}$ into the above inequality, we perform the following derivation:

$$
\begin{aligned}
& \beta R \mathbb{E}_0 \exp\Big(- \gamma(\overline{C}_1 - \overline{C}_0)\Big) > 1 \\
\Longleftrightarrow & \beta R \mathbb{E}_0 \exp\Big(- \gamma(e_1 - e_0 + \overline{\xi} P^f (R+1))\Big) > 1 \\
\Longleftrightarrow & \log\Big(\beta R \mathbb{E}_0 \exp\Big(- \gamma e_1\Big)\Big) + \gamma e_0 - \gamma \overline{\xi} P^f (R+1) > \log(1) = 0 \\
\Longleftrightarrow & \overline{\xi} < \frac{\log\Big(\beta R \mathbb{E}_0 \exp(-\gamma e_1)\Big) + \gamma e_0}{\gamma P^f (R+1)},
\end{aligned}
$$

where an upper bound of $\overline{\xi}$ is obtained as in Equation (5). Inequality (5) is consistent with the following intuitions: (i) the capital control should be stringent enough (reflected by a small $\overline{\xi}$) to prevent the household investor from achieving their first-best consumption allocation; (ii) when the economic outlook is pessimistic or a recession is coming, e_1 is expected to be small and the household investor would be more incentivized to save. Hence, Assumption 1 becomes slacker and easier to hold.

The solution for the portfolio choice model (4) can be developed in a similar way as the baseline case (1).

Proposition 3. *Starting with Assumption 1, we have* $\xi_f^* = \overline{\xi}$*. Furthermore, when* $\xi_c^* > 0$ *exists, we have*

- $C_0^* = e_0 - \overline{\xi} P^f - \xi_c^* P^c < \overline{C}_0$ *(more investment);*
- $C_1^* = e_1 + \overline{\xi} P^f R + \xi_c^* P^c R^c > \overline{C}_1$ *;*
- $U(C_0^*, C_1^*) > U(\overline{C}_0, \overline{C}_1)$ *(improved welfare).*

To ensure the existence of $\xi_c^* > 0$, we need the following condition:

$$
\beta \mathbb{E}_0 \left(\frac{u'(C_1)}{u'(C_0)} R^c \right) = \beta \mathbb{E}_0 \left(\frac{u'(e_1 + \overline{\xi} P^f R)}{u'(e_0 - \overline{\xi} P^f)} R^c \right) > 1, \tag{6}
$$

which is implied by Assumption 1 if we also assume independence between the endowment e_1 and the risky-asset return R^c. To satisfy the no-arbitrage condition $\beta \mathbb{E}_0 \left(\frac{u'(C_1)}{u'(C_0)} R^c \right) = 1$, we know that Equation (6) is not at its optimum. As a result, the investor can be strictly better off if they hold some positive savings in the form of stablecoins.

By specifying the negative exponential utility function $u(c) = -\exp\{-\gamma c\}$, the above condition (6) can be reduced to

$$\bar{\xi} < \frac{\log\left(\beta R \mathbb{E}_0 \exp\{-\gamma e_1\}\right) + \gamma e_0}{\gamma P^f (R+1)},$$

which is identical to what was derived under the same specification in the baseline model (5).[2]

Proof : Let $V(\xi_f, \xi_c) = u(e_0 - \xi_f P^f - \xi_c P^c) + \beta u(e_1 + \xi_f P^f R + \xi_c P^c R^c)$ be the value function, and let (ξ_f^*, ξ_c^*) be the corresponding maximizer. Since the investor has no incentive to buy any unit of the risky asset when the safe asset is still available for sale, under Assumption 1 we obtain $\xi_f^* = \bar{\xi}$ and ξ_c^* from the first order condition (FOC) $\frac{u'(C_1)}{u'(C_0)} = \frac{R^c}{\beta}$.

With the assumption $u'(0+) = +\infty$ and condition (6), we can obtain the two boundary conditions

$$\left. \frac{u'(e_1 + \bar{\xi} P^f R + x P^c R^c)}{u'(e_0 - \bar{\xi} P^f - x P^c)} \right|_{x=0} > \frac{R^c}{\beta},$$
$$\left. \frac{u'(e_1 + \bar{\xi} P^f R + x P^c R^c)}{u'(e_0 - \bar{\xi} P^f - x P^c)} \right|_{x \to \frac{e_0 - \bar{\xi} P^f}{P^c}} \to 0 < \frac{R^c}{\beta}.$$

The Intermediate Value Theorem ensures that there exists a $\xi_c^* \in (0, \frac{e_0 - \bar{\xi} P^f}{P^c})$ such that the FOC holds. The solution $\xi_c^* > 0$ is also unique from the monotonicity of the SDF, which also implies $V(\bar{\xi}, \xi_c^*) > V(\bar{\xi}, 0)$.

[2] The detailed derivations will be provided upon request.

2.2 Model Implications

To better understand the proposed model, in this subsection we provide a calibration exercise. To obtain a closed-form solution, we first need to assume the functional form of the household?s utility. Considering a risk-averse agent, we assume that they have a negative exponential utility function. Although this assumption makes the results less general, it allows us to visualize the welfare implications of the tightness of capital control.

Table 3 presents a list of parameters used in the baseline calibration. For simplicity, we assume that the endowments are equal to 1 for periods 0 and 1 without uncertainty. For the subjective discount rate we use 0.9, and for the return on the risk-free asset we assume 20%, so the gross return is equal to $R = 1.2$. The absolute risk aversion γ takes the value of 0.1.

