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Crypto as a Marketplace for Capital Flight

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Crypto as a Marketplace for Capital Flight

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ABSTRACT: This paper shows how cryptocurrency markets can fuel cross-border capital flight by serving as marketplaces that match counterparts with and without (illicit) access to FX. In countries where international transactions are restricted, crypto exchanges effectively allow domestic agents to pay a premium to buy foreign currency. The counterparts to these transactions are agents with access to FX, who sell crypto holdings purchased abroad. A stylized model illustrates that restricted foreign currency amid economic imbalances incentivizes these transactions via persistent crypto premia in local relative to global markets.
We analyze relative crypto pricing data in several country case studies, providing empirical support that crypto markets serve as marketplaces for capital flight that already took place, rather than a novel channel for capital flight. We make available a novel dataset on crypto market premia, which we propose as indicators of excess demand for foreign currency and capital control intensity. The dataset will be posted along with this paper and updated periodically.

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WORKING PAPERS

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1 Introduction

Over the past decade, cryptocurrencies have rapidly gained adoption globally, especially in emerging and frontier markets. The decentralized, borderless, and pseudonymous nature of cryptocurrencies has propelled their use to transfer funds across borders, especially amid capital controls, as documented by Graf von Luckner, Reinhart and Rogoff (2023). This has raised concerns among policymakers over the implications for macroeconomic and financial stability (Auer and Claessens, 2018; He et al., 2022; IMF, 2022a, 2021; Copestake et al., 2023b). In this paper, we investigate the mechanisms through which crypto markets can undermine capital flow management and exchange rate policies.[1] For ease of reference, we use the term ”capital flight” to refer to capital outflows that circumvent restrictions.

We argue that crypto exchanges effectively serve as marketplaces for capital flight. That is, these exchanges provide a platform to match counterparts who want to buy and sell access to foreign exchange amid restrictions on external transactions. At its core, the mechanics of crypto as a marketplace for capital flight are simple. In countries that restrict access to foreign exchange, macroeconomic imbalances and financial stability concerns can lead to excess demand for FX. Residents cannot convert local currency using the official exchange rate and are willing to pay a premium to obtain FX. Typically, crypto exchanges allow residents to convert local currency into crypto, which they can then sell for hard currency on a foreign crypto exchange. The counterparty to this transaction is an agent seeking to make the reverse transaction (e.g. for remittances); or someone with access to FX (often illicit).[2] By using FX to buy crypto in the global market and selling it domestically, the counterparty can ”earn” an arbitrage

[1]The relevant restrictions to international transactions include Capital Flow Management Measures (CFMs, often referred to as capital controls), exchange restrictions (which relate to current international transactions such as payments for imports), and multiple currency practices (i.e., measures that impose different exchange rates for different types of transactions). In this paper, we use the terms restrictions to external transactions, capital controls, and CFMs interchangeably, as most measures relate to restrictions to capital flows.

[2]A typical way in which capital flight traditionally takes place is misinvoicing of trade. For example, exporters may underinvoice exports, repatriating only a portion of their export proceeds at the official exchange rate. The remaining export proceeds could then be used to purchase cryptocurrency on the global market.

premium that the resident is willing to pay. The domestic crypto exchange thus matches the two counterparties to that transaction, serving as a marketplace for capital flight.

A key feature of this marketplace is a crypto FX premium, which balances supply and demand for FX in the crypto market place. This premium can be defined as the price of crypto observed in local currency relative to the price of crypto on the global market (expressed in local currency using the official exchange rate). Other things equal, the greater the excess demand for FX, the higher the premium. Also, the more restricted international transactions are, the higher the premium. The premium is what drives supply of FX to the local market. Since the domestic supply of FX is scarce, additional supply is typically obtained via capital flight (i.e. the evasion of capital controls). As a result, crypto markets reinforce traditional channels for capital flight (such as trade misinvoicing) by making it possible to monetize access to capital flight on the crypto market.

