Digital Economy and the Global Financial System*

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Abstract

The growth of the Digital Economy could have important implications for international financial markets, including the centrality of traditional reserve assets such as the US dollar. On the one hand, the creation of digital assets, especially Stablecoins, could increase the demand for traditional reserve assets. On the other, digital assets could serve as a substitute for traditional reserve assets, reducing their global demand. We find that, in the long-run, the increase in the demand for reserve assets dominates the substitution of traditional reserve assets. This would lead to lower US interest rates and larger US foreign borrowing. We also find that the expansion of the Digital Economy would result in higher idiosyncratic consumption volatility in the US US but lower volatility in the rest of the world.

Keywords: Digital assets, Stablecoins, US interest rate, consumption insurance.

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1 Introduction

The US government debt plays a unique role in global financial markets, acting as a reliable store of value, in addition to its liquidity role or more generally as a provider of convenience services. This translates into lower interest rates paid by T-bills and other dollar-denominated assets. In this paper we ask how the possible growth of the Digital Economy could affect the centrality of the US debt in global financial markets. Our goal is not to explore the role of digital assets as a *means of payment* but as *store of value*—that is, as financial instruments used for the allocation of savings.

The extreme volatility of digital assets, such as cryptocurrencies, is a major impediment to substitute safe assets denominated in dollars or other popular reserve currencies. However, the extreme volatility of digital assets does not apply to Stablecoins. Stablecoins are a special type of cryptocurrencies designed to reduce (or even eliminate) fluctuations in their value relatively to other safe instruments such as dollar-denominated assets. Effectively, they are currencies pegged to the US dollar or other reserve currencies.

Figure 1 plots the market capitalization of the most popular Stablecoins, all pegged to the US dollar. Their total market value at the beginning of 2024 exceeded 100 billion dollars, a substantial figure relative to the total market capitalization of all cryptocurrencies, which was around 2.5 trillion dollars. Still, the market capitalization of cryptocurrencies is relatively small compared to US treasuries, worth about 27 trillion dollars. However, the market for digital assets is still in its infancy and could grow significantly in the future.

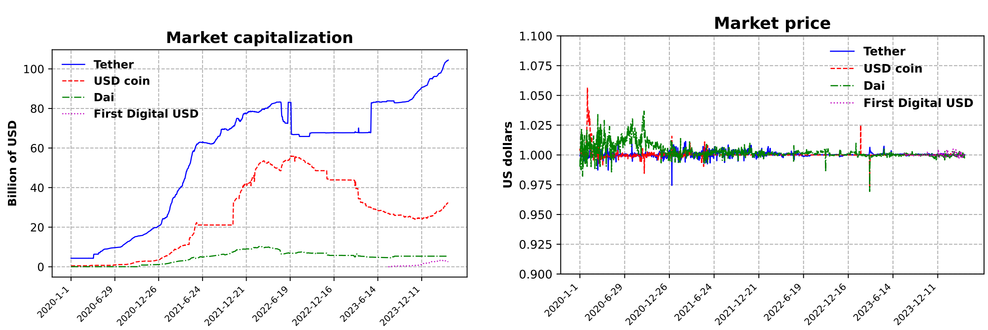

Figure 1: Market capitalization and price for major Stablecoins. *Sources*: coincodex.com

An important feature of Stablecoins is that their prices (should) remain stable around the targeted peg of 1 US dollar (if the dollar is the pegging asset). Although there have been well-known cases of implosion—among them the case of the Terra stablecoin that collapsed in May 2022—the second panel of Figure 1 shows that the prices of the most popular Stablecoins have remained stable.[1]

To understand the potential role of Stablecoins for international financial markets, consider the investment choices of savers in countries where the dollar plays an important role as a store of value, including developing and emerging countries. In some of these countries, savers face financial barriers to holding US safe assets in the form of high transaction costs. Some of these costs could be related to capital controls. However, capital controls are not the only reason for the high transaction costs. Market imperfections, such as those related to the market power of financial intermediaries or limited access to standard technology, could be much more important and pervasive. The same factors also affect the market return earned on dollar-denominated assets after their acquisition. The technological advances of decentralized digital markets could allow these savers to acquire and trade dollar-pegged Stablecoins with lower transaction costs and higher returns than traditional dollar-denominated assets.

There is another reason why Stablecoins could be attractive for savers. Some of the most popular dollar assets held outside the United States are US government bonds. These bonds pay lower yields because they provide convenience services. But for certain savers around the world, the convenience service provided by US treasuries could be lower than for US savers. For example, foreign savers may engage less in refinancing facilities where treasuries are used as collateral. Still, despite the lower yield and convenience service, these savers choose to hold US government bonds as a store of value. Arguably, this is the result of limited supply of alternative saving instruments. Stablecoins could then provide an alternative saving vehicle that, as a store of value, is similar to US government bonds but could provide a higher return (net of the transaction costs) to savers.

The same consideration applies to monetary authorities around the world.

[1] The fact that the digital market has so far displayed significant turbulence with the creation of many competing Stablecoins, some of which have already failed and others are probably going to fail in the future, is a typical feature of a new industry. It is common for new industries to be very turbulent initially but, eventually, they consolidate with a few dominant survivals. This is likely to be the pattern also for the new emerging Digital Economy.

Central banks hold large volumes of reserves, a large fraction of which in US dollar-denominated assets. And they do that despite their low return. Stablecoins could provide a more attractive, higher-return alternative to US dollar reserves. The incentive for some of these institutions to hold Stablecoins, rather than US treasuries, could be further enhanced by geopolitical tensions.

Of course, for Stablecoins to become an attractive alternative to traditional dollar-denominated assets, the peg must be credible. This can be achieved when Stablecoins are fully backed by safe dollar assets. In this case, the ownership of Stablecoins is effectively equivalent to the ownership of dollars. Still, due to its digital nature, Stablecoins could be more easily accessible than traditional dollar-denominated assets, either because the transaction costs are lower or they provide higher market returns. This implies that the diffusion of Stablecoins could boost the demand for dollar-denominated assets as more dollars reserves are needed to back up the Stablecoins.

Stablecoins, however, can also be backed by other assets, including digital assets such as cryptocurrencies. In this case, Stablecoins can truly function as substitutes for US dollars, and they could possibly diminish the privileged position of the dollar in global financial markets. So, ultimately, whether the growth of Stablecoins strengthens or weakens the demand for dollar or other reserve assets depends on the prevalence of the backing instruments: if the peg is prevalently guaranteed by dollar reserves, the demand for dollars increases; if the peg is guaranteed by other digital assets, the demand for dollars decreases. But what determines the prevalence of one type of backing assets over the other?

To understand the various forces at play, we develop a multi-country model that is representative of three countries/regions (i) the US economy, (ii) the rest of the world (RoW), and (iii) the 'Digital Economy' (DiEco). The US and RoW are traditional economies that produce physical goods and services. DiEco can be thought as a separate economy which, however, is not defined by geographical borders as traditional national economies. What defines the Digital Economy is the particular technology used to produce and trade services and financial assets. Conceptually, the Digital Economy functions as a standard national economy with its own currency, its own production system, and its own regulatory framework.

For the Digital Economy to have a relevant role in the world economy, it must be sizable. Although the size of DiEco is still small compared to the traditional economy, its growth potential is significant. We will use the model to predict the implications of its potential growth. Although the digital growth could be driven by many factors, we focus on one specific factor: the extent to which agents in the traditional economy become familiar and comfortable transacting and doing business with the Digital Economy. We formalize this process through a mechanism that is similar to the epidemic SIR model, that is, more agents become accustomed to (being infected by) the Digital Economy as the number of agents already interacting with the Digital Economy (already infected) increases.

As more agents become accustomed to the Digital Economy, they will consider adding digital assets in their saving portfolio. This increases the demand for digital assets—a consequence of the digital diffusion we refer to as the 'financial demand' channel. At the same time, agents might also consider purchasing certain services, such as financial intermediation services, that are produced in the Digital Economy rather than in the traditional economy. This increases the demand for digital production—a consequence of the digital diffusion we refer to as the 'real demand' channel.

Through the 'financial demand' channel, the expansion of the Digital Economy induces lower US interest rates and larger global imbalances, that is, higher US foreign borrowing. The 'real demand' channel, instead, leads to higher US interest rates and lower US foreign borrowing. In both cases, however, the supply of Stablecoins increases, but the implication for financial risk-taking differs. While the 'financial demand' channel induces riskier financial portfolios in the US and in the rest of the world (they contain a larger share of risky assets), the 'real demand' channel leads to safer portfolios (they contain a lower share of risky assets). The quantitative simulation of the model shows that the 'financial demand' channel dominates the 'real demand' channel in the long-run. As a result, the long-run US interest rate declines while global imbalances rise. The quantitative exercise also shows that the growth of the Digital Economy will be associated with greater idiosyncratic consumption volatility in the US but lower idiosyncratic consumption volatility in the Rest of the World.

1.1 Literature review

In many contributions to the literature, the fundamental value of crypto derives from its use as a medium of exchange as in Schilling and Uhlig (2018). The transactional service is also central to the model developed by Athey et al. (2016), which highlights the use of Bitcoins for remittances. Biais et al. (2023) emphasize the transactional value of cryptocurrencies that derives from facilitating cross-border transfers in regions with capital controls or unreliable banking systems compared to traditional money. Empirical evidence of the latter is provided by von Luckner et al. (2023), who document the use of crypto to move capital across borders and exchange one fiat currency for another.

In our model, the value of crypto derives from being an input of production. Crypto also acts, indirectly, as a collateral for the issuance of Stablecoins, that is, fixed income liabilities issued by the owners of non-stable cryptocurrencies. For the buyer, Stablecoins are safe assets, which emphasize their importance as store of value (as opposed to means of payment).

There is a growing scholarly interest in Stablecoins. Existing studies cover a range of topics going from the comparison of Stablecoins to traditional financial market instruments to characterizing their arbitrage role within the wider crypto market. For example, Eichengreen (2019) describes the key properties of Stablecoins, while Makarov and Schoar (2022) and Lyons and Viswanath-Natraj (2023) analyze their arbitrage dynamics. There is also a body of theoretical contributions that analyze the possibility of speculative risks such as Cong et al. (2022) and Routledge and Zetlin-Jones (2022). Gorton et al. (2022) addresses how Stablecoins achieve relative price stability and a consistent \$1 value despite the potential for runs. See also Carapella et al. (2022) and Azar et al. (2022) for a descriptive analysis of financial stability in the broader market for digital assets. Although runs are indeed real possibilities, for simplicity we abstract from speculative attacks in our model and assume that Stablecoins are risk-free assets.

Another important branch of related literature studies the implications of central bank digital currency (CBDC).[2] Economically, CBDC is still fiat money regulated by a centralized institution (the central bank) and Stablecoins are additional to CBDC. As a reserve asset that backs up Stablecoins, the digital currency issued by the US central bank will play the same role as more traditional dollar-denominated safe assets.

Jermann (2023) develops a macro-finance model for the supply of digital money that formalizes some of the most salient features of the Ethereum

[2]Examples include Auer et al. (2022), Andolfatto (2021), Barrdear and Kumhof (2022), Böser and Gersbach (2020), Brunnermeier and Niepelt (2019), Chiu et al. (2019), Davoodalhosseini (2022), Fernández-Villaverde et al. (2021), Garratt and Van Oordt (2021), Keister and Sanches (2023), Niepelt (2020), Paul et al. (2024), Whited et al. (2022).

blockchain. We share the view, formalized in the model, that the Digital Economy represents a distinct ecosystem with his own currency. Our paper integrates the Digital Economy in a more general Non-digital Economy and we study broader implications that go beyond money supply and crypto valuation.