The calibration results are shown in Figure 4. We demonstrate the quantitative implications for investment/saving and welfare as in Proposition 3. The horizontal axis is the degree of capital control $\overline{\xi}$. We find that $\overline{\xi}$ is positively correlated with both investment/saving (lower chart) and welfare (upper chart), implying that a stronger capital control has negative welfare implications with or without access to stablecoin markets. On the other hand, the availability of stablecoin markets cannot further improve welfare if the capital control is unbinding with large $\overline{\xi}$. Aligned with Proposition 3, stablecoin markets can result in higher savings and investment and hence greater welfare improvement when the government imposes a stronger capital control.

2.3 Extension: Modelling Capital Control Policy

We now distinguish two types of intervention policy: procyclical and countercyclical. In other words, the degree of the capital-control policy depends on the economic state. Procyclical policy assumes a binding capital control in a recession, while control would be slack during a boom. Conversely, countercyclical policy implies no capital control during a recession and tighter control during a boom. We would like to incorporate this feature in our current portfolio choice model.

To formalize the model, we consider a binary-state economy where q represents the probability of recession and $q \leq \frac{1}{2}$.[3] Hence, a boom period occurs with probability $1-q$. At each time t, the endowment is assumed to be $e_t/(1-q)$ in a boom period and 0 in a recession period. This assumption ensures comparability with the current model, in which the expected endowment with linear probability weighting is equal to e_t.

Moreover, we assume procyclical policy as $2\overline{\xi} - \xi^*$ with probability $1-q$ in the recession state and ξ^* otherwise, where ξ^* represents the frictionless level of demand for the risk-free asset. As a result, the inequality $\overline{\xi} \leq \xi^*$ always holds. This design ensures the deviation $(\alpha = \xi^* - \overline{\xi} > 0)$ from the baseline capital control $\overline{\xi}$ is identical between the recession and non-recession periods

Without access to the stablecoin market, the constrained equilibrium consumption for households at period 0 implied by the countercyclical policy is

$$\overline{C}_0^{\text{Pro}} = e_0 - P^f[q\xi^* + (1-q)(2\overline{\xi} - \xi^*)]. \tag{7}$$

From Proposition 3, we show that a household can enjoy a larger welfare improvement when introducing stablecoins if the equilibrium consumption $\overline{C}_0^{\text{Pro}}$ is distorted further away from its frictionless counterpart C_0^*. Comparing with the equilibrium constrained by time-invariant (naive) capital control, we can calculate the consumption change resulting from the procyclical policy:

$$\overline{C}_0^{\text{Pro}} - \overline{C}_0 := \Delta^{\text{Pro}} = -P^f(1-2q)(\overline{\xi} - \xi^*). \tag{8}$$

With the conditions $q \leq \frac{1}{2}$ and $\overline{\xi} \leq \xi^*$, we obtain $\Delta^{\text{Pro}} > 0$. Equilibrium consumption under the procyclical policy is higher than under the naive policy, implying less investment and hence a negative welfare implication. We diagnose bad policy if the tightness of capital control is procyclical; that is, a stronger control expressed by a smaller $\overline{\xi}$ when the economy is in a good state. Alternatively, the change in current consumption under the countercyclical

[3] According to the business cycle tracked by NBER, there are more days of non-recession than recession, justifying the assumption of a small $q \leq 1/2$.

policy can be obtained from

$$\overline{C}_0^{\text{Counter}} - \overline{C}_0 := \Delta^{\text{Counter}} = -P^f(1-2q)(\xi^* - \overline{\xi}), \tag{9}$$

implying instead a negative change when $q \geq \frac{1}{2}$. Hence, we diagnose good policy if the tightness of capital control is countercyclical. In fact, such a policy can act as an economic stabilizer that helps households smooth their consumption. Specifically, when the economy is in the good state, the government eases capital control so that households can invest more. Otherwise, tight control simply forces households to overconsume as saving will most likely perish in the next period. On the other hand, the government tightens capital control in the bad state where the demand for investment is much weaker. Effectively, this policy design would impose weaker constraints than the procyclical policy. The improvement in household welfare also demonstrates why countercyclical control is a better policy than procyclical. Based on this finding, we expect to find stronger demand for stablecoins in countries whose governments frequently impose a procyclical capital-control policy.

Although the countercyclical policy is better than procyclical capital control, it remains an economic friction that causes a deadweight loss in welfare, which can be compensated when stablecoin markets become available to households. The difference between current consumption under countercyclical control and frictionless consumption can also be computed explicitly, as

$$\overline{C}_0^{\text{Counter}} - C_0^* := \Delta^{\text{Counter'}} = -P^f(2q)(\overline{\xi} - \xi^*), \tag{10}$$

which would be positive for $q \neq 0$. Therefore, the countercyclical policy results in lower investment/saving and thus lower welfare than the frictionless equilibrium. Overall, we can rank the different capital-control policies based on household welfare. The best policy would be no capital control, followed by countercyclical, naive, and procyclical controls. We also remark that the welfare deviations (i.e. the increase for the countercyclical control and the decrease for the procyclical control) from the naive policy decrease with increasing probability q of recession. The welfare loss of imposing a bad policy is larger in the good economic state. As a result, one would expect to find stronger demand for stablecoins, especially in the good state.

Below we provide two possible applications in the real economy to illustrate how one can interpret the implications of our model.