In this paper, we develop a stylized portfolio choice model to examine the interplay of buyers and sellers of crypto under different settings. We show how in countries with currency pressures amidst binding capital controls, restricted supply of foreign exchange leads to the emergence of persistent crypto FX premia relative to global market prices.

We then examine crypto price data from centralized exchanges over the 2019-2024 period to provide country case study evidence corroborating the model's predictions. Consistent with theory, we document near price parity across crypto exchanges under open financial accounts, while substantial deviations arise when external transactions are severely restricted. Time series data on crypto FX premia show spikes when external restrictions are introduced or tightened, suggesting that these premia can be interpreted as "shadow exchange rates" that reflect imbalances in the supply and demand for FX. We argue that these data contain valuable signals on FX pressures during periods of stress, especially in near-crisis situations. We propose using real-time data on crypto shadow exchange rates as a novel empirical indicator for monitoring the buildup of currency devaluation pressures. This new dataset on crypto shadow

exchange rates is made available online and will be updated periodically. Our analysis shows that crypto assets generally do not provide a new channel for capital flight. Instead, the traditional channels (such as trade misinvoicing) persist, and can get amplified through the role of crypto exchanges, which can provide an easy and lucrative way to monetize access to FX. We discuss associated regulatory challenges and argue that most countries actively managing capital flows have adjusted their crypto regulations in concordance with these findings, as evidenced by the stark correlation between financial account restrictions and bans on crypto trading.

It is worth noting that there are several other important motives for the use of crypto assets in cross-border transactions, aside from pursuing capital flight. Additional motives include (1) investment/speculation to benefit from potential price gains; (2) cost-effective transfer of remittances; (3) illicit activities including money-laundering, taking advantage of the pseudonymous nature of crypto assets; and (4) other cross-border payments, taking advantage of the high speed at which transactions can be executed. The focus of this paper is the capital flight motive.

The rest of this paper is organized as follows. Section 2 provides a brief overview of previous studies exploring the link between the use of cryptocurrencies for cross-border and cross-currency transactions and the existence of capital flow management measures. Section 3 introduces the illustrative model and shows why relative prices are more informative regarding capital flight than crypto trading volumes. The following section 4 presents four country case studies in support of the assertions made in section 3 and shows that crypto regulators have generally acted in concordance with the idea that crypto exchanges can reinforce traditional channels for capital flight. Section 5 and the conclusion discuss policy implications and highlight questions left for future research.

2 Literature

Our paper builds on the existing body of literature that documents the use of cryptocurrencies for cross-border and cross-currency transactions. Graf von Luckner et al. (2023) examine off-chain peer-to-peer transactions involving bitcoin to identify trades in which the crypto currency is used to make cross-border and cross-currency transfers (rather than to ”invest” in Bitcoin itself). Importantly, the authors find such trades to be most common in economies with capital controls and exchange restrictions in place. Focusing on the case of China, Hu et al. (2021) identify traders that buy bitcoin at Chinese exchanges and sell it at foreign exchanges with the aim of circumventing China's outflow capital controls. The authors find that the aggregate volume of trades that evade capital controls is sizable and positively associated with Chinese economic policy uncertainty and the bitcoin premium in Renminbi.

Using survey data and cross-country correlations, Alnasaa et al. (2022) confirm that crypto-asset use has a significant positive association with increased perceived corruption and the intensity of capital controls. Chen and Sarkar (2022) confirm the importance of capital controls as drivers of price differences across countries: in particular, price differences are found to correlate with the time-variant intensity of capital controls. The present paper builds on this finding and proposes to make use of the price differential of crypto in the local vs. the external market as an indicator of excess demand for foreign currency (with the dataset made available online as a public good).

In addition to serving as a vehicle for cross-border transactions, crypto assets have also been found to serve as hedging instruments against exchange rate and inflation risks — particularly in countries with weaker economic fundamentals (IMF, 2021). Cerutti et al. (forthcoming) find that cross-border flows via bitcoin behave differently from portfolio capital flows as they are less sensitive to traditional drivers like the VIX and the U.S. dollar.