While most of the contributions in the literature have studied the digital market in closed economies, recent research have used two-country models, which is also our approach. For instance, Benigno et al. (2022) explores the competition between interest-bearing bonds and money as a store of value, a phenomenon termed 'cryptoization' (see IMF (2021)). Their primary interest is to understand how Stablecoins impact monetary policies in individual countries. Le et al. (2023) introduces a New Keynesian model to assess how Stablecoins issued abroad influence the monetary policy of a smaller, developing economy. The findings indicate that Stablecoins not only improve liquidity and offer a hedge against inflation for local users but also encourage currency substitution, leading to "digital dollarization" (see Brunnermeier et al. (2019)). This trend disrupts banking intermediation and diminishes the effectiveness of domestic monetary policy, intensifying the adverse effects of economic downturns and heightening risks within the banking sector. Ferrari-Minesso et al. (2022) consider a two-country DSGE model where central bank digital currencies increase international linkages and amplify international spillovers shocks.

The goal of our paper is not to understand the role of the Digital Economy for monetary policy. Instead, we are interested in understanding the transitional and long-run implications of a rising Digital Economy as provider of digital services and new saving instruments. As a provider of new saving instruments, our paper is also related to the literature that emphasizes the shortage of assets as store of value. We see the expansion of the Digital Economy, and Stablecoins in particular, as a mechanism that could reduce the shortage of saving instruments, with different implications across countries.

2 Overview of Digital Economy

We provide a brief overview of how the Digital Economy operates and how Stablecoins are created. This important to motivate some of the modeling choices made in the construction of the theoretical framework. It is useful to start with a quick description of a 'blockchain' since this is the technology underlying the operation of the Digital Economy.

2.1 Blockchains and digital production

A blockchain is a decentralized public ledger (database) that is concurrently maintained across multiple networked computers. It stores data in sequential units called 'blocks.' Any valid transaction, for example, the transfer of cryptocurrency from one user's account to another, is included in a block. A newly formed block containing a certain number of transactions will be added to previous blocks sequentially (forming a chain) in a way that is secure and immutable. It is the addition of the newly formed block to the existing chain that makes the included transactions definitive and unchangeable.

Computers actively linked to the network, called 'nodes', are in competition to validate and add a new block of transactions in return for a reward (compensation). The provision of validation services, however, is also costly. Both costs and rewards depend on the particular protocol—that is, the rules—used by the specific blockchain to select the node eligible to add a block to the chain. The most common protocols are Proof-of-Work (PoW) and Proof-of-Stake (PoS). Before a new block can be added to the chain, the network must reach a consensus that the selected node is legitimately chosen and the transactions included in the proposed block are valid.

The two largest and well known blockchains are Bitcoin and Ethereum. Bitcoin blockchain was launched in 2009 and was designed primarily as a system that governs its own cryptocurrency, BTC. The Ethereum blockchain was created in 2015 with a broader scope that goes beyond the governance of its native cryptocurrency, ETH (Ether). It has the ability to host decentralized applications (dApps) capable of providing a variety of services with the validation and execution of smart contracts.

Digital production. An important point to keep in mind is that DiEco is a production economy and often referred to as 'ecosystem'. It resembles a traditional economy in the sense of using production inputs—labor and capital—to produce services traded in the marketplace. An example is the provision matching services for the short-term lease of an apartment. This is done through decentralized applications (dApps) governed by smart contracts, and they play a similar role as traditional real estate agents. Once a match arises, the lease is executed by transferring a digital key that allows the lessee to enter the apartment, and by transferring Crypto (one of the official currencies of the ecosystem) from the account of the lessee to the account of the lessor. Production inputs are needed to execute these operations and the associated fees paid to execute these transactions provide a way to quantify the value of these services.

Differently from traditional economies, physical location is irrelevant because services are produced digitally. Hence, our reference to the 'Digital Economy'. The absence of national borders implies that there is no central government dictating the rules of the game. Governments, of course, can impose restrictions on the participation of their own citizens. However, the market cannot be fully regulated unless all countries in the world coordinate their policies.

The size of the Digital Economy is important for determining the impact on the (traditional) world economy. It would be useful, then, to have some estimates of the economic size of the Digital Economy. For this purpose, we focus on the Ethereum network because of its broader functionality: it is not limited to a pure payment system (like Bitcoin) but it provides a platform for executing a multitude of transactions. The Ethereum ecosystem has the ability to host decentralized applications (dApps) that can provide (that is, produce) a multitude of services to users with self-executing contractual agreements as in the above example of a short-term lease. Since all transactions executed in the network are recorded in the blockchain, it is possible to come up with a measure of production by aggregating the overall amount of fees paid to validate and execute transactions.

The first panel of Figure 2 plots the monthly transaction fees paid by users for the validation and execution of their transactions. It is important to point out that this is only a partial measure of production because the validation fees do not include the more direct fees that are paid for the provision of services associated with the transaction. For example, if a user exchanges Tethers for Bitcoins in a DEX (decentralized exchange), the user pays directly (or indirectly) a fee to the DEX similar to the fee that we would pay to exchange Dollars for Euros in a bank. In the traditional economy, that fee contributes to the value added of the banks and, by the same token, the fee paid to the DEX contributes to the value added created by the Digital Economy. In addition to this direct fee, the user pays the network fees for the validation of the transaction. The data plotted in Figure 2 includes only the validation fees, not the direct fees.

In 2023, the total amount of fees amounted to 2.4 billion dollars, which

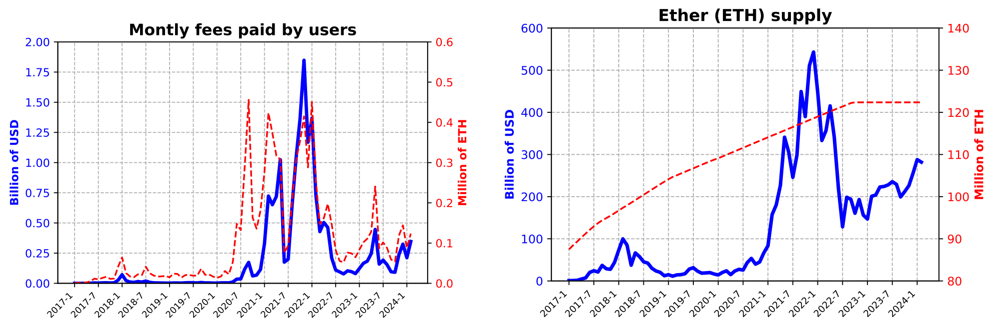

Figure 2: Ethereum monthly transaction fees paid by users (left) and Ether supply (right). *Sources*: Authors' computation using data from Etherscan.

is about 0.0023% the value of world GDP. When compared to the size of the world economy, our measure of Ethereum production is not very big. However, Ethereum is only one of the blockchains active in the Digital Economy. Furthermore, many transactions and their corresponding fees take place off-chain and are not included in our calculation. Finally, already observed, our measure of Ethereum's production does not include the direct fees paid by users to the decentralized application.

The total stock of the Ethereum native cryptocurrency, Ether, is shown in the second panel of Figure 2. In 2023, it exceeded 400 billion dollars, corresponding to about 15% of the market capitalization of all cryptocurrencies. Again, compared to the total supply of US treasuries, it may not seem like a very big number, but it is not negligible.

Although the current size of the Digital Economy appears relatively small compared to the world economy, it is still at its infancy and could grow substantially in the future. The goal of this paper is to understand the global implications of a possible digital growth.

Crypto as a production input. In September 2022, Ethereum changed the validation protocol from Proof-of-Work (PoW) to Proof-of-Stake (PoS). With the new validation system, validators earn fees upon verification of the validity and authenticity of the transactions based on the wealth they can lock in the system (staking). Validators that lock more wealth—either because they own it directly or it was delegated to them—earn more fees paid by users. Since the wealth used to earn validation fees must be in ETH, the Etherium native currency is essentially an input of production for validation services.[3]

Figure 3 plots some variables related to staking in the Ethereum blockchain. The first panel shows the quantity of ETH locked in by validators. The series start in October 2022, after the change of the validation system from PoW to PoS. The amount of staked ETH has increased significantly since then, both in units of ETH (red dashed line) and in dollar value (solid blue line). Even though the supply of ETH grew over this period (recall Figure 2), the amount of staked ETH grew even faster, as we can see from the left panel of Figure 3. In march 2024, 33% of the total ETH supply was locked for validation purposes.

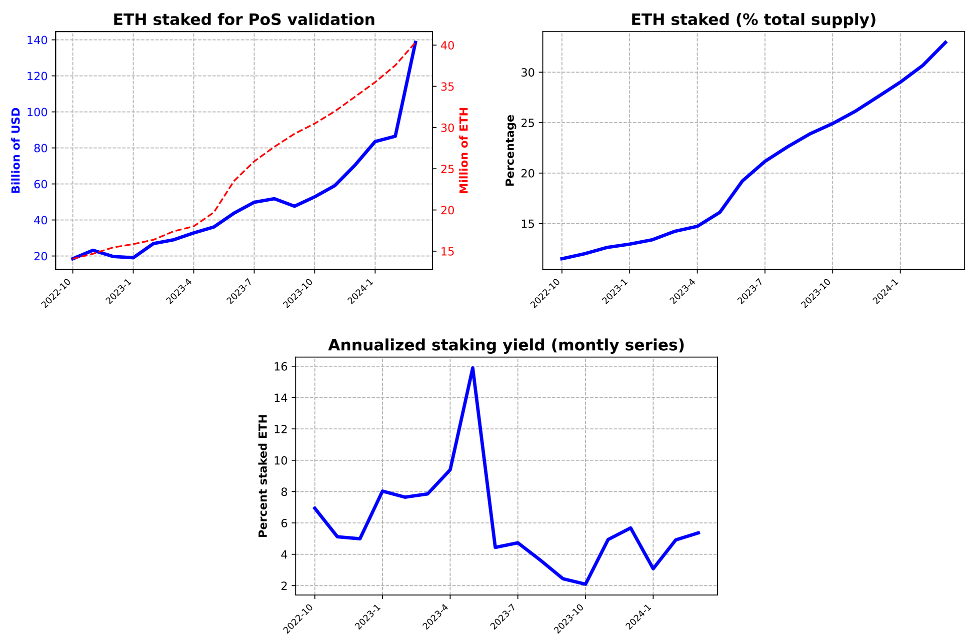

Figure 3: Ethereum staking and yield. *Sources*: Authors' computation using data from Etherscan.

[3]Validators are entrepreneurs or more generally businesses that use labor, physical capital (computers) and financial capital (staked ETH) to produce validation services. With the Proof-of-Stake, the importance of financial capital has become the most important input. In return for their services, validators earn fees paid by users and, in some cases, they receive newly created ETH.

The last panel shows the staking yield. This is calculated as the ratio of dollar fees paid by Ethereum users to validators and the dollar value of staked ETH. The graph plots the monthly series where the fees are the sum of all fees paid during the month and the staked ETH are measured at the beginning of the month. The monthly yield, denoted by y_m, is annualized using the compounding formula $(1 + y_m)^{12} - 1$.

The yield displays a great deal of variation, but on average is close to 5% annually. There are also direct costs that validators incur such as the user cost of computers. However, after the shift to the PoS protocol, these costs have dropped dramatically. So we can interpret the yield as a proxy for the marginal product of ETH in the production of validation services.

It is important to emphasize that our measure of yield does not include capital gains which, of course, could be very important in determining the effective return of ETH. The measure of yield is close to the inverse of the price-earning ratio, commonly used to assess the valuation of a corporation.

To sum up. Based on this brief overview, it should be clear that (i) the Ethereum network is a production economy and (ii) its native cryptocurrency, Ether, is a form of financial capital that enters as an input of the production function (in addition to be a unit of account, a means of payment, and a store of value in the Ethereum ecosystem). This will be important for motivating the particular design of the theoretical model.

2.2 Creation of Stablecoins

Stablecoins are liabilities issued by some entities with their value pegged to an underlying asset. We focus on Stablecoins pegged to the US dollar. This implies that one unit of a Stablecoin should always be redeemable for one dollar. To insure redeemability, the issuer must hold reserve assets whose value is at least the value of the issued Stablecoins.