Application 1: Exchange rate policy. It is not uncommon for an export-oriented country such as India to maintain an exchange rate policy that targets the rupee?dollar exchange rate below the market price. In practice, the government constantly restricts the supply of U.S. dollars accessible to Indian investors and/or firms in the foreign-exchange market. The parameter $\overline{\xi}$ can be used to measure the degree of intervention in place in the rupee?dollar exchange rate. Moreover, a countercyclical policy with an overall stronger tendency to intervene in the foreign-exchange market accurately reflects policymaking decisions observed in emerging economies such as India.

Application 2: Inflation risk. Inflation risk in emerging economies is usually higher than in advanced ones. In addition, high inflation is usually associated with re- cession as it rapidly erodes purchasing power, especially through financial assets denominated in the domestic currency. This phenomenon is captured by assigning a zero value in the recession state of the proposed model. Furthermore, the probability q also represents the inflation risk. In an environment with high-inflation risk, a countercyclical policy results in higher demand by households that search for a substitute asset for the risk-free asset even if it is risky, rationalizing their risk-taking behavior in the presence of policy friction.

3 Empirical Analysis

3.1 Data

Our data can be categorized into two groups. First, the daily price and trading volume of stablecoins including Tether USD (USDT), USD Coin (USDC), and Dai USD (DAI) are collected from *Yahoo Finance* with the tickers USDT-USD, USDC-USD, and DAI-USD respectively. Among these, USDT has the longest and DAI the shortest history. Second, foreign exchange rates against the U.S. dollar of 22 developed and emerging economies are collected from *Datastream*. Our selection is based on G20 countries plus a few currencies that are com- monly used in international finance studies. The 22 currencies in our data set are the Argentine peso (ARS), Australian dollar (AUD), Brazilian lira (BRL), Canadian dollar (CAD), Swiss franc (CHF), Chinese yuan renminbi (CNY), Euro (EUR), British pound sterling (GBP), Indian rupee (INR), Indonesian rupiah (IDR), Japanese yen (JPY), Korean won (KRW), Mexican peso (MXN), Norwegian kroner (NOK), New Zealand dollar (NZD), Russian ruble (RUB), Saudi riyal (SAR), Singaporean dollar (SGD), Swedish krona (SEK), Thailand baht (THB), Turkish lira (TRY), and South African rand (ZAR). We also construct the dollar factor in the spirit of Lustig et al. (2011); Verdelhan (2018) by taking the simple average across the 22 currencies in our data set.

3.2 Preliminary Findings

Summary statistics for our data set can be found in Table 1. The daily data begins at November 9$^{\text{th}}$, 2017 and ends with July 18$^{\text{th}}$, 2022. This gives us 1223 observations in total for each time series, assuming no missing data. Note that stablecoins have transaction data even during weekends and statutory holidays, while foreign exchange rate observations are often observed as the same or missing values in non-business days; we delete the latter to avoid an excessive number of zeros in the data set. During this five-year period, the average returns for USDT and USDC are close to zero and the autocorrelation is weakly negative. Nevertheless, average returns for stablecoins seem to decrease with the number of observations, reflecting that the market demands a higher risk premium from newer stablecoins (see Figure 2). On the other hand, average currency returns vary substantially across countries but remain mostly positive, except for the Turisk lira and the Latin American currencies ARS and BRL. The standard deviation of stablecoins is similar to that of the foreign exchange rates, approximately 10% per annum. As for correlation across asset classes, Table 2 shows that returns are closely correlated among the three stablecoins, while the correlation between the stablecoins and the dollar factor is still positive but much lower.

There are several studies documenting evidence that stablecoins do not seem to be as stable as they claim (Bullmann et al., 2019; Lyons and Viswanath-Natraj, 2020; Hoang and Baur, 2021; Grobys et al., 2021). With our longer sample period, we find that excessive volatilities occur in the earlier life of stablecoins. For instance, Figure 1 shows lower volatility for all three stablecoins after the year 2021, a period that is not covered in the above studies. We also remark that stablecoin returns have been affected by COVID-19 pandemic risk but do not seem to comove with the recent stock market downturn due to the current worldwide inflation crisis.

Table 4 compares summary statistics across three different subsamples. Panel A reports statistics for the periods P1: 2017?2018, P2: 2019?2020, and P3: 2021?2022; Panel B shows changes in the statistics. One striking pattern that distinguishes stablecoins from foreign exchange rates is the change in the standard deviation. We find in Panel B negative (positive) numbers for the stablecoins (foreign exchange rates), implying that the former (latter) are becoming less (more) volatile with time. Furthermore, both USDC and DAI returns are dropping significantly over time (7.80% and 20.01% per annum, respectively), indicating the stabilizing feature of these stablecoins. Note that we do not find this feature in foreign exchange rates. Conversely, USDT returns seem to increase over time, but the changes are quantitatively small. Furthermore, dollar factor mean returns initially decrease from the first subperiod to the second one and then increase afterward. The appreciation of the dollar factor could be reflected by inflation and consequent interest rate hikes since March of 2022, as documented in Lustig et al. (2011).

3.3 Results and Discussion

In this section, we test two hypotheses that are relevant for our model predictions. First, we test whether the mean difference between stablecoin and foreign exchange rate returns is zero. Second, we test whether stablecoin returns have a larger standard deviation than foreign exchange rate returns.