Our work also relates to prior research documenting the cross-county (and cross-exchange)

differences in relative prices (Makarov and Schoar, 2020; Borri and Shakhnov, 2022; Hu and Zhang, 2023; Pieters, 2016; Pieters and Vivanco, 2017; Tang and You, 2021; Borri and Shakhnov, 2022) and studies that analyze the drivers of crypto prices (Liu and Tsyvinski, 2021; Glaser et al., 2014; Garcia et al., 2014). Our model and empirical evidence align with the view that longstanding premia in relative prices of crypto currencies reflect macro imbalances in the presence of of financial account restrictions; rendering them similar to parallel, or *black market* exchange rates.[3] Other works have instead described such price differences to be driven by risk premia (Borri and Shakhnov, 2022); differences in regulation (Pieters and Vivanco, 2017) or cultural levels of distrust prevalent in a given country (Tang and You, 2021).

Other works that have studied the impact of cryptocurrencies on macroeconomic policies more broadly include Benigno et al. (2022), which argues that the presence of a globally traded crypto currency would force countries with open financial accounts to homogenize their interest rates, or risk national currencies becoming redundant, turning Mundell-Fleming's Impossible Trinity into a Dilemma. Enajero (2021) adds that because cryptocurrencies are both a medium of exchange and a store of value, widely adopted cryptocurrencies could remove any effects of real exchange rate devaluations in small open economies. And Copestake et al. (2023b) analyze the effects of a widely adopted stablecoin in a small open economy, arguing that it can amplify currency substitution and capital outflows in response to negative shocks.

Finally, our work relates to the broader literature on crypto currency regulation, as in Auer and Claessens (2018); Copestake et al. (2023a); IMF (2022a). For example, IMF (2022a) argues for capital control laws and regulations to be effective in the digital age, it is imperative that capital control laws and regulations cover crypto assets. Moreover, the study emphasizes that an important input into effective capital flow management in the age of cryptocurrencies is to address data gaps and facilitate timely risk monitoring to support capital control implementation. The present paper aims to make a contribution towards that objective by laying

[3] A view also supported by Makarov and Schoar (2020); Graf von Luckner et al. (2023) and Pieters (2016), inter alia.

out a framework for monitoring excess demand for foreign currency and providing a dataset to facilitate such monitoring.

3 A Stylized Illustrative Model

3.1 Conceptual Framework: Capital flight via Crypto Vehicle Trades

While the academic literature has converged on the view that cryptocurrencies can help facilitate cross-border capital flight and enable individuals to circumvent capital controls (Graf von Luckner et al., 2023; Hu et al., 2021; Ju et al., 2016), the mechanism and piping of this novel driver for capital flight remain nebulous. In particular, countries that struggle with capital flight generally prohibit the use of domestic funds for purchasing crypto assets on markets outside the country. Therefore, capital flight via crypto assets is not simply a matter of a resident selling a domestic asset for a foreign (crypto) asset. Instead, residents purchase cryptocurrencies domestically (i.e., from other residents) in order to exchange them for foreign currencies abroad (a so-called crypto vehicle trade [4]).

Clearly, a crypto asset that is changing hands between residents of the same country does not itself constitute capital flight. How does the underlying capital flow transaction take place then? Put differently: How can crypto transactions facilitate capital flight? And what information can data from crypto exchanges provide about the dynamics of underlying capital flight and the effectiveness of capital controls?