At the cost of oversimplifying, we outline two mechanisms that would guarantee redeemability. In the first mechanism, the pegged value is maintained by holding the same quantity of dollar reserves as the number of Stablecoins. In the second, Stablecoins are over-collateralized with crypto assets. Because the dollar value of Crypto is not constant, the over-collateralization guarantees that the value of reserves does not fall below the pegged value of Stablecoins. Although there are other mechanisms such as the arbitrage algorithm used for Terra, the two described here are the most common.

Backed with dollar reserves. In this case, Stablecoins are created by keeping the same or similar amount of dollars in a locked account. The balance sheet of the issuer is illustrated in Figure 4. On the left-hand-side there are dollar-denominated assets; on the right-hand-side there is the same dollar value of Stablecoins which, for the issuer, are liabilities. The issuer can transfer the Stablecoins to other users. Whoever receives the Stablecoins can redeem them for dollars at any time. Until the Stablecoins are redeemed (burned), the dollar assets remain locked and cannot be withdrawn for alternative uses.

ASSETS	**LIABILITIES**
Dollar assets	Stablecoins

Figure 4: Balance-sheet when stablecoins are backed one-to-one with dollars.

This is the mechanism underlying two of the most popular Stablecoins in terms of volume: Tether and USDC. Provided that the mechanism is enforced—that is, the dollar deposits are not withdrawn for alternative uses and the reserves are kept in safe dollar assets—the value of Stablecoins should always be 1 dollar.

Being safe, dollar-denominated assets earn low returns. Assets that pay higher returns could be more attractive, but they would endanger the stability of the peg: capital losses could deplete the value of the reserves below the pegged value of the issued Stablecoins.[4]

Backed with Crypto assets. An alternative mechanism to create Stablecoins is by holding reserves in Crypto assets. In this case, the issuer faces a balance-sheet mismatch where the denomination of assets differs from the denomination of its liabilities. Because the market value of Crypto fluctuates significantly over time, Stablecoins must be over-collateralized. Thus, for each Stablecoin, the issuer holds Crypto for a value that exceeds 1 dollar. The balance sheet of the issuer is shown in Figure 5. Since the value of assets is greater than the value of liabilities (Stablecoins), the difference represents the equity owned by the issuer.

[4]Reports in the media have questioned the safety of Tether's reserves, something that is difficult to fully verify given the limited disclosure requirements for crypto operators. Until now, however, Tether has remained stable as shown by Figure 1.

ASSETS	LIABILITIES
Crypto assets	Stablecoins
	Equity

Figure 5: Balance-sheet when Stablecoins are over-collateralized with Crypto.

The decentralized application MakerDao is an example Stablecoins backed by over-collaterilized Crypto reserves. Anyone with a digital portfolio linked to MakerDao can create units of a Stablecoin called DAI. The user deposits an amount of digital coins such as ETH and then borrows an amount of DAI up to a pre-specified fraction of the market value of deposit. For example, if the deposited value of ETHs is worth 300 dollars, the DAI debt may not exceed 100 dollars. Over time, if the market price of an ETH declines, the user needs to repay some of the debt or deposit additional ETHs. Failing to do so triggers forced liquidations.

To sum up. There are two main mechanisms that allow the creation of Stablecoins: (i) One-to-one backing with dollar-denominated assets; (ii) Over-collateralization with Crypto. Both mechanisms will be embedded in the theoretical model we will describe in the next section. Before doing so, however, we would like to emphasize that, while the mechanism based on dollar reserves does not involve a significant risk for the issuer, the mechanism based on Crypto backing carries significant risks. The Stablecoin issuer takes a risky leveraged position. Whoever acquires the newly created Stablecoins, instead, holds a safe asset. Thus, the issuer of Stablecoins provides insurance to the Stablecoins' holders by taking more risk itself. This is an important feature of our theoretical model.[5]

[5]It is worth noting that the issuance of Stablecoins is similar to bank intermediation where banks issues assets and liabilities that are not perfectly matched in terms of risk. An important difference, however, is that traditional banks are subject to extensive regulation that does not apply to the issuers of Stablecoins. This raises an important concern for the stability of the whole system.

3 Model

There are three countries/regions in the model: The United States (US), the Rest of the World (RoW), and the Digital Economy (DiEco). As discussed earlier, we think of the Digital Economy as a distinct economy with its own currency. What defines the Digital Economy, however, are not the geographical borders but the technological platform at the basis of its operations—the blockchain. In some sense, the blockchain plays the role that the geographical territory plays in defining a national economy.

3.1 Digital economy

The Digital Economy is populated by a continuum of agents that maximize the expected lifetime utility from consumption

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln(c_t).$$

The population of DiEco consists of agents whose primary economic interest is in the Digital Economy. The variable c_t is a consumption basket that aggregates two types of goods or services, $c_{D,t}$ and $c_{N,t}$ according to

$$c_t = c_{D,t}^{\alpha} c_{N,t}^{1-\alpha}.$$

Goods $c_{N,t}$ are produced only in the Non-digital economy (US and RoW), while goods $c_{D,t}$ are produced in both the Digital and Non-digital economies. The idea is that certain goods and services, such as automobiles and haircuts, can be produced only in the Non-digital economy. However, there are services that can be produced also digitally in DiEco, in alternative to those produced in the traditional economy. For example, financial intermediation services could be provided by decentralized applications in alternative to traditional banks. From now on, we will use the term 'goods' to indicate both goods and services.

Although D-goods produced in the digital economy are perfectly substitutable to D-goods produced in the traditional economy, their relative price could be different from 1. As we will describe below, this follows from a market segmentation in which agents may not have access to all markets.

Throughout the paper we will use the N-good as numeraire and denote by e_t the relative price of D-goods produced in DiEco (real exchange rate).

DiEco's agents consume both D-goods and N-goods. Since N-goods are not produced in the Digital Economy, DiEco's agents must import them from the traditional economy, while they can export part of the produced D-goods. The cost of the consumption basket in units of N-goods is $m_t = e_t c_{D,t} + c_{N,t}$.

The first order conditions for the optimal choice of the two goods return

$$\frac{c_{N,t}}{c_{D,t}} = \left(\frac{1-\alpha}{\alpha}\right) e_t.$$

Thus, DiEco's agents allocate a constant share α of consumption expenditures to D-goods, that is, $e_t c_{D,t} = \alpha m_t$.

There is a fixed stock K of Crypto, traded only by the residents of DiEco at price p_t. In reality, Cryptocurrencies are reproducible. However, this is not important for the particular question addressed in this paper. What matters is the total market value of Crypto, not its physical quantity. A higher supply would be reflected in a lower market price of Crypto, keeping its total value unchanged.

DiEco's production: DiEco produces only D-goods. Production takes place through the validation of digital transactions where Crypto is a staking input. With the PoS protocol, staking is effectively a working capital constraint: to provide x_t units of validation services, validators must satisfy the constraint

$$x_t \leq \omega p_t k_t.$$

The left-hand-side is the services produced by validators. The right-hand-side is the capacity constraint determined by the financial wealth staked by DiEco's agents (the quantity of Crypto multiplied by its price). The staked wealth is scaled by the parameter ω.[6]

The actual revenue earned by an individual agent is subject to an exogenous idiosyncratic shock z_t. The idiosyncratic shock could capture, among other things, the fact that the revenues from staking are uncertain: two validators that stake the same value of Crypto could receive different rewards. Thus, the revenue earned by an individual agent is $z_t e_t x_t$, where e_t is the market price for one unit of x_t (in units of N-goods) and z_t is the idiosyncratic

[6] Not all Cryptocurrencies are staked to produce validation services. Another use of Cryptocurrencies is for transaction purposes within the Digital Economy. For example, to pay for the digital services provided by a dApp, agents need Ether. This is similar to a cash-in-advance constraint.

shock. The aggregation over all agents, however, washes out the idiosyncratic shock which in aggregate is always equal to 1.

The model described so far features a close link between the price of services produced by the Digital Economy, e_t, and the price of Crypto, p_t. As the demand for D-goods produced in DiEco rises, the price e_t increases, which in turn raises the rewards from staking. This makes Crypto more valuable, increasing its price p_t. The demand for D-goods produced by DiEco comes in part from DiEco's residents, and in part from residents of the Non-digital economy, US and RoW, as we will describe below.

Stablecoins and financial markets: In addition to holding Crypto and using it in production, DiEco's residents can issue digital liabilities s_t. Each unit of liabilities is sold at price $1/R_t^S$ and pays back 1 unit in the next period. Price and repayment are both denominated in units of the numeraire (N-goods). Since the repayment is fixed in units of the numeraire, the value of the liabilities is stable and we refer to s_t are Stablecoins.[7] Differently from Crypto, Stablecoins can also be sold to residents of the Non-digital economy—US and RoW.

DiEco's residents can also hold foreign bonds, that is, liabilities issued by the US or RoW. However, without loss of generality, we focus on DiEco's holding of US bonds, which we denote by f_t (initial for 'foreign' bonds). These are also riskless assets: each unit purchased at price $1/R^{US}$ with promise to repay 1 in the next period, both in units of N-goods.

If $R_t^S < R_t^{US}$, DiEco's agents could arbitrage the purchase of US bonds f_t, with the issuance of liabilities s_t. This implies that in equilibrium R_t^S cannot be smaller than R_t^{US}. Thus, we limit the analysis to $R_t^S \geq R_t^{US}$, and DiEco will not hold US bonds if the inequality is strict, that is, $R_t^S > R_t^{US}$.

The budget constraint for a DiEco's agent, in units of N-goods, is

$$m_t + p_t k_{t+1} + \frac{f_{t+1}}{R_t^{US}} - \frac{s_{t+1}}{R_t^S} = p_t k_t + e_t z_t x_t + f_t - s_t,$$

where $m_t = e_t c_{D,t} + c_{T,t}$ denotes consumption expenditures and $e_t z_t x_t$ is the unit payout from Crypto staking. Since in equilibrium the working capital

[7] In reality, issuers of Stablecoins do not pay interest. However, holders of Stablecoins have various options to earn a return in the Digital Economy. For example, they could lend them through a decentralized application (DAO) such as Aave or Compound. The interest rate R_t^S in our model captures the various returns that Stablecoins holders earn by redeploying them in the ecosystem.

constraint is satisfied with equality, we have that $x_t = \omega p_t k_t$.

Define $a_t = (1+e_t z_t \omega)p_t k_t + f_t - s_t$ the end-of-period wealth in units of N-goods, before consumption. The following lemma characterizes the optimal policies chosen by DiEco's residents.

Lemma 3.1 *Given end-of-period wealth a_t and sequence of prices $\{p_t, R_t^{US}, R_t^S\}_{t=0}^{\infty}$, the optimal policies chosen by DiEco's agents are*

$$m_t = (1-\beta)a_t,$$
$$p_t k_{t+1} = \phi_t \beta a_t,$$
$$\frac{f_{t+1} - s_{t+1}}{R_t^S} = (1-\phi_t)\beta a_t,$$

where $f_{t+1} = 0$ if $R_t^S > R_t^{US}$ and ϕ_t satisfies

$$\mathbb{E}_t \left[\frac{R_t^S}{\phi_t \left(\frac{(1+e_{t+1}/\omega)p_{t+1}}{p_t} \right) + (1-\phi_t) \cdot R_t^S} \right] = 1.$$

A fraction $1-\beta$ of the end-of-period wealth is spent in consumption. Then, What remains after consumption, a fraction ϕ_t is allocated to Crypto and the remaining fraction $1-\phi_t$ is allocated to fixed income assets (US bonds net of Stablecoins). When $R_t^S > R_t^{US}$, the return from Stablecoins dominates the return from US bonds. In this case f_{t+1} will be zero since DiEco's agents cannot short US bonds. If f_{t+1} and s_{t+1} pay the same returns, however, US bonds and Stablecoins are economically indistinguishable for DiEco's agents and they will be indifferent between holding one or the other. While $f_{t+1} - s_{t+1}$ is determined for an individual agent, its composition is not: purchasing an extra unit of US bonds and funding it with Stablecoins does not affect individual income, wealth and riskiness of the portfolio.

Optimal portfolio choice: To grasp some intuition about the portfolio choices made by DiEco's agents, we provide here a numerical overview of how these choices are affected by some key variables and parameters.