The results are reported in Table 5. Results for the first test are in Panel A, for which the null hypothesis is H_0: the mean return of stablecoins is equal to the dollar factor. There are two alternative hypotheses for which we can calculate the p-values: a one-sided test against H_a: the mean return difference is smaller than zero (i.e. the mean return on stablecoins is less than that on foreign exchange rates) and a two-sided test against H_a: the mean return difference is different from zero. The p-values are mostly insignificant for both tests, except for the comparison between USDT and the dollar factor (p-value = 7.78%). At a 10% significant level, we therefore reject the null in this one case and conclude that the USDT return is lower than the dollar factor in the one-sided test. In short, we find little evidence of different levels of return between the stablecoins and the currencies, which validates Assumption 2 in the model section.

We are also interested in comparing the second moment of the return distributions. The results of variance ratio testing are reported in Panels B and C of Table 5. In Panel B, we compare the standard deviation between three stablecoins and the dollar factor, while in Panel C, the comparison is made at the currency level. The two-sided tests clearly reject the null H_0: that the variance ratio is equal to 1. However, the one-sided tests reject the null for half of the currencies but not for the dollar factor. The implications of this test vary substantially for investors residing in different countries. For the U.S. investor, the stablecoin is as volatile as the U.S. dollar. However, for investors from Canada, the euro area, and the United Kingdom, among others, the stablecoins have higher volatility than the currencies in these countries. Finally, the currencies of Brazil, Mexico, Turkey, and South Africa, among others, exhibit higher volatility than the stablecoins. In short, investors might prefer to hold either stablecoins or fiat money depending on the country they reside in.

4 Conclusion

This paper offers an asset pricing model to study the role of stablecoins and the benefits they can bring to an economy constrained by capital-control policy. To validate the conditions imposed in our model, we also conduct empirical analysis on the return distri- butions of three stablecoins and 22 fiat currencies. We find that the availability of stablecoins is beneficial for investors residing in a country whose government imposes foreign-exchange intervention. In other words, under equilibrium with stablecoins, the model predicts a higher level of savings and investment and also of household welfare. Additionally, empirical analysis confirms that the expected return on the fiat currencies is equal to that on the stablecoins, although the latter are more volatile. For future studies, it would be interesting to extend the current setup to understand the role of central bank dig- ital currencies (CBDC) as in (Cong and Mayer, 2021) and present empirical evidence across countries for interactions among fiat currency, stablecoins, and CBDC.

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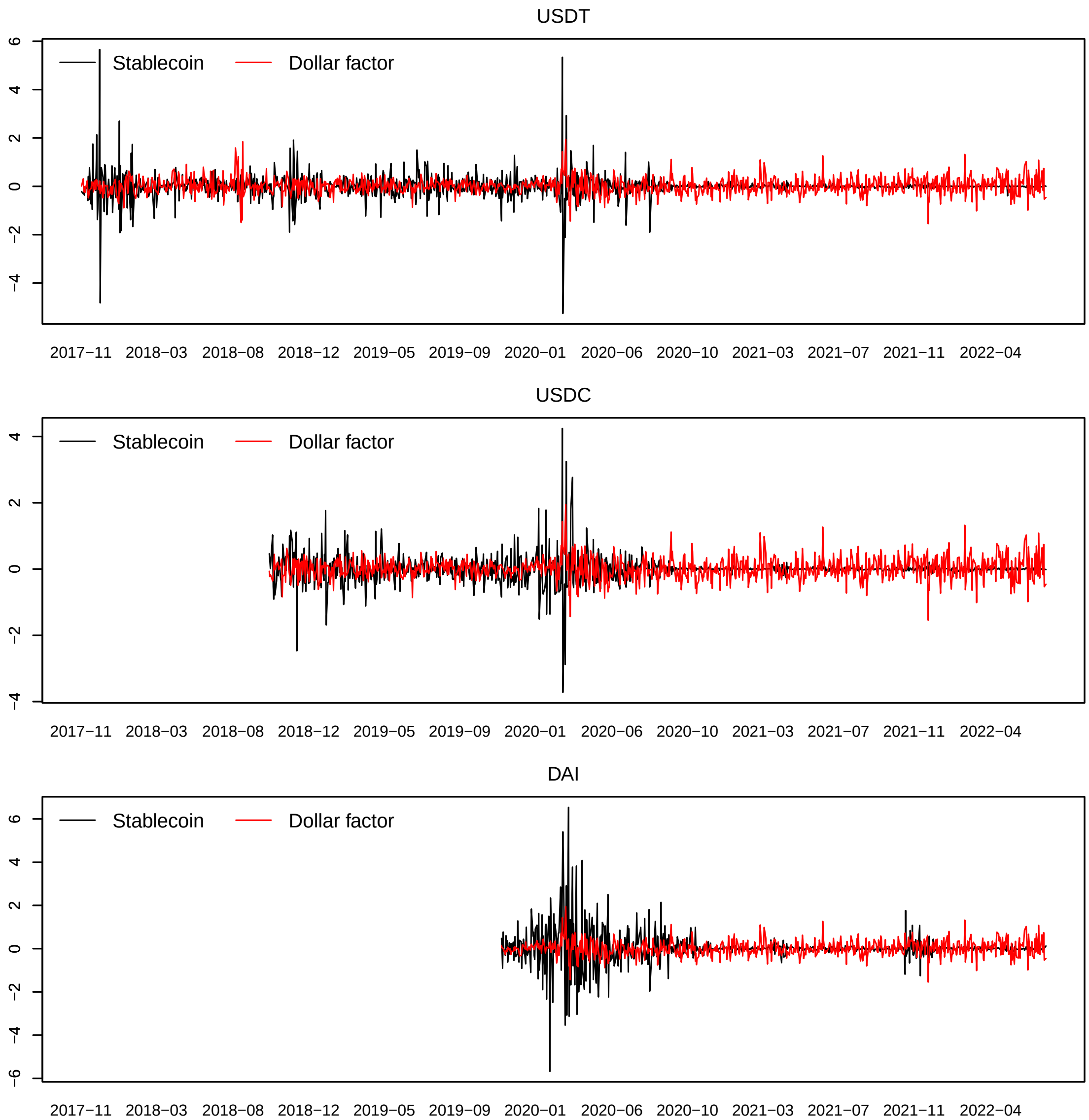