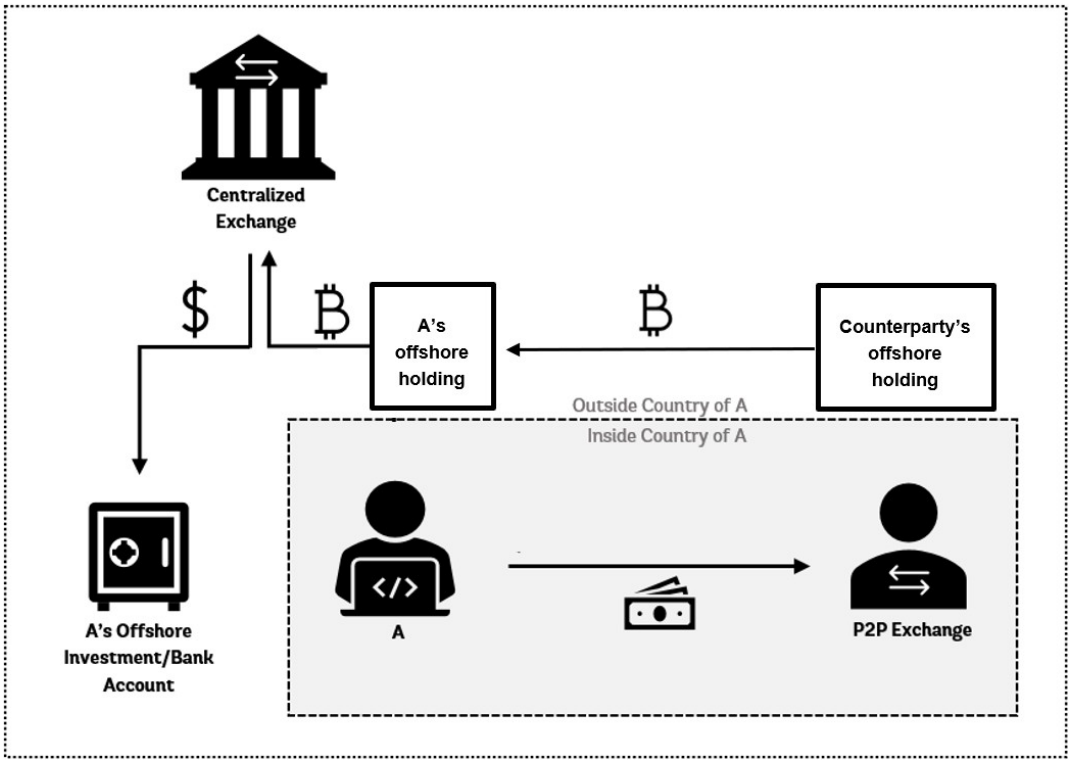
To answer these questions, we will first illustrate how crypto vehicle trades work, and then embed these transactions in a stylized portfolio choice model to illustrate their macro impact. Figure 5 below illustrates a crypto vehicle transaction. Imagine person A, seeking to exchange her local currency bank savings for offshore bank deposits in foreign currency. When capital controls impede such an exchange via a bank transfer, A can purchase cryptocurrency with her

[4] A crypto vehicle trade describes a transaction in which a cryptocurrency is used to make cross-border and cross-currency payments rather than for investment purposes. See Graf von Luckner et al. (2023) for a detailed discussion.

local currency savings (from a resident of her country). Then, A can sell the cryptocurrency overseas in exchange for foreign currency, which can then be moved to A's offshore bank account.

From an accounting perspective, the cryptocurrency can be thought of as a foreign asset, regardless of whether A held control over it. A useful analogy is to think of purchasing crypto currency from another resident as akin to purchasing the key to an overseas bank locker from another resident: The stock of foreign assets held at the national level is unaffected by such a transaction. In other words, although A clearly achieved her objective of moving her savings abroad, the crypto purchase leaves the national net foreign assets unaffected. So how did the capital flow take place that we observe in A's portfolio? To preview the answer, the model shows that the crypto trade is akin to a buying access to FX for a given amount on a market place (after the capital flight has already taken place).

Figure 1: Illustration: Capital Flight via Crypto Vehicle Trades



Based on Graf von Luckner et al. 2023

3.2 The Model

To illustrate the incentives that drive the supply of and demand for crypto assets in the presence of capital controls, we develop a simple portfolio choice model, entailing capital allocation across domestic currency, a crypto asset and foreign currencies. The crypto currency can be used for crypto vehicle trades (i.e. exchanged for foreign currency abroad), or simply be held as an asset.