Figure 6 shows the consolidated balance-sheet of DiEco's agents in the steady state equilibrium of the calibrated model. The aggregate balance sheet can be interpreted as the consolidation of the two balance sheets shown in Figures 4 and 5. The steady state numbers replicate the quantities observed in the data since they are used as targets for the calibration of the model (as we will describe in Section 4).

ASSETS	LIABILITIES
Crypto (2,500 billion)	Stablecoins (252 billion)
US bonds (203 billion)	Equity (2,451 billion)

Figure 6: Equilibrium balance-sheet in DiEco for calibrated parameters.

Starting from the baseline calibration, we explore how the portfolio choices made by DiEco's agents change in response to three variables: (i) the relative price of D-goods produced in DiEco (exchange rate); (ii) volatility of the idiosyncratic shock in DiEco; (iii) interest rate on Stablecoins.

The goal here is not to explore the general equilibrium impact of these changes but how individual portfolios react to these changes. Keeping this in mind, the portfolio responses are computed under the assumption that the interest rate on US bonds is equal to the interest rate on Stablecoins, and the holding of US bonds does not change. Keeping the same holding of US bonds is not sub-optimal when the interest rate on Stablecoins is equal to the interest rate on US bonds, that is, $R^S = R^{US}$. Furthermore, the responses to (i) and (ii) are computed under the assumption that the interest rate on Stablecoins remains constant. However, the price of Crypto must adjust to clear the market since Crypto is traded only locally. This is important because the price of Crypto affects the agents' wealth, which in turn affects the issuance of Stablecoins.[8]

Section (a) in Figure 7 shows how the change in the price of D-goods produced in DiEco, the variable e_t, affects three variables: Crypto price, supply of Stablecoins, and dollar reserve ratio. The dollar reserve ratio is computed by dividing the holdings of US bonds by the value of Stablecoins.

A higher price of D-goods is associated with a higher market price of Crypto. This is intuitive since the price of Crypto is the discounted value of production flows. If the value of production increases, the value of Crypto must also increase. The second panel shows that the supply of Stablecoins

[8]The experiment can be interpreted as conducted in a small open economy. Since DiEco is a small economy, the foreign demand for Stablecoins issued by DiEco and the foreign supply of US bonds are perfectly elastic. Instead, the price of Crypto must adjust to clear the market because Crypto is traded only locally. When we consider a change in the interest rate on Stablecoins, case (iii), we can interpret the impulse response as driven by a change in the US interest rate.

increases with e_t. Agents become wealthier since Crypto is worth more. Because of their higher wealth, they rescale their portfolio by holding more assets but also more liabilities (Stablecoins).

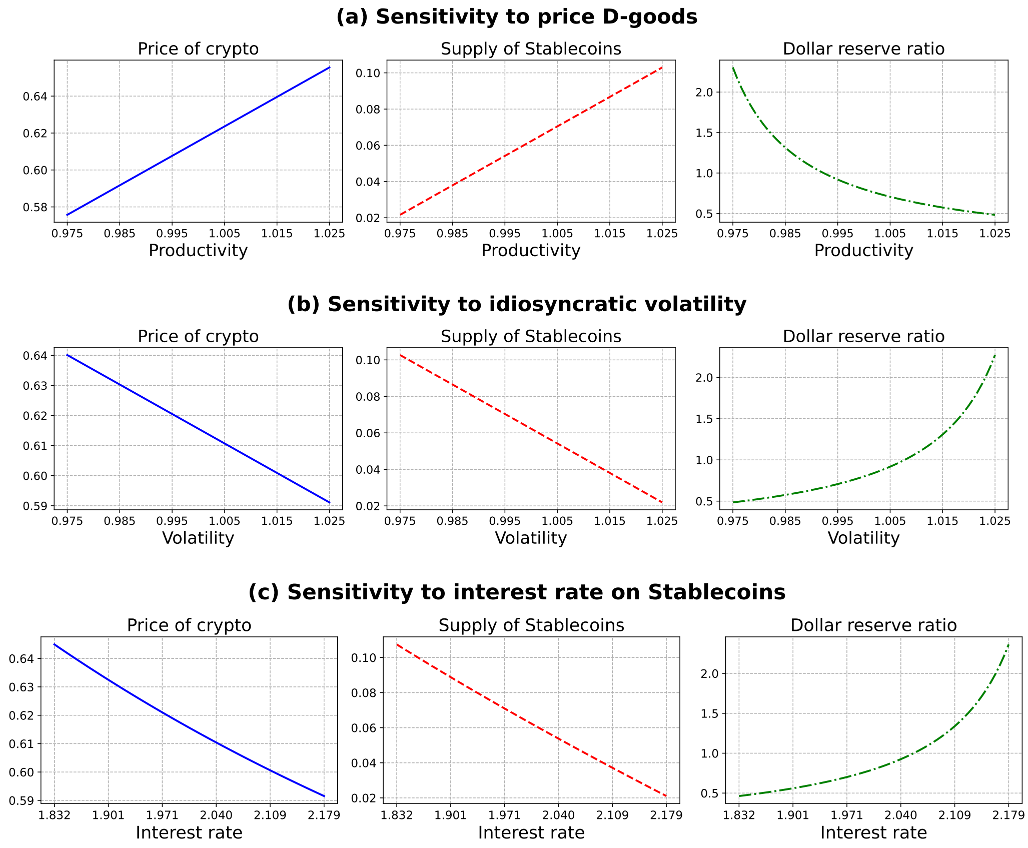

Figure 7: Portfolio sensitivity to productivity, volatility and interest rate.

We now consider changes in the idiosyncratic risk. Section (b) in Figure 7 shows the sensitivity to volatility. In the calibration we specify the distribution of the idiosyncratic shock z to be uniform. Therefore, its volatility is captured by the domain range of z. Higher volatility has a negative impact on the price of Crypto: risk aversion implies that agents now discount more heavily future cash flows generated by Crypto. The higher risk also implies that DiEco's agents issue less Stablecoins (de-leveraging), as we can see from the middle panel. As a result, a larger share of Stablecoins are now backed by US bonds.

Finally, we consider an exogenous change in the interest rate paid by Stablecoins. The interest rate on US bonds also changes so that R^{US} remains equal to R^S. As the interest rate on Stablecoins increases, DiEco's agents issue less Stablecoins. Lower leverage, then, decreases the price of Crypto since now DiEco's agents earn a lower spread between the productivity of Crypto and the cost to fund it with debt.

In summary, we have shown that a higher price of S-goods leads to greater supply of Stablecoins. Higher uncertainty or higher interest rates, instead, reduce the supply of Stablecoins. Of course, the interest rate on Stablecoins is endogenous and will be determined in general equilibrium. The analysis presented here, however, helps us understanding the general equilibrium properties we will characterize later after the description of the whole model. Before doing so, however, it will be instructive to characterize the hypothetical equilibrium in which the Digital economy is not integrated with the rest of the economy.

Financially segmented DiEco. Suppose that DiEco's agents cannot hold US bonds and cannot sell Stablecoins to neither US or RoW (financial autarky). However, they can still trade goods with the Non-digital Economy so that they can consume both goods (remember that DiEco produces only D-goods and they must import N-goods). The equilibrium with financial autarky is only hypothetical. Nevertheless, its characterization is instructive because it provides a reference point to which we can compare the environment with integrated financial markets.

With financial autarky we have that $f_{t+1} = 0$. Since Lemma 3.1 established that agents choose the same composition of portfolio, in equilibrium $s_{t+1} = 0$ for all agents. The interest rate R^S_t is then determined so that agents are indifferent between issuing or holding Stablecoins. A property of the equilibrium is that the interest rate on Stablecoins is smaller than the expected return on Crypto. This is because Crypto is risky and the expected return carries a risk premium. We state these properties formally in the next proposition.

Proposition 3.1 *In an equilibrium with financial autarky, $s_t = 0$ and $R^S_t < \mathbb{E}\left\{\frac{(1+e_{t+1}z_{t+1}\omega)p_{t+1}}{p_t}\right\}$.*

This is helpful for understanding whether DiEco's agents issue Stablecoins when financial markets get integrated. The sufficient condition is that agents in the US or RoW are willing to hold Stablecoins at the autarky interest rate R_t^S. If this condition is satisfied, financial integration allows foreigners to buy Stablecoins, which leads to a higher price $1/R_t^S$. Thanks to the higher price, DiEco's agents start issuing Stablecoins, that is, they will choose $s_t > 0$.

3.2 Non-digital Economy

The United States (US) and Rest of the World (RoW) are similar with one important exception we will describe below.

In both countries there is a unit mass of agents with the same preferences as DiEco's agents. They maximize the expected lifetime utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln(c_t), \qquad \text{with} \qquad c_t = c_{D,t}^{\alpha} c_{T,t}^{1-\alpha},$$

where $\beta \in (0,1)$ is the intertemporal discount factor and c_t is the aggregation of D-goods and N-goods.

Production: There is a constant supply K of non-reproducible land used in production. Land is perfectly divisible and can be traded at price p_t only domestically. An agent that owns k_t units of land produces $z_t k_t$ units of either D-goods or N-goods. The variable z_t is an idiosyncratic iid productivity shock with mean value $\bar{z}$. Since agents can produce either of the two goods with the same technology, the relative price will be 1.[9] However, the price of D-goods produced in DiEco, which we denoted by e_t, could be smaller than 1. This is possible because, as we will see, only a fraction of agents that reside in the US or RoW have access to D-goods produced in DiEco.

The only important difference between US and RoW is in the volatility of the idiosyncratic shock z_t. Agents in RoW face higher idiosyncratic volatility than US agents. This could derive from higher volatility of shocks or lower ability to insure them. In equilibrium, this assumption implies that the US has a lower net foreign asset position than RoW, consistently with the data.

Assumption 3.1 *The distribution of $z/\mathbb{E}z$ in RoW has a higher mean preserving spread than in the US.*

[9] Alternatively, we can assume that agents produce an intermediate good which is then transformed, one-to-one, in either D-goods or N-goods.

Agents' type: At any point in time, a fraction μ_t of agents in US and RoW are knowledgeable about the Digital economy and would consider purchasing D-goods from DiEco. They will do so only if D-goods are cheaper in DiEco, that is, $e_t < 1$. They also would consider the purchase of Stablecoins in the allocation of their savings. We refer to these agents as 'accustomed'.

The remaining fraction $1-\mu_t$ of agents, instead, are unfamiliar or skeptical about the Digital economy. Because of this, they do not purchase D-goods from DiEco, even if they are cheaper than in the US or RoW ($e_t < 1$). These agents are also unfamiliar or skeptical about the viability of digital assets and, therefore, they do not hold Stablecoins. We refer to these agents as 'unaccustomed'.

The status of an agent—accustomed or unaccustomed—could change over time. Agents who are unaccustomed at $t-1$ become accustomed at t with probability θ_t. Agents who are accustomed at $t-1$ become unaccustomed at t with probability δ. Based on these assumptions, the fraction of accustomed agents evolves according to

$$\mu_t = (1-\delta)\mu_{t-1} + \theta_t(1-\mu_{t-1}).$$

If the probability of becoming accustomed θ_t is constant, the fraction of accustomed agents will converge to the steady state $\mu = \theta/(\delta+\theta)$. However, borrowing from the SIR epidemic model, the probability θ_t is a function of the current stock of accustomed agents μ_t (contagious agents). In particular, we assume that θ_t (contagion probability) is determined by the function

$$\theta_t = 1 - e^{-\frac{\mu_{t-1}}{1-\mu_{t-1}}}.$$

This formulation posits that the probability of becoming accustomed is low when there are few accustomed agents. However, as the fraction of accustomed agents μ_t increases, the contagion probability rises.

Changes in μ_t play a very important role for the dynamics of the model: As the fraction of accustomed agents increases, the demand for D-goods produced by DiEco and the demand for Stablecoins both rise.