Figure 1. Daily Returns of Stablecoins

This figure displays daily returns on three stablecoins (USDT, USDC, DAI) against the dollar factor, computed as the cross-sectional average of the 22 currencies in our sample. Both stablecoins and the dollar factor are computed as log returns expressed as percentages. The stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

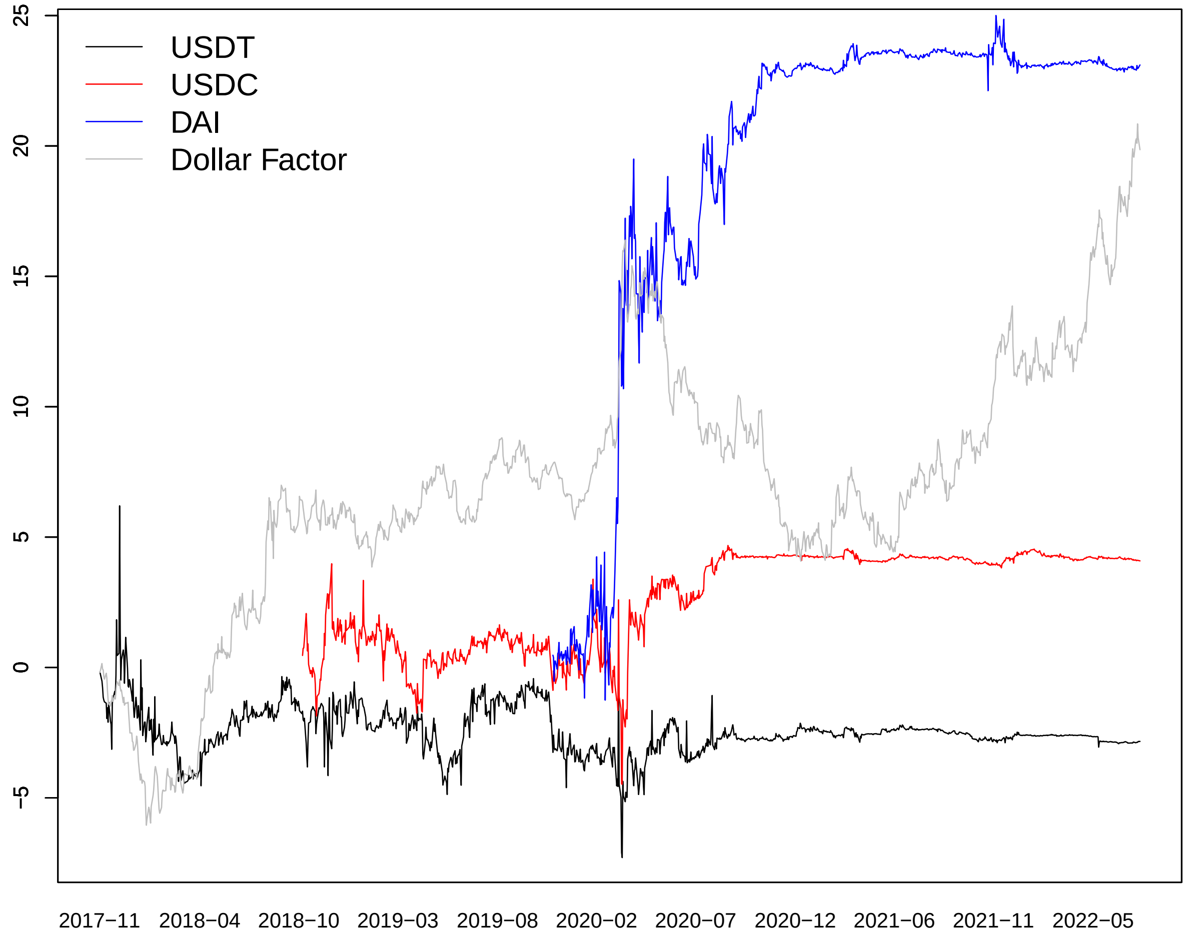

Figure 2. Cumulative Returns on Stablecoins and Dollar Factor

This figure displays cumulative returns on three stablecoins (USDT, USDC, DAI) and the dollar factor, computed as the cross-sectional average of the 22 currencies in our sample. Both stablecoins and the dollar factor are computed at daily frequency in the form of log returns expressed as percentages. The stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