The model economy features N agents to hold savings in any combination of three assets (which we assign the subscript j): local/domestic currency (L), an international crypto currency (B) and a foreign currency (F). Each agent chooses portfolio weights w_L, w_B and w_F to allocate savings, S, at the start of every period. The exchange rate e_F and e_B are the price of the respective currency expressed in terms of the local currency (e^e_{t+1} indicates an anticipated/expected exchange rate). At the onset we assume L and F trade at unitary value; and that the crypto currency is a stablecoin, so that it always trades at unitary value with the foreign currency **in international markets**. Because markets are not fully integrated (due to FX controls), the same does not need to hold on the domestic market. Agents allocate their savings so as to maximize the expected future portfolio value, V_{t+1}, denominated in domestic currency terms at the future exchange rate, e_{t+1}. Agents can trade assets and adjust portfolio allocations each period. $\sum w_j = 1$, i.e. portfolio weights must sum to one; and neither the shorting of assets nor leverage exist, so that

$$0 \leq w_j \leq 1 \forall j$$

There are no barriers to trading the crypto currency with foreign currency or moving between domestic and crypto currency. The exchange between domestic and foreign currency is subject to capital controls (a quota Q), restricting how much agents can adjust their foreign currency

position.

$$max(V_{t+1}) = S_t \times (w_D + w_F(1 + \Delta e_{F,t+1}) + w_B(1 + \Delta e_{B,t+1}))$$

$$s.t.\ S_t \Delta w_F \leq Q$$

3.3 The Modeled Shock

Assume a confidence shock affects a subset of the population, a_N, who now expect a devaluation of the local currency in the near future. a_N hence seek to move their savings into crypto or foreign currencies. Using up their assigned quota, they increase w_F up to the constraint and move a stock of

$$\sum_{i \in a_N} Q_i$$

abroad. Leaving

$$\sum_{i \in a_N} w_{D,i,t-1} S_i - Q_i$$

of savings in the hands of residents seeking to exchange them. For simplicity, we only denote time-subscripts when $t \neq 0$. The only remaining legal way for residents to move money abroad is to buy the cryptocurrency, B, which is not subject to the quota or any other capital controls or restrictions.[5] Residents who expect a devaluation, so that $e^e_{B,i} > 1$, will seek to exchange their remaining assets for B, as long as $e_B = 1$, so that the a_N's maximum demand for crypto is $\Delta w_{B,i} S_i = \sum_{i \in a_N} w_{D,i,t-1} S_i - Q_i$.

Eventually, marginal demand will depend on whether the devaluation expected by the agent exceeds the premium of crypto currency on the market, which is not regulated. Therefore, the total demand for crypto currency, D_B, becomes a function of e_B. Assuming that the expected future exchange rate, e^e_i, and hence the degree of the expected devaluation, is not uniform over

[5] In reality, another way to access foreign currency could be via black market exchanges for hard currency, often prevalent under circumstances such as those modelled here. We abstract from these in the model, but they follow similar dynamics, reflected in the fact that the premia paid for crypto and hard currency cash in these markets are generally similar. Arguably, crypto would be the preferred asset when both options exist, thanks to its borderlessness and high liquidity compared to hard currency cash "under a mattress."

a_N, there is a downward sloping marginal demand curve for additional capital flight[6].

$$D_B(e_B) = \sum_{i \in \alpha_N} \Delta w_{B,i}(e_B, e^e_{B,i}) S_i$$

To investigate market clearing conditions, in the following, we will derive an inverse supply schedule by showing who supplies crypto currency under what conditions and at what prices. Building this supply schedule gradually will allow to illustrate (1) that whether the capital movements in the portfolio are net foreign asset neutral for the country depends on the supplier; and (2) what type of supply occurs at higher relative prices. To illustrate this, we present possible demand and supply schedules graphically,