Financial markets: In the US and RoW there is a government that issues public debt $B_{t+1} \geq 0$ at price $1/R_t$. The government also raises lump-sum taxes T_t paid by domestic residents. Their budget constraint is $B_t = \frac{B_{t+1}}{R_t} + T_t$. Bonds can be sold to domestic and/or foreign agents, including

DiEco's residents. We indicate the individual holding of 'domestic' bonds by d_t, and the individual holdings of 'foreign' bonds by f_t. Per-capita (average) holdings are indicated by capital letters D_t and F_t. Agents in both countries can also hold Stablecoins s_t, that is, liabilities issued by DiEco's agents (as described earlier).

An important assumption is that the holdings of foreign government bonds is costly.

Assumption 3.2 *US and RoW incur the cost* $\varphi(F_{t+1})\frac{f_{t+1}}{R_t^*}$ *to hold foreign bonds, but there is no cost to hold Stablecoins.*

The assumption that the function $\varphi(.)$ depends on *aggregate* foreign holdings, as opposed to individual holdings, simplifies the analysis but it is not essential for the key properties of the model. For the moment we only impose that $\varphi(.)$ is positive, non-decreasing in $F_{t+1} > 0$, and satisfies $\varphi(0) = 0$. As a special case, the function could be constant or strictly increasing and convex. The star superscript on the interest rate indicates the foreign country.

There are different ways to justify the financial cost. One interpretation is that bond holdings require the service of financial intermediaries that charges management or transaction fees. For certain countries it could be related to capital controls that limit access to foreign investments. However, capital controls are not the only factor determining this cost. Fees charged by financial intermediaries could be much more important.

Differently from the holdings of foreign bonds, there is no cost for holding Stablecoins. The idea is that the operation of the Digital Economy does not need the expensive infrastructures used by traditional intermediaries. It also does not have the market power of traditional intermediaries. This allows for a significant reduction in transaction costs. See Harvey et al. (2021) for a discussion of this point. However, it takes time for agents to get accustomed and trust the system to the point of being willing to substitute traditional financial assets (government bonds in the model) with digital assets (Stablecoins in the model). The dynamics of μ_t formalized in the SIR model reflects this learning process.

Optimal policies: The agents' budget constraint differs for accustomed and unaccustomed agents. For accustomed agents we have

$$m_t + p_t k_{t+1} + \frac{d_{t+1}}{R_t} + \frac{[1+\varphi(F_{t+1})] f_{t+1}}{R_t^*} + \frac{s_{t+1}}{R_t^S} + T_t \ = \\ (z_t + p_t) k_t + d_t + f_t + s_t,$$

where $m_t = e_t c_{D,t} + c_{T,t}$ denotes consumption expenditures, R_t is the domestic interest rate, R_t^S the interest rate paid by Stablecoins, and R_t^* the interest rate on foreign bonds. For a US agent, R_t^* is the interest rate paid by government bonds issued by RoW. For an agent in RoW, R_t^* is the interest rate paid by government bonds issued by the US.

For non-accustomed agents, the budget constraint is similar but with consumption expenditures given by $m_t = c_{D,t} + c_{T,t}$ (since D-goods are purchased locally at price 1) and $s_{t+1} = 0$ (since they do not hold Stablecoins).

Define $a_t = (z_t + p_t)k_t + d_t + f_t + s_t - B_t$ the end-of-period wealth before consumption, but net of government debt B_t. Agents' decisions are characterized by the following lemma.

Lemma 3.2 *Given a_t and the sequence $\{p_t, R_t, R_t^*, R_t^S, B_{t+1}, F_{t+1}\}_{t=0}^{\infty}$, the optimal portfolio choice of accustomed agents' satisfy*

$$m_t = (1-\beta) a_t,$$
$$p_t k_{t+1} = \phi_t \beta a_t,$$
$$\frac{d_{t+1} - B_{t+1}}{R_t} + \frac{[1+\varphi(F_{t+1})] f_{t+1}}{R_t^*} + \frac{s_{t+1}}{R_t^S} = (1-\phi_t) \beta a_t,$$

where ϕ_t solves

$$\mathbb{E}_t \left[\frac{\max\left\{ R_t \, , \, \frac{R_t^*}{1+\varphi(F_{t+1})} \, , \, R_t^S \right\}}{\phi_t \left(\frac{z_{t+1}^i + p_{t+1}}{p_t} \right) + (1-\phi_t) \cdot \max\left\{ R_t \, , \, \frac{R_t^*}{1+\varphi(F_{t+1})} \, , \, R_t^S \right\}} \right] = 1.$$

Unaccustomed agents' policies satisfy the same conditions, but with $s_{t+1} = 0$.

The lemma establishes the precise allocation of savings between land and bonds. However, for accustomed agents, it does not specify how the investment in bonds is allocated among domestic bonds, foreign bonds, and Stablecoins. If one of the returns—R_t, $R_t^*/(1+\varphi_t(F_{t+1}))$ or R_t^S—is strictly greater than the others, the agent invests only in the asset with the highest return—d_{t+1}, f_{t+1} or s_{t+1}. If the returns are equal, the agent is indifferent. In this case the individual composition of portfolio is undetermined. Only the aggregate portfolio composition will be determined.

Equilibrium w/o Digital Economy. Before characterizing the equilibrium with full integration, it will be useful to derive some properties of the equilibrium without the Digital Economy. In this section we focus on steady state equilibria. Since the US differs from the RoW only in the volatility of the idiosyncratic shock ($z^{US}/\mathbb{E}z^{US}$ is less volatile than $z^{RoW}/\mathbb{E}z^{RoW}$), the steady state of the integrated economy has the following properties:

- RoW holds US bonds ($F^{RoW} > 0$), but the US does not hold RoW bonds ($F^{US} = 0$).
- The US interest rate is greater than in RoW, that is, $R^{US} > R^{RoW}$.
- The US interest rate is lower than in autarky (US privilege).

These results are obtained by aggregating the agents' decisions characterized in Lemma 3.2, and imposing market clearing. The detailed derivation will be provided in the appendix.

The first property derives from the fact that higher idiosyncratic uncertainty (higher risk) induces more saving. The country that saves more (the RoW in the model) lends on net to the other country (the US in the model).

The second property can be explained as follows. If RoW chooses to hold both domestic and US bonds, their net returns must be equalized. But since the holding of foreign bonds is costly, agents in RoW will hold US bonds only if they pay a higher interest rate than the interest rate paid by RoW bonds (so that, net of the financial cost, the returns on US and RoW bonds are equalized for RoW agents).

This property may seem at odd with the common view that the US government pays a lower interest rate than the rest of the world. However, when comparing interest rates, we should use instruments that are 'perfect' substitutes. This is very difficult to do, especially for emerging and developing countries. The right interpretation of the exorbitant privilege is that financial integration allows the US to borrow at a lower interest rate than it would pay in absence of financial integration. This is exactly what the third property says.

3.3 Fully integrated world economy

We now consider the fully integrated economy in which accustomed agents in the US and RoW can hold Stablecoins issued by DiEco, and DiEco's agents can hold bonds issued by the US and RoW. The following proposition characterizes some of the steady state properties.

Proposition 3.2 *In a steady state equilibrium:*

(i) RoW holds US bonds ($F^{RoW} > 0$), but not viceversa ($F^{US} = 0$).

(ii) The interest rates on US and RoW bonds satisfy

$$\frac{R^{US}}{1 + \varphi(F^{RoW})} = R^{RoW}.$$

(iii) The interest rates on Stablecoins and US bonds satisfy

$$R^{S} \geq R^{US}, \qquad (= \textit{if } F^{DiEco} > 0).$$

(iv) Accustomed agents in RoW hold Stablecoins but not RoW bonds.

(v) Accustomed agents in US are indifferent between Stablecoins and US bonds if $R^S = R^{US}$. They hold only Stablecoins if $R^S > R^{US}$.

Proof 3.1 *The first property derives from the assumption that RoW agents face higher idiosyncratic uncertainty than US agents. The second property derives from the arbitrage of ROW. The left-hand-side is the return from holding US bonds and the right-hand-side is the return from holding domestic bonds. Since $F^{RoW} > 0$, agents in RoW hold both domestic and foreign bonds and, therefore, their returns must be equal. The relation between R^S and R^{US} derives from the arbitrage of DiEco's agents. They could issue liabilities (Stablecoins) that pay R^S and invest in US bonds. They will choose to do so only if $R^S = R^{US}$. In this case accustomed agents in US are indifferent between holding US bonds and Stablecoins. However, if $R^S > R^{US}$, DiEco's agents do not hold US bonds since the return is lower than the cost of liabilities issued to fund them, and accustomed agents in the US hold only Stablecoins.*

These properties will be helpful for understanding the quantitative properties of the model we are going to study next.

4 Quantitative analysis

In this section we quantify how the growth of the Digital economy impacts local and global financial markets. The growing size of the Digital economy depends on the extent to which agents in the Non-digital economy are accustomed with the Digital economy. This is captured in the model by the variable μ_t.

The increase in μ_t affects the economy through two channels. The first is through the demand for Stablecoins: As more agents become receptive to the idea of adding digital assets to their saving portfolio, the demand for Stablecoins increases. We refer to it as the 'financial demand' channel.

The second channel operates through the demand for services produced in DiEco, the D-goods. As more agents become accustomed to the Digital economy, they substitute services produced in the traditional economy with the same services produced in the Digital economy. For example, short-term real-estate rentals could be arranged with specialized dApps rather than traditional real estate companies. Also, financial intermediation (borrowing and lending) could be arranged with dApps instead of traditional banks. The greater demand for services produced by the Digital economy will then increase the supply of these services, and makes Crypto more valuable. We refer to it as the 'real demand' channel.

While the two channels are driven by the same force—the increase in the fraction of accustomed agents μ_t—we will be able to separate them through counterfactual simulations. Let's first describe the parametrization of the model.

4.1 Calibration

The main quantitative exercise consists in the simulation of the model to construct the transition dynamics induced by changes in μ_t (fraction of accustomed agents in the traditional economy). The starting year for the simulation is 2023 and some of the parameter values are chosen to replicate empirical targets observed in 2023.

Let's first specify the functional forms for the financial cost and the distribution of the idiosyncratic shock. The financial cost takes the form $\varphi(F) = \kappa F$ and the distribution of the idiosyncratic shock is uniform. Thus, the distribution is fully characterized by two parameters: the mean ($\bar{z}^{DiEco}$, $\bar{z}^{US}$, $\bar{z}^{RoW}$) and the domain (σ^{DiEco}, σ^{US}, σ^{RoW}).

Parameter values. The discount factor is chosen to have an average return from Crypto similar to the average return from staking showed in the third panel of Figure 3. According to the series plotted in the graph, the average return from staking is about 5%. Thus, we set $\beta = 0.95$.

We think of D-goods as services, a large share of which related to finance. In the US, the finance industry (FIRE) accounts, currently, for about 8% of GDP. However, the Digital economy could also contribute to other industries besides finance. To account for that we set the share of expenditures in D-goods to $\alpha = 0.1$, which is slightly higher than the share of FIRE. Note that this does not mean that agents in the Non-digital economy allocate 10% of their consumption expenditures to purchase services produced by the Digital economy. Only accustomed agents, who remain a minority, purchase D-goods from DiEco.

Let's focus now on the parameters that determine the dynamics of μ_t. The fraction of accustomed agents evolves over time according to

$$\mu_t = (1-\delta)\mu_{t-1} + \theta_t(1-\mu_{t-1}-\gamma), \qquad \theta_t = 1 - e^{-\frac{\mu_{t-1}}{1-\mu_{t-1}}}.$$

Compared to the function specified earlier, the equation presented here has the additional parameter γ. This does not affect the qualitative properties of the model but gives us some flexibility in matching the calibration targets.

As a calibration target we use the fraction of accustomed agents in the long run (steady state), $\bar{\mu}$. Higher is δ and lower is the steady state fraction of accustomed agents. By choosing δ we can target any value of $\bar{\mu}$. However, in order to target a relatively small value of $\bar{\mu}$, we need δ to be close to 1, which is not very plausible.[10] With the extra parameter γ we can target a relatively small value of $\bar{\mu}$ while using a more plausible value of δ.