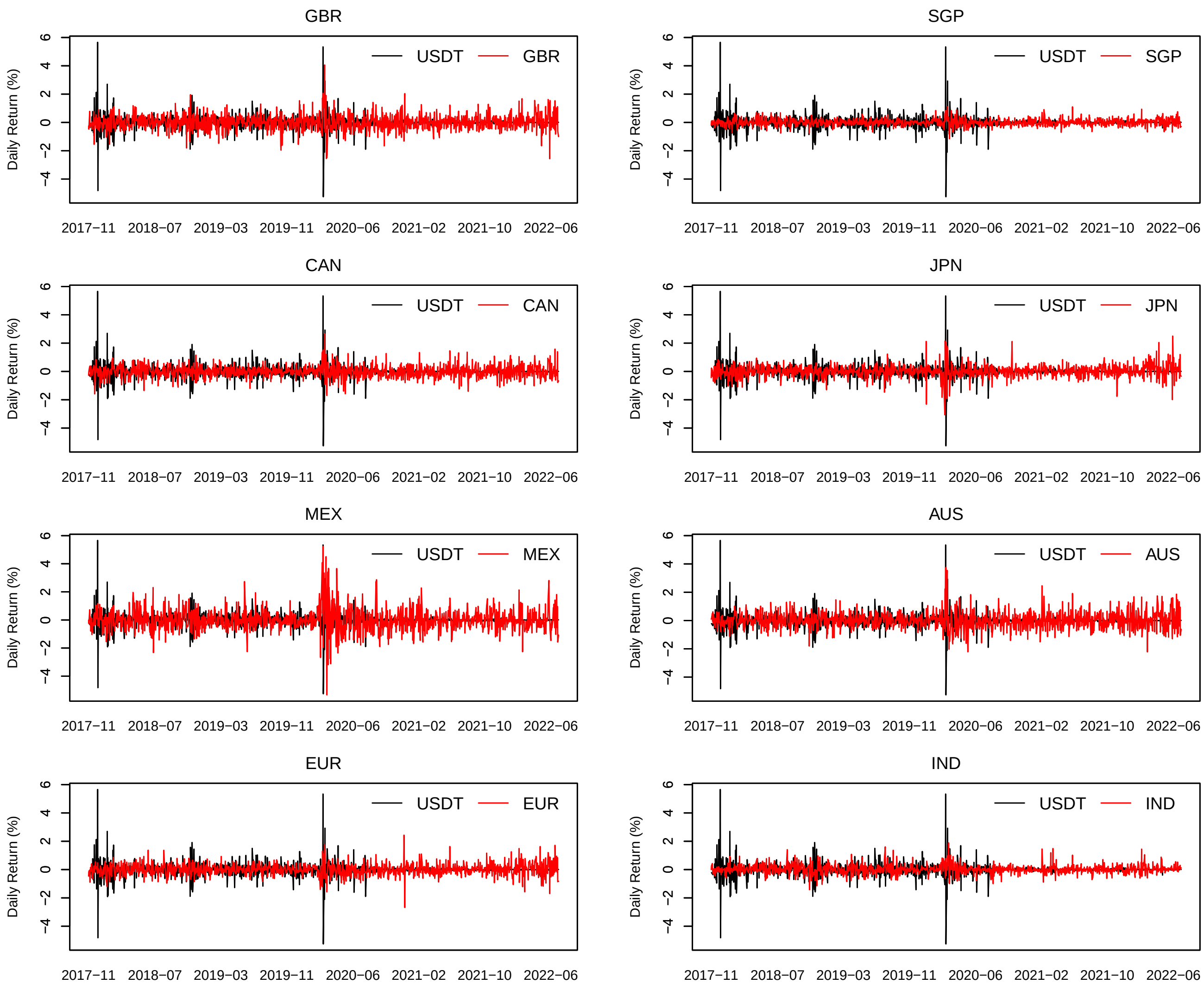

Figure 3. Stablecoins vs. U.S. Dollar-based Exchange Rates for Selected Countries

This figure displays daily returns on the stablecoin USDT against the U.S. dollar-based foreign exchange rates of eight selected countries, namely the United Kingdom (GBR), Singapore (SGP), Canada (CAN), Japan (JPN), Mexico (MEX), Australia (AUS), the Euro Area (EUR), and India (IND). The USDT stablecoin is represented by the black line while the foreign exchange rates are shown in red. Both USDT and the foreign exchange rates are computed as log returns expressed as percentages. Stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream.*