3.3.1 Scenario one, with a large domestic stock of crypt $\sum_{i \notin \alpha_N} S_i w_{B,i,t-1} \geq \sum_{i \in \alpha_N} w_{D,i,t-1} S_i - Q_i$

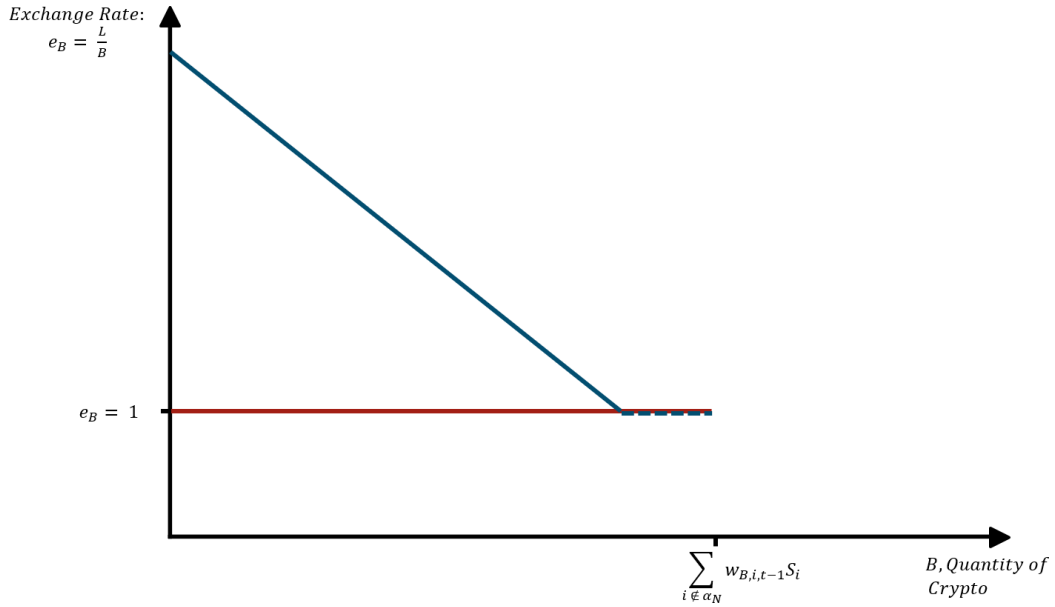
Crypto assets can either be bought abroad with foreign currency or domestically with domestic currency. The demand for crypto within the economy can hence only be satisfied with domestic crypto holdings (having been purchased before) and abroad with foreign currency. It follows that as long as there is a crypto stock held by agents indifferent between holding cryptocurrency or domestic currency, which is at least as large as the asset stock seeking to flee, $\sum_{i \in / \alpha_N} S_i w_{B,i,t-1} \geq \sum_{i \in \alpha_N} w_{D,i,t-1} S_i - Q_i$, there is sufficient supply of the crypto asset available to satisfy the demand for crypto caused by the shock. The agents seeking to hedge their savings from the expected devaluation simply exchange all their local currency savings for crypto. They can then either keep these savings in crypto, or exchange them for F in a market abroad. Importantly, although one would observe trading activity in crypto markets, all of the crypto transactions made do not affect the country's net foreign asset position. Moreover, ceteris paribus, the three currencies continue to trade at unitary value at time t, so the deval- uation in $t + 1$, anticipated by some, does not translate into a devaluation at time t. Figure 2

[6] Note that, as mentioned above, $D_B(\overline{e_B}) = \sum_{i \in \alpha_N} w_{D,i,t-1} S_i - Q_i$ for $e_B = 1$

depicts this scenario with an illustrative inverse demand schedule. The inverse supply function, ϵ_B^S for this first scenario is thus simply:

$$e_B^S = \begin{cases} 1, & \text{for } \sum_{i \notin \alpha_N} w_{B,i,t-1} S_i \geq \sum_{i \in \alpha_N} \Delta w_{B,i} S_i \end{cases}$$

Figure 2: Scenario One: Capital Flight Without Affecting (Shadow) Exchange Rates.