We proceed as follows. We set $\delta = 0.2$ and then we target $\bar{\mu} = 0.1$ (10% in the long-run) to pin down γ. Given the values of the parameters δ and γ, the dynamics of μ_t is fully determined once we have its initial value.

To set the initial value of μ_t in 2023, we target the market value of Crypto in the same year.[11] The estimated value is around 2.5 trillion dollars. As-

[10] A value of δ close to 1 implies that almost all accustomed agents are replaced by different agents in every period.

[11] To see why the valuation of Crypto is related to μ_t, let's consider the value added generated by the Digital economy. In the model this is equal to $e_t X_{D,t}$, where $X_{D,t}$ is the demand for services produced by DiEco and e_t is its price. The demand $X_{D,t}$ comes

suming a world capital-output ratio of 3, this corresponds to about 0.8% the value of world capital.[12] Thus, we choose 0.8% as calibration target for μ_t.

The value of Crypto in the model is determined by the price p_t^{DiEco}. The relation between μ_t and p_t^{DiEco} is complex because asset prices are forward looking. Even if we can solve for the price of Crypto numerically, the required value of μ_t depends on other parameters. Therefore, it must be determined jointly with other parameters we will describe below.

To calibrate the average productivities $\bar{z}^{US}$ and $\bar{z}^{RoW}$, we first normalize the fixed inputs K^{US} and K^{RoW} to 1. This is without loss of generality because the linearity of the production function implies that a higher productivity is equivalent to a higher production input. We also normalize $\bar{z}^{US}$ to 1 since what matters is the relative size of the two countries. Given the normalization, we choose $\bar{z}^{RoW}$ so that relative output of the US in 2023 is equal to the value in the data. The US GDP in 2023 was about 25% the world GDP. Thus, we set $\bar{z}^{RoW} = 3$.

We now turn to production in DiEco. The market value of Crypto is proportional to production, that is, $p_t^{DiEco} K^{DiEco} = \omega X_{D,t}$, where p_t^{DiEco} is the price of Crypto, K^{DiEco} is the stock of Crypto, $X_{D,t}$ is the production of D-goods in DiEco, and ω is a parameter. Remember that digital production requires Crypto: higher is the staked value of Crypto and higher is the produced amount of digital services. The parameter ω is chosen so that the price of D-goods produced in DiEco, e_t, is close to 1 in the long-run equilibrium.[13]

from agents in DiEco and from accustomed agents in US and RoW. As the fraction of accustomed agents μ_t increases, $X_{D,t}$ also increases. The higher demand generates an increase in the price e_t, which in turn increases the market value of Crypto p_t^{DiEco}, thanks to higher profits. Thus, there is a positive relation between μ_t and p_t^{DiEco}.

[12]The US GDP in 2013 was about 27 trillion dollars, while the world GDP was about 108 trillion dollars (four times the US GDP). With a capital-GDP ratio of 3, we estimate that total capital in the world was 324 trillion dollars (108×3). Thus, 2.5 trillion dollars worth of cryptocurrencies correspond to 0.8% the value of world capital.

[13]To see how ω relates to the long-run value of e_t, let's first consider the expression that defines the price of Crypto in the long-run (steady state). The price of Crypto p_t^{DiEco} is the expected discounted value of services produced by each unit of Crypto. The steady state price is approximately equal to

$$p^{DiEco} = \frac{\beta}{1-\beta} \left(\frac{eX_D}{K^{DiEco}} \right).$$

The term in parenthesis is the value of services produced by each unit of Crypto (total value of production divided by the stock of Crypto). This is constant in the steady state. Discounting the production flows by β we obtain the above expression. Notice that this is

The precise value of ω will be chosen jointly with other parameters due to their interdependence.

We still have four additional parameters: κ, σ^{DiEco}, σ^{US}, σ^{RoW}. We calibrate these parameters together with ω and the initial share of accustomed agents μ_t (discussed above) to target six moments:

1. The interest rate on US bonds in 2023 is 2%.
2. The US net foreign asset position in 2023 is -30% the value of output.
3. The value of Stablecoins in 2023 is 10% the value of Crypto.
4. The fraction of Stablecoins backed by US bonds in 2023 is 80%.
5. The value of Crypto in 2023 is 0.8% the value of global capital.
6. The price of $D-$goods is close to 1 in the long-run (final steady state).

To calculate the US net foreign asset position (second targeted moment), we have to take into account that in our economy production is only earned by land (capital). In the real economy, however, capital income is only a fraction of GDP. Output in the model corresponds to net capital income in the data, which is about 20 percent the value of GDP. This implies that the net foreign asset position of the US in the model should be -150%, that is, the NFA-to-GDP ratio of -30% multiplied by 5.

Although the five parameters and the initial μ_t all contribute to determine the six moments, we can outline the primary impact of each parameter on the targeted moments.

An increase in the idiosyncratic volatility (both US and RoW) raises the insurance benefit of holding riskless bonds and reduces their interest rate. Thus, in order to have a US interest rate of 2% when the inter-temporal discount rate is 5%, we need significant idiosyncratic volatility.

Given the US idiosyncratic volatility, σ^{US}, the RoW volatility σ^{RoW} affects the US net foreign asset position: Higher is the idiosyncratic volatility

an approximation to the actual long-run price because the actual discount factor used by agents is not β. Agents also take into account that revenues are stochastic for an individual agent (risk) and they also borrow (so that they received leveraged cash flows). However, the actual price of Crypto will not be very different from the one calculated from the above expression. We can now substitute p^{DiEco} in the equation $p_t^{DiEco}K^{DiEco} = \omega X_{D,t}$, evaluated at the steady state, from which we obtain $e = (1-\beta)\omega/\beta$. This (approximate) equation shows that the steady state price e increases with the parameter ω.

in RoW, relatively to the US, and larger is the stock of US bonds held by RoW (larger imbalance). In order for the US to have a negative net foreign asset position, we need $\sigma_z^{RoW}/\bar{z}^{RoW} > \sigma_z^{US}/\bar{z}^{US}$, consistently with Assumption 3.1. Furthermore, bigger is the difference in idiosyncratic volatility and larger is the imbalance.

The parameter κ is important for determining the demand for Stablecoins: higher is the value of κ and lower is the net return from holding US bonds. Lower net return on US bonds, then, increases the incentive of RoW's agents to hold Stablecoins. This will determine in equilibrium the stock of Stablecoins.

The relative idiosyncratic volatility of DiEco, captured by the parameter σ^{DiEco}, is important for determining the fraction of Stablacoins backed by US bonds. The issuance of Stablecoins that are backed by US bonds is not risky for DiEco's agents because their balance-sheet will be augmented by both assets and liabilities of the same value. However, the issuance of Stablecoins that are not backed by US bonds raises the portfolio risk since DiEco's agents become more leveraged. If DiEco's assets are riskier (higher value of σ^{DiEco}), DiEco's agents reduce leverage to scale down the portfolio risk. Instead, if DiEco's assets are safer, DiEco's agents will take more leverage by increasing the issuance of Stablecoins that are not backed by US bonds.

Finally, the parameter ω and the initial share of accustomed agents μ_t are important for determining the long-run price of DiEco's production and the initial value of Crypto as we discussed above. Table 1 provides the full list of parameters with their calibrated values.

4.2 Transition equilibrium

Figure 8 plots the transition dynamics for four variables. The first variable, plotted in Panel (a), is the fraction of accustomed agents in the Non-digital economy (US and RoW), that is, μ_t. The exogenous evolution of this variable is the driving force for the dynamics of the model. The initial value of μ_t is 0.4% but afterwards it grows gradually and in the long-run converges to 10%.

Panel (b) plots the price of D-goods produced in the Digital economy (exchange rate). Initially, the price is significantly lower than in the Non-digital economy (about 0.2 versus 1). This is possible because, at the beginning, few agents in the Non-digital economy purchase D-goods produced in DiEco. However, as the fraction of accustomed agents μ_t increases, the demand and

Table 1: Model parameters and calibration values

Description	*Parameter*	*Value*
Discount factor	β	0.9500
Consumption share of D-goods	α	0.1000
Dynamics accustomed agents (parameter 1)	δ	0.2000
Dynamics accustomed agents (parameter 2)	γ	0.7098
Production technology in DiEco	ω	20.9000
Mean productivity US	$\bar{z}^{US}$	1.0000
Mean productivity RoW	$\bar{z}^{RoW}$	3.0000
Domain range shocks in DiEco	σ^{DiEco}	11.0356
Domain range shocks in US	σ^{US}	11.7400
Domain range shocks in RoW	σ^{RoW}	41.1176
Holding cost foreign bonds	κ	0.0197
Initial fraction of accustomed agents	μ_0	0.0040

price for these goods also increase. As a result, the value added generated by DiEco increases from 0.2 percent the value of world production to about 1.1 percent (Panel (c)).

Panel (d) plots the market price of Crypto over the market value of DiEco's production. Since DiEco's production represents earnings generated by Crypto, this is the price-earning ratio. The ratio is very high initially (over 100) but over time it declines to its long-term value of about 20. The high initial value is justified by the high valuation of Crypto in the initial simulation year, 2023. Even if Crypto does not generate high earnings initially, its current valuation reflects the expectation of higher future earnings. This feature is similar to what we observe in new industries: companies are traded at high market prices even if they are not yet generating profits. As the industry matures, however, valuations return to more normal levels. This is what the model predicts for DiEco.

Figure 9 plots the dynamics of additional variables. The continuous line in Panel (a) is for the US interest rate. Initially, the US rate increases but then it declines monotonically to a lower long-run level.

The non-monotonic dynamics of the interest rate results from two contrasting forces. On the one hand, the increase in μ_t raises the demand for Stablecoins as more agents in RoW substitute US bonds for Stablecoins. This reduces the interest rate on Stablecoins. Since some of the Stablecoins are backed by US bonds, the US interest rate also declines. On the other,

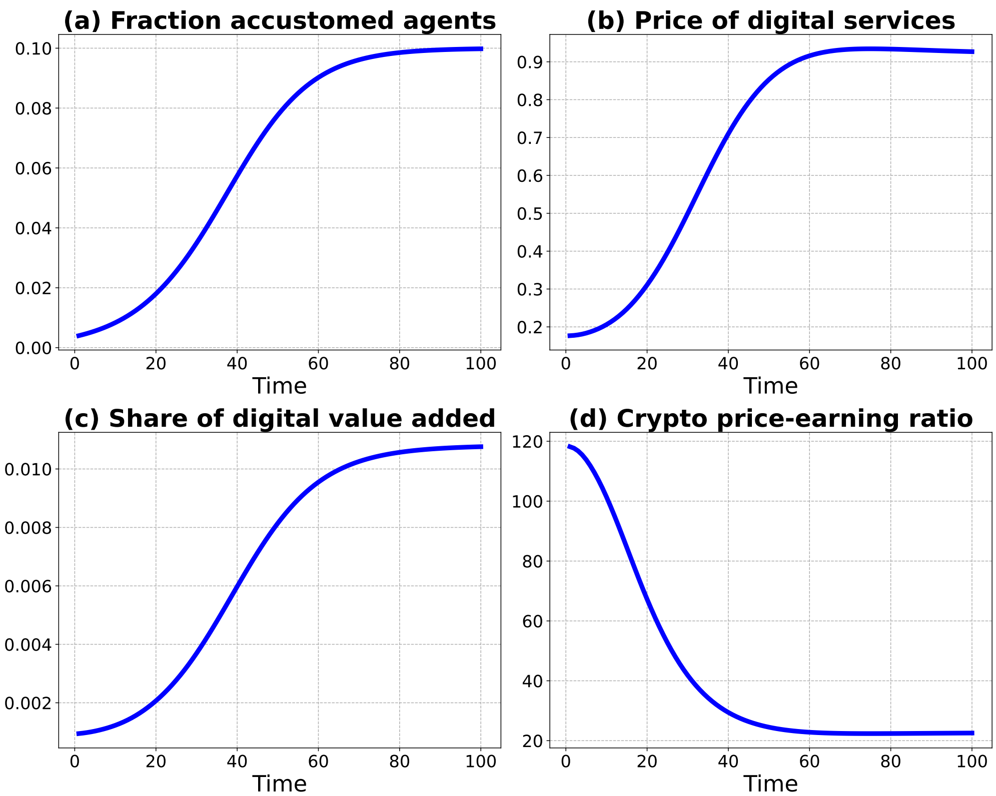

Figure 8: Dynamics of fractions of accustomed agents, price of D-goods, world share of DiEco's production, and Crypto price-earning ratio.

the increase in μ_t raises the demand for D-goods produced by DiEco, which raises the price e_t. With a higher price of D-goods sold by DiEco, Crypto becomes more valuable (remember that Crypto is essentially an input of DiEco's production), which in turn increases the wealth of DiEco's agents. As their wealth rises, DiEco's agents are willing to supply more Stablecoins, which increases the interest rate on both Stablecoins and US bonds.