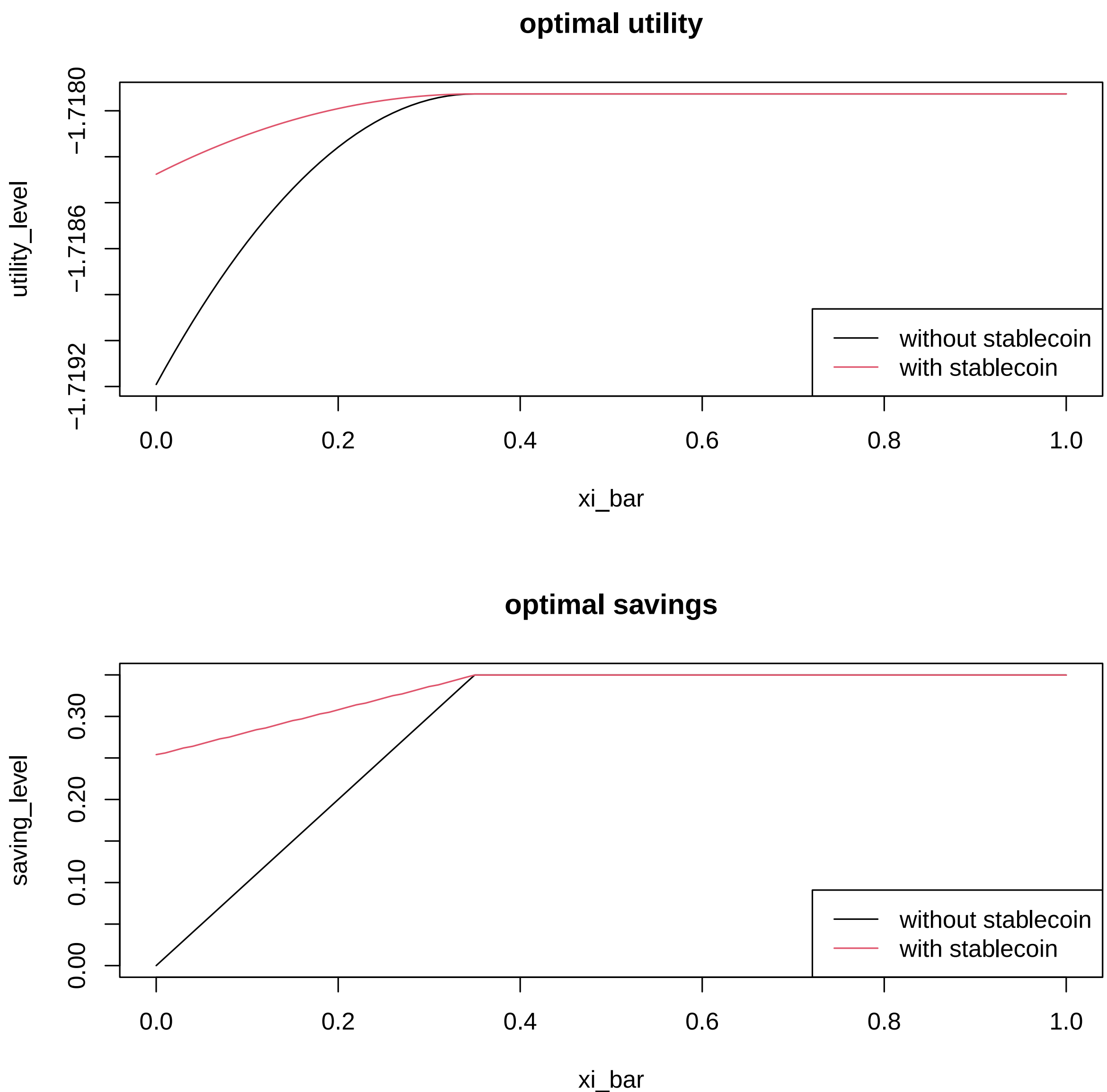

Figure 4. Model Implications

This figure illustrates the equilibrium results of the model. The calibration assumes the following parameter values: $e_0, e_1, P^f = 1$, $\beta = 0.9$, $R = 1.2$, $\gamma = 0.1$, and $\sigma = 1$. The black (red) solid line represents equilibrium without (with) the stablecoins traded in the markets.

Table 1. Summary Statistics

This table presents summary statistics for the stablecoin and foreign exchange rate data. Panel A reports three stablecoins, USDT, USDC, and DAI, while Panel B records a cross-section of 22 frequently traded developed and emerging currencies. The U.S. dollar factor in the last row of Panel B is defined as the cross-sectional average of the 22 currencies. 'Mean' refers to the average log returns of stablecoins and currencies, and 'Std' to the corresponding standard deviations. 'AR(1)' is the coefficient of the time-series autocorrelation. The sample consists of daily observations with the start date indicated in the last column 'From'; the end date is the same for all series, namely July 18$^{\text{th}}$, 2022. 'N' represents the number of observations. Stablecoin data are collected from Yahoo Finance and the foreign exchange rates are from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

		Mean	Std	AR(1)	N	From
Panel A: Stablecoins						
USDT		–0.58	7.93	–0.33	1222	11-10-2017
USDC		1.05	6.41	–0.24	985	10-9-2018
DAI		8.43	12.30	–0.32	691	11-25-2019
Panel B: U.S. dollar-based foreign exchange rates						
ARS	Argentina	41.04	17.98	0.03	1223	11-9-2017
AUD	Australia	2.40	9.56	0.06	1223	11-9-2017
BRL	Brazil	10.28	16.11	0.00	1223	11-9-2017
CAD	Canada	0.36	6.94	0.02	1223	11-9-2017
CHF	Switzerland	–0.50	6.72	0.02	1223	11-9-2017
CNY	China	0.34	4.04	–0.01	1223	11-9-2017
EUR	Euro area	2.70	6.80	0.04	1223	11-9-2017
GBP	United Kingdom	1.84	8.88	0.01	1223	11-9-2017
IDR	Indonesia	2.12	6.34	0.14	1223	11-9-2017
INR	India	4.28	5.19	–0.01	1223	11-9-2017
JPY	Japan	3.99	7.05	–0.04	1223	11-9-2017
KRW	Korea	3.43	7.31	–0.08	1223	11-9-2017
MXN	Mexico	1.37	12.89	0.03	1223	11-9-2017
NOK	Norway	4.31	12.10	0.04	1223	11-9-2017
NZD	New Zealand	2.37	9.77	–0.01	1223	11-9-2017
RUB	Russia	–0.47	27.95	0.04	1223	11-9-2017
SAR	Saudi Arabia	0.02	0.21	–0.16	1223	11-9-2017
SGD	Singapore	0.51	4.00	0.03	1223	11-9-2017
SEK	Sweden	4.35	9.51	0.04	1223	11-9-2017
THB	Thailand	2.07	5.08	0.12	1223	11-9-2017
TRY	Turkey	31.02	25.98	0.03	1223	11-9-2017
ZAR	South Africa	3.92	14.94	0.04	1223	11-9-2017
Dollar factor		5.53	5.50	0.13	1223	11-9-2017

Table 2. Correlation Matrix

This table presents the correlation matrix for the three stablecoins (USDT, USDC, and DAI) and the U.S. dollar factor (DF). The latter is defined as the cross-sectional average of the 22 currencies. Note that the data ranges for each stablecoin and DF are not always the same. Therefore, the correlation coefficient is obtained from the year after the last stablecoin DAI has generated observations. Stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

	USDT	USDC	DAI	DF
USDT	1			
USDC	0.787	1		
DAI	0.053	0.226	1	
DF	0.036	0.042	0.090	1

Table 3. Parameter Values for Model Calibration

This table presents the parameter values used in the model calibration.