When $e_B < 1$, demand is infinite (indicated by the dotted line), because of unrestricted and technically unlimited arbitrage profits.

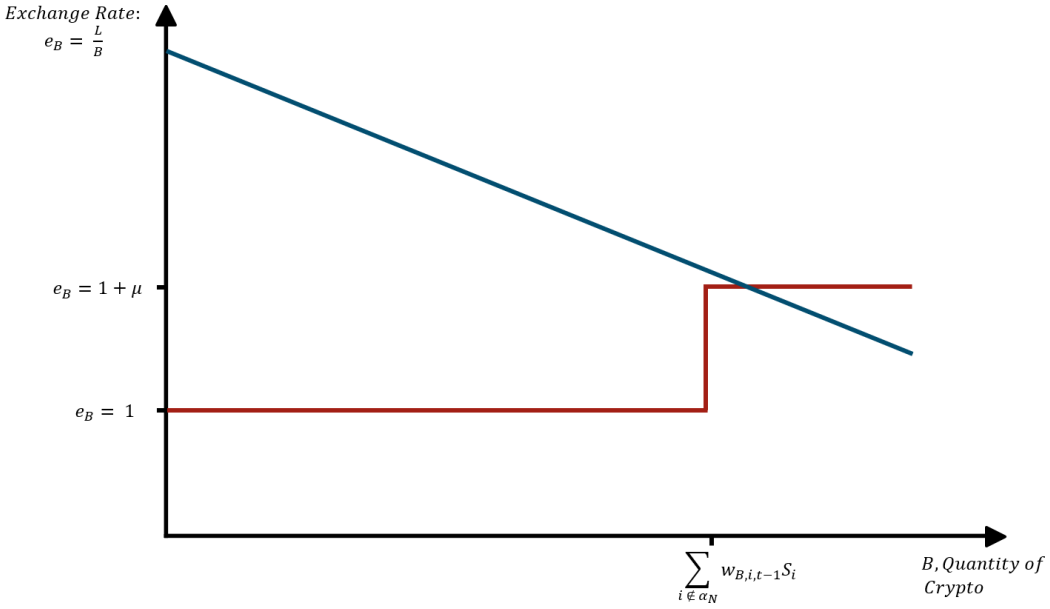
3.3.2 Scenario two, with an insufficient domestic stock of crypto, $\sum_{i \in / \alpha_N} S_i w_{B,i,t-1} < \sum_{i \in \alpha_N} w_{D,i,t-1} S_i - Q_i \sum$

When after the quotas have been used up, the stock of savings in the hands of residents that expect a devaluation exceeds the stock of available cryptocurrency, an imbalance arises. Demand exceeding supply leads to an increase in crypto prices. Because all residents that do not expect a devaluation, $i \notin \alpha_N$, have not yet used up their quotas, the relative price has to increase to a level at which they are incentivized to use their quota, exchange foreign currency for crypto assets abroad and sell it on the domestic market. Assuming a *reservation*

compensation μ (akin to a reservation wage) above which they do so, a new source of supply arises, leading to a new equilibrium in the market, depicted in figure 3.

$$e_B^S = \begin{cases} 1, & \text{for } \sum_{i \notin \alpha_N} w_{B,i,t-1} S_i \geq \sum_{i \in \alpha_N} \Delta w_{B,i} S_i \\ 1+\mu, & \text{for } \sum_{i \notin \alpha N} w_{B,i,t-1} S_i < \sum_{i \in \alpha N} \Delta w_{B,i} S_i \end{cases}$$

Figure 3: Scenario Two: Trading Foreign Exchange Quotas on Crypto Markets.



The differences to the scenario with large domestic crypto stocks are important. First, some of the supply now stems from residents using their foreign exchange quotas they otherwise did not have an incentive to use. Hence the crypto market spurs additional capital flight that otherwise would not have occurred. Moreover, the relative prices of crypto trade at a premium relative to the domestic market.