Both forces increase the issuance of Stablecoins as shown in Panel (b). However, the relative importance of the two forces changes over the transition. In the first phase of the transition, the US interest rate rises, indicating that the increase in supply dominates the increase in demand.

This is further validated by Panel (c) which plots the dollar reserves (US bonds) held by DiEco as a fraction of Stablecoins. We see that in the first

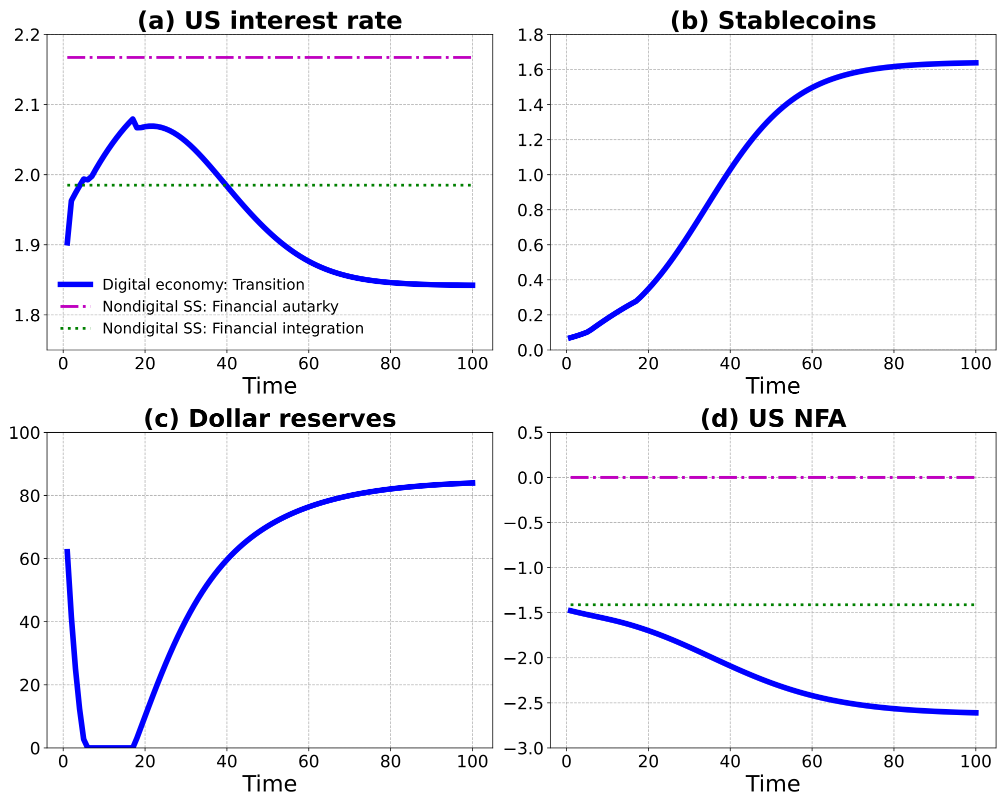

Figure 9: Dynamics of interest rate, Stablecoins, dollar reserves, and US net foreign asset position.

phase of the transition, DiEco holds less US bonds relatively to the stock of Stablecoins. This weakens the demand for US bonds and leads to a higher US interest rate. In the second phase, however, the reserve ratio increases, reinforcing the demand for US bonds.

Panel (a) also shows the steady state interest rate in absence of the Digital economy and for two regimes. In the first regime, US and RoW are not financially integrated (autarky), while in the second regime their capital markets are integrated. We observe first that the steady state interest rate in the US is higher in autarky compared to the regime with financial integration. This shows that financial integration allows the US to pay a lower interest rate than in a regime without integration (exorbitant privilege). The interest rate with the Digital economy is even smaller. This is shown by the continuous line being lower than the dotted line for most periods. Thus, the Digital economy seems to reinforce the US exorbitant privilege rather than weakening it.

The expansion of the Digital economy also impacts the cross-country ownership of financial assets. The model is calibrated so that the US has, initially, a negative net foreign asset position of 30% the value of its GDP. As the Digital economy expands, the US NFA deteriorates (see Panel (d)). Thus, an implication of the growth of the Digital economy is that the US imbalance becomes more sizable.

4.3 Consumption insurance

The growth of the Digital economy impacts global financial markets through the issuance of a new financial instrument, Stablecoins. The supply of this new financial instrument allows agents to change the composition of their portfolios, which in turn affects the volatility of individual consumption and wealth.

Appendix A derives the analytical formula for the standard deviation of individual consumption growth, which takes the form

$$\begin{aligned}\mathrm{Var}_t(g_{t+1}) \quad = \quad & \beta\tilde{e}_t^{\alpha}\Bigg\{\left(\frac{\phi_t}{p_t}\right)^2\left[\left(\frac{1}{e_{t+1}}\right)^{2\alpha}\lambda_t+1-\lambda_t\right]\frac{\sigma^2}{12}+ \\ & \lambda_t(1-\lambda_t)\left[\phi_t\left(\frac{\mathbb{E}z_{t+1}+p_{t+1}}{p_t}\right)+(1-\phi_t)R_t\right]^2\left[\left(\frac{1}{e_{t+1}}\right)^{\alpha}-1\right]^2\Bigg\}^{\frac{1}{2}}\end{aligned} \tag{1}$$

The variable λ_t is the probability of being accustomed at $t+1$ and $1-\lambda_t$ the probability of being unaccustomed. These probabilities depend on the current agent's type. For an agent that is accustomed at time t, the probability of being accustomed at $t+1$ is $\lambda_t = 1-\delta$. For an agent that is unaccustomed at time t, the probability of being accustomed at $t+1$ is $\lambda_t = \theta_t$. For DiEco's agents $\lambda_t = 1$ since they do not switch type.

The price of D-goods, $\tilde{e}_t$, also depends on the agent's type. For an accustomed agent $\tilde{e}_t = e_t$ while for an unaccustomed agent $\tilde{e}_t = 1$. Finally, the variable R_t denotes the gross return earned on fixed-income investments. For accustomed agents this is the interest rate on Stablecoins, that is, $R_t = R_t^S$. For unaccustomed agents is the interest rate on local bonds, that is, $R_t = R_t^{US}$ for the US and $R_t = R_t^{RoW}$ for RoW. For DiEco's agents is also equal to the interest rate on Stablecoins since this is what they pay on their borrowing. However, since $\lambda_t = 1$ for DiEco's agents, R_t does not affect the standard deviation of consumption growth.

Looking at equation (1), we can see that consumption volatility increases with the volatility of the idiosyncratic shock, σ. It also depends on the portfolio allocation ϕ_t since agents that hold a larger share of wealth in risky assets experience higher consumption volatility. This differs not only across countries but also among agents' types.

Quantitative properties. Figure 10 plots the standard deviation of consumption growth over the transition for each country and for different types of agents. Panel (a) is for the US (continuous line for accustomed agents and dashed line for unaccustomed agents). Consumption volatility for accustomed agents increases over time. This is a direct consequence of the fact that the US experiences a decline in NFA: the US borrows more from abroad (higher levered position), which implies more net worth volatility. Higher volatility of net worth then implies higher consumption volatility. For unaccustomed agents, however, volatility is high also initially. This captures the fact that accustomed agents could switch to unaccustomed in the next period, in which case they will experience a large increase in the price paid for D-goods (and, thus, high consumption uncertainty). Over time, the price difference declines and the effect described here becomes less important.

Panel (a) also plots consumption volatility in the steady state equilibrium without a Digital economy when the US is not financially integrated with RoW (dotted line), and when the US is financially integrated with RoW (dotted-dashed line). Without the Digital economy, all agents are unaccustomed. In the long-run, consumption volatility experienced by US residents (both accustomed and unaccustomed) will be higher when they are integrated with the Digital economy. In the short-run, however, accustomed agents experience smaller volatility, which is caused by the lower price paid for D-goods purchased from DiEco (see equation (1)). As we saw in Figure 8, the initial price of D-goods produced in DiEco is significantly lower than the price of D-goods produced in US and RoW.

Panel (b) plots the standard deviation of consumption growth for agents in RoW. Accustomed agents experience lower consumption volatility compared to unaccustomed agents. This is because, thanks to their access to the Digital economy, they can purchase higher return bonds (Stablecoins). As a

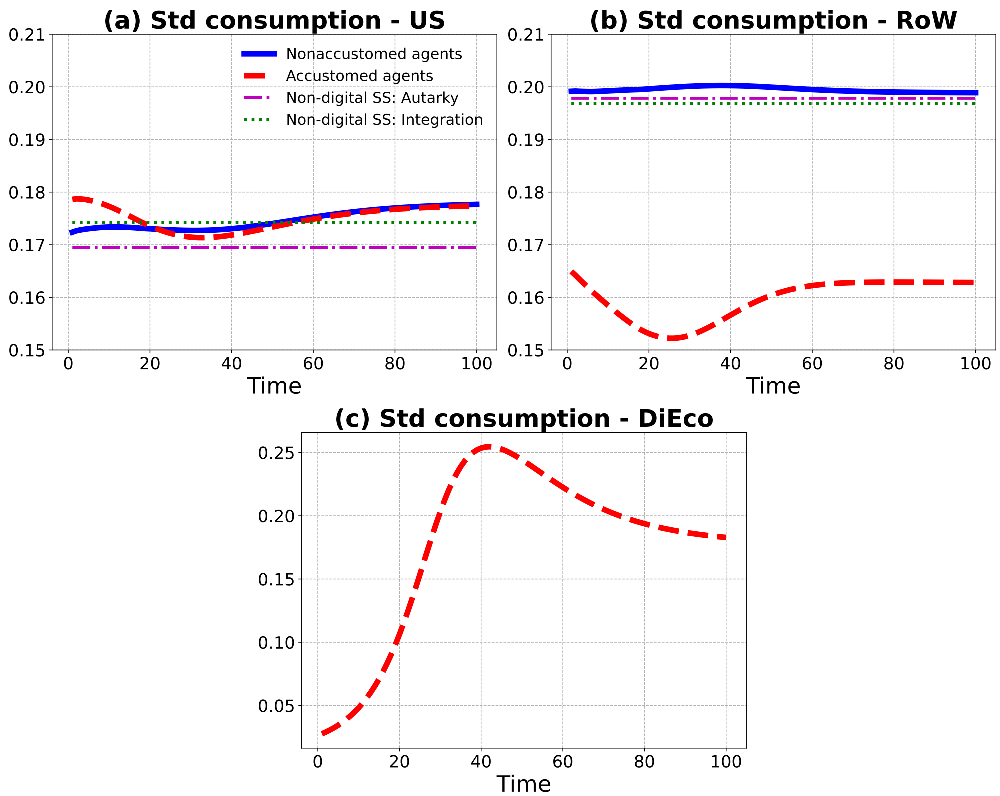

Figure 10: Standard deviation of consumption growth.

result, they change their portfolio composition toward more fixed income assets (they reduce the holding of risky land). Because of this, their net worth becomes less volatile, which in turn implies lower volatility of consumption.