Notation	Variable	Value
e_0	Endowment at period 0	1
e_1	Endowment at period 1	1
P^f	Price of the risk-free asset	1
β	Subjective discount facter	0.9
R, R^c	Expected asset returns	1.2
γ	Absolute risk aversion	0.1
σ	Return volatility for R^c	1

Table 4. Subsample Summary Statistics

This table presents summary statistics for three different subsamples of two-year observa- tions of the three stablecoins (USDT, USDC, and DAI) and the U.S. dollar factor. The latter is defined as the cross-sectional average of the 22 currencies. Panel A reports the results in each of the three subsamples while Panel B records the changes in summary statistics between two different subsamples. 'Mean' refers to the average log returns of stablecoins and currencies, 'Std' to the corresponding standard deviations. 'AR(1)' is the coefficient of the time-series autocorrelation. Stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

Panel A: Statistics of three subsamples									
	P1: 2017–2018			P2: 2019–2020			P3: 2021–2022		
Statistics	Mean	Std	AR(1)	Mean	Std	AR(1)	Mean	Std	AR(1)
USDT	−1.32	11.53	−0.34	−0.42	8.43	−0.32	−0.25	0.93	−0.32
USDC	7.68	9.46	−0.23	1.18	8.17	−0.24	−0.12	0.84	−0.32
DAI				20.07	18.66	−0.32	0.06	3.11	−0.47
Dollar factor	7.32	5.17	0.17	1.63	5.36	0.20	9.28	5.91	0.04

Panel B: Differences between two subsamples									
	P2-P1			P3-P2			P3-P1		
Statistics	Mean	Std	AR(1)	Mean	Std	AR(1)	Mean	Std	AR(1)
USDT	0.90	−3.10	0.03	0.17	−7.50	0.00	1.07	−10.60	0.03
USDC	−6.49	−1.29	−0.01	−1.30	−7.32	−0.08	−7.80	−8.61	−0.09
DAI				−20.01	−15.56	−0.15			
Dollar factor	−5.69	0.20	0.03	7.65	0.55	−0.17	1.96	0.74	−0.14

Table 5. Distributional Tests on Stablecoin and Foreign Exchange

This table presents the results of the two distributional tests on the returns on the three stablecoins (USDT, USDC and DAI), the 22 foreign exchange rates, and the U.S. dollar factor. The latter is defined as the cross-sectional average of the 22 currencies. Panel A reports the test results on the mean differences while Panels B and C record the test results on the variance ratio. 'diff.' is calculated as the difference between a stablecoin and the dollar factor. 'Std. Err.' is the corresponding standard error. 'sd(·)' represents the standard deviation. For each panel, we report the p-values of the two different alternative hypotheses 'H_a' which share the same the null hypothesis 'H_0'. Stablecoin data are collected from *Yahoo Finance* and the foreign exchange rates are from *Datastream*.

	Mean (diff.)	Std. Err. (diff.)	t-stat	H_0: Mean = 0 H_a: Mean < 0	H_a: Mean ≠ 0
Stablecoin	Panel A: diff. = Stablecoin - dollar factor				
USDT	−6.142	4.322	−1.421	0.078	0.156
USDC	−3.375	4.220	−0.800	0.212	0.424
DAI	3.075	7.974	0.386	0.650	0.700
	Std. Err. (Stablecoin)	**Std. Err. (Currency)**	**f-stat**	**H_0: ratio = 1 H_a: ratio ≠ 1**	**H_a: ratio > 1**
Stablecoin	Panel B: ratio = sd(stablecoin) / sd(dollar factor)				
USDT	3.60	2.50	2.08	0.00	0.00
USDC	3.24		1.36	0.00	0.00
DAI	7.43		5.00	0.00	0.00
Currency	Panel C: ratio = sd(USDT) / sd(Currency)				
ARS		8.16	0.19	0.00	1.00
AUD		4.34	0.69	0.00	1.00
BRL		7.31	0.24	0.00	1.00
CAD		3.15	1.30	0.00	0.00
CHF		3.05	1.39	0.00	0.00
CHN		1.83	3.85	0.00	0.00
EUR		3.09	1.36	0.00	0.00
GBP		4.03	0.80	0.00	0.00
IDR		2.88	1.57	0.00	0.00
INR		2.36	2.33	0.00	0.00
JPY		3.20	1.26	0.00	0.00
KRW		3.32	1.18	0.00	0.00
MXN		5.85	0.38	0.00	1.00
NOK		5.49	0.43	0.00	1.00
NZD		4.43	0.66	0.00	1.00
RUB		12.69	0.08	0.00	1.00
SAR		0.09	1500.00	0.00	0.00
SGD		1.82	3.93	0.00	0.00
SEK		4.31	0.70	0.00	1.00
THB		2.31	2.43	0.00	0.00
TRY		11.79	0.09	0.00	1.00
ZAR		6.78	0.28	0.00	1.00