Panel (c) shows consumption volatility for DiEco's agents. Residents of DiEco experience a significant increase in consumption volatility. To understand why, let's go back to Figure 8. Panel (d) shows that the price-earning ratio for Crypto declines over time. This is a consequence of the increase in the price of D-goods, e_t. As the price-earning ratio declines, a larger share of wealth held by DiEco's agents—the variable a_t—derives from current earnings (which are subject to the idiosyncratic risk) and a smaller share from the market value of Crypto (which is not subject to the idiosyncratic risk). As a result, the end-of-period wealth becomes more volatile for an individual agent. This implies that individual consumption becomes more volatile.

To summarize, the growth of the Digital economy could have non-negligible consequences for risk-sharing across the globe. In the long-run, the US extends its provision of insurance to agents in other parts of the world. Part of the insurance is also provided by the (virtual) residents of the new Digital economy. Since individual consumption volatility is related to the volatility of individual wealth, wealth concentration will rise in the US but could decline in the rest of the world (set aside the residents of the Digital economy).

5 Conclusion

Thanks to its proven stability, the US dollar is at the center of the international financial system, serving both as a *means of payment* and as a *store of value*. We explored how the potential growth of the Digital economy and Stablecoins in particular, could impact the global financial system. We have shown that this depends on the relative importance of two channels associated with the growth of the Digital economy. The first channel increases the demand for Stablecoins. Since Stablecoins are in part backed by dollar-denominated assets, this causes a decline in the US interest rate and an increase in global imbalances. The second channel increases the supply of Stablecoins backed by non-dollar assets. This increases the US interest rate and reduces global imbalances. The simulation of the model shows that, in the long-run, the first channel dominates the second, and the US interest rate declines. This also implies that US net foreign borrowing will continue to rise.

We have also explored the implications of the Digital economy for consumption volatility at the micro level. In general, the expansion of the Digital economy will be associated with an increased supply of Stablecoins that allows certain agents to enjoy greater consumption smothing. In particular, this benefit is more likely to arise for agents in the Rest of the World who become accustomed to the Digital economy. Their lower consumption volatility, however, will be at the cost of higher consumption volatility for US and DiEco's agents.

Is the expansion of the Digital economy welfare improving? On a global level the answer should be positive. This is because the Digital economy provides cheaper services (services produced in the Digital economy) as well as insurance by creating more accessible safe assets. However, the benefits are not symmetric among countries and across agents within a country. Exploring the welfare implications of the emerging Digital economy will be the next research step.

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A Derivation of equation (1)

Expenditures m_t are allocated to D-goods and N-goods according to

$$\begin{aligned} c_{D,t} &= \left(\frac{\alpha}{\tilde{e}_t}\right) m_t, \\ c_{N,t} &= (1-\alpha) m_t, \end{aligned}$$

where $\tilde{e}_t$ is the relative price of D-goods. The relative price is equal to 1 for non-accustomed agents in US and RoW, but it is equal to $e_t < 1$ for DiEco's agents and accustomed agents in US and RoW. The consumption bundle is then

$$c_t = \left[\left(\frac{\alpha}{\tilde{e}_t}\right)^{\alpha} (1-\alpha)^{1-\alpha} \right] m_t \tag{A.1}$$

Given logarithmic utility, consumption expenditures at time t and $t+1$ are

$$m_t = (1-\beta) a_t, \tag{A.2}$$

$$m_{t+1} = (1-\beta) a_{t+1}, \tag{A.3}$$

with a_t the end-of-period wealth before consumption at time t, and a_{t+1} is the end-of-period wealth before consumption at $t+1$.

Let's consider first accustomed agents in US and RoW. The end of period wealth at $t+1$ is

$$a_{t+1} = (z_{t+1} + p_{t+1}) k_{t+1} + s_{t+1}. \tag{A.4}$$

Remember that accustomed agents hold land, k_{t+1}, and Stablecoins, s_{t+1}.

The optimal portfolio decision of accustomed agents gives rise to the following investment policies,

$$p_t k_{t+1} = \phi_t \beta a_t, \tag{A.5}$$

$$\left(\frac{1}{R_t^S}\right) s_{t+1} = (1-\phi_t) \beta a_t, \tag{A.6}$$

where R_t^S is the interest rate on Stablecoins and $1/R_t^S$ its price.

Using equations (A.5) and (A.6) to eliminate k_{t+1} and s_{t+1} in (A.18), we obtain

$$\frac{a_{t+1}}{a_t} = \beta \left[\phi_t \left(\frac{z_{t+1} + p_{t+1}}{p_t} \right) + (1-\phi_t) R_t^S \right]. \tag{A.7}$$

Equations (A.2) and (A.3) imply $m_{t+1}/m_t = a_{t+1}/a_t$. Substituting and using the expression for c_t (and c_{t+1}) from (A.1), we obtain

$$\frac{c_{t+1}}{c_t} = \beta \left[\phi_t \left(\frac{z_{t+1} + p_{t+1}}{p_t} \right) + (1 - \phi_t) R_t^S \right] \left(\frac{e_t}{\tilde{e}_{t+1}} \right)^{\alpha}. \tag{A.8}$$

Since we are considering an accustomed agent, the price paid for D-goods at time t is e_t, which we take into account when we use (A.1). The next period price, however, is unknown at time t since an accustomed agent could become unaccustomed. Thus, in the formula, the next period price is indicated by $\tilde{e}_{t+1}$.

Equation (A.8) defines the gross growth rate of consumption as a linear function of the next period realization of the idiosyncratic shock, z_{t+1}. The function depends on two stochastic variables. The first is the next period idiosyncratic productivity z_{t+1} and the second is the next period price of D-goods $\tilde{e}_{t+1}$. The standard deviation of consumption growth then depends on the probability distribution of these two stochastic variables.

It will be useful to rewrite consumption growth more compactly as

$$g_{t+1} = \frac{c_{t+1}}{c_t} = f(z_{t+1}) h(\tilde{e}_{t+1}), \tag{A.9}$$

where the two functions are

$$f(z_{t+1}) = \beta \left[\phi_t \left(\frac{z_{t+1} + p_{t+1}}{p_t} \right) + (1 - \phi_t) R_t^S \right] \tag{A.10}$$

$$h(\tilde{e}_{t+1}) = \left(\frac{e_t}{\tilde{e}_{t+1}} \right)^{\alpha}. \tag{A.11}$$

The first function depends on z_{t+1} but not on $\tilde{e}_{t+1}$. The second function depends on $\tilde{e}_{t+1}$ but not on z_{t+1}.

Deriving the standard deviation. We first derive the variance of consumption growth and then we derive the standard deviation by taking the sqare root. Using the law of total variance, the variance can be written as

$$\text{Var}(g_{t+1}) = \mathbb{E}\Big\{ \text{Var}\Big(g_{t+1} | \tilde{e}_{t+1} \Big) \Big\} + \text{Var}\Big\{ \mathbb{E}\Big(g_{t+1} | \tilde{e}_{t+1} \Big) \Big\} \tag{A.12}$$

Using (A.9) this can be rewritten as

$$\text{Var}(g_{t+1}) = \mathbb{E}\Big\{ h(\tilde{e}_{t+1})^2 \Big\} \text{Var}\Big\{ f(z_{t+1}) \Big\} + \Big\{ \mathbb{E} f(\tilde{z}_{t+1}) \Big\}^2 \text{Var}\Big\{ h(\tilde{e}_{t+1}) \Big\} \tag{A.13}$$

The right-hand-side has four components. Using the definition of $f(z_{t+1}$ and $h(\tilde{e}_{t+1}$ provided in equations (A.10) and (A.11) and taking into account that an accustomed agent beccomes unaccustomed with probability δ, we can show that the four components are equal to

$$\mathbb{E}\Big\{h(\tilde{e}_{t+1})^2\Big\} = e_t^{2\alpha}\left[\left(\frac{1}{e_{t+1}}\right)^{2\alpha}(1-\delta)+\delta\right] \tag{A.14}$$

$$\mathrm{Var}\Big\{f(z_{t+1})\Big\} = \left(\frac{\beta\phi_t}{p_t}\right)^2 \mathrm{Var}(z_{t+1}) \tag{A.15}$$

$$\Big\{\mathbb{E}f(\tilde{z}_{t+1})\Big\}^2 = \beta^2\left[\phi_t\left(\frac{\mathbb{E}z_{t+1}+p_{t+1}}{p_t}\right)+(1-\phi_t)R_t^S\right]^2 \tag{A.16}$$

$$\mathrm{Var}\Big\{h(\tilde{e}_{t+1})\Big\} = e_t^{2\alpha}\left[\left(\frac{1}{e_{t+1}}\right)^{\alpha}-1\right]^2\delta(1-\delta) \tag{A.17}$$

Since the distribution of the idiosyncratic shock z_{t+1} is uniform, the variance $\mathrm{Var}(z_{t+1})$ can be computed analytically. Given the domain σ, that is, the difference between the highest and lowest values of z, we have $\mathrm{Var}(z_{t+1}) = \sigma^2/12$.

Substituting in equation (A.9) we obtain

$$\begin{aligned}\mathrm{Var}(g_{t+1}) = \beta^2 e_t^{2\alpha}\Bigg\{ & \left(\frac{\phi_t}{p_t}\right)^2\left[\left(\frac{1}{e_{t+1}}\right)^{2\alpha}(1-\delta)+\delta\right]\frac{\sigma^2}{12} + \\ & \delta(1-\delta)\left[\phi_t\left(\frac{\mathbb{E}z_{t+1}+p_{t+1}}{p_t}\right)+(1-\phi_t)R_t^S\right]^2\left[\left(\frac{1}{e_{t+1}}\right)^{\alpha}-1\right]^2\Bigg\}\end{aligned}$$

For unaccustomed agents we obtain a similar expression once we take into account that unaccustomed agents do not hold Stablecoins. Thus the return on fixed-income investments is the return on local bonds, R^{US} or R^{RoW}. Also, unaccustomed agents become accustomed with some probability $\tilde{\theta}_t$. Finally, in period t the price of D-goods is 1 for unaccustomed agents. With these changes the variance of consumption growth is

$$\begin{aligned}\mathrm{Var}(g_{t+1}) = \beta^2\Bigg\{ & \left(\frac{\phi_t}{p_t}\right)^2\left[\left(\frac{1}{e_{t+1}}\right)^{2\alpha}\tilde{\theta}_t+1-\tilde{\theta}_t\right]\frac{\sigma^2}{12} + \\ & \tilde{\theta}_t(1-\tilde{\theta}_t)\left[\phi_t\left(\frac{\mathbb{E}z_{t+1}+p_{t+1}}{p_t}\right)+(1-\phi_t)R_t\right]^2\left[\left(\frac{1}{e_{t+1}}\right)^{\alpha}-1\right]^2\Bigg\}.\end{aligned}$$

For US unaccustomed agents R_t is the interest rate in the US. For RoW agents R_t is the interest rate in RoW.

Finally, for DiEco's agents, we can derive the variance using the same procedure but with the end of period wealth at $t+1$ given by

$$a_{t+1} = \left(1+\frac{z_{t+1}e_{t+1}}{\omega}\right)p_{t+1}k_{t+1}+f_{t+1}-s_{t+1}, \tag{A.18}$$

and with the investment policies,

$$p_t k_{t+1} = \phi_t \beta a_t, \tag{A.19}$$

$$\left(\frac{1}{R_t^S}\right)\left(f_{t+1} - s_{t+1}\right) = (1 - \phi_t)\beta a_t. \tag{A.20}$$

The resulting expression for the variance of consumption growth is

$$\text{Var}(g_{t+1}) = \left(\frac{\beta \phi_t e_{t+1} p_{t+1}}{\omega p_t}\right)^2 \left(\frac{e_t}{e_{t+1}}\right)^{2\alpha} \frac{\sigma^2}{12}.$$

The expression for DiEco's agents is much simpler because they do not switch type and they always pay the price e_t at time t and e_{t+1} at time $t+1$ for D-goods. The next period price e_{t+1} shows twice in the formula because for DiEco's agents the price of D-goods affects also their income, in addition to the cost of their consumption.