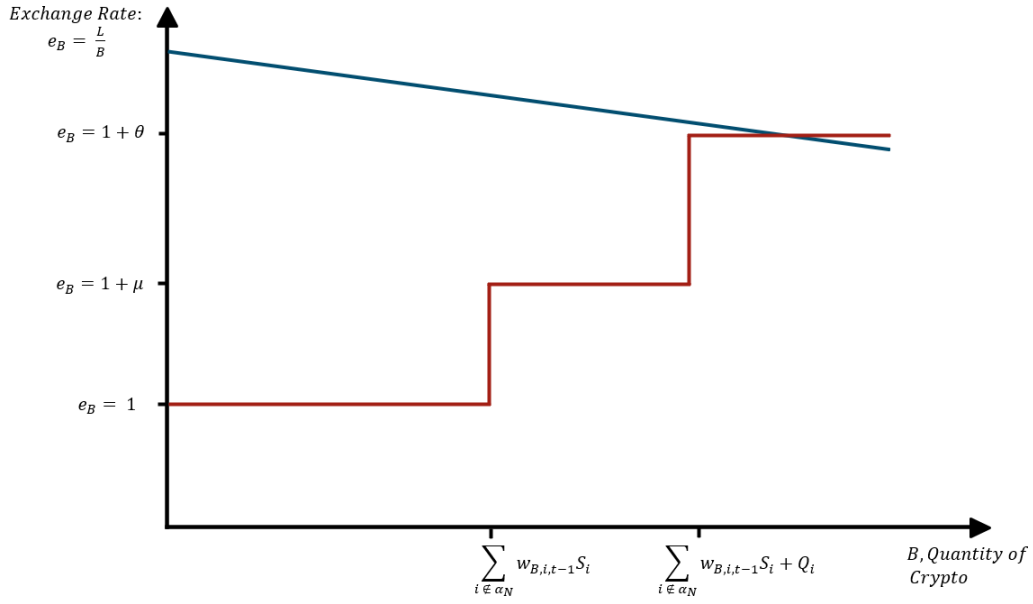
3.3.3 Scenario three, with an insufficient domestic stock of crypto and additional capital flight channels, $\sum_{i \in / \alpha_N} S_i w_{B,i,t-1} + Q_i < \sum_{i \in \alpha_N} w_{D,i,t-1} S_i - Q_i$

Assume the demand for capital flight via crypto exceeds even the sum of domestic crypto holdings and the quotas the ”indifferent” population can use to increase supply and make an

arbitrage profit. With such outflow pressures, some agents find ways to circumvent the capital controls. Assume a small subset, Θ_N of N, can mis-invoice exports/imports and obtain foreign currency well beyond their quota. Assuming their cost of capital control evasion is θ, including the arbitrage reward they seek to take on the risk of detection. There is then a third source of supply so that:

$$e_B^S = \begin{cases} 1, & \text{for } \sum_{i \notin \alpha_N} w_{B,i,t-1} S_i \geq \sum_{i \in \alpha_N} \Delta w_{B,i} S_i \\ 1+\mu, & \text{for } \sum_{i \notin \alpha_N} w_{B,i,t-1} S_i < \sum_{i \in \alpha_N} \Delta w_{B,i} S_i \\ 1+\theta, & \text{for } \sum_{i \notin \alpha N} w_{B,i,t-1} S_i + Q_i < \sum_{i \in \alpha_N} \Delta w_{B,i} S_i \end{cases}$$

Figure 4: Scenario Three: Trading Illicit Capital Flight.



In scenarios two and three, residents could also engage in contracts to get access to others' unused quotas/channels for capital flight. The crypto market simply facilitates matching, price discovery and execution.

3.4 Takeaways

The stylized model offers two critical insights: (A) cryptocurrencies primarily function as tokens for trading access to capital flight, and (B) they provide valuable information on capital flow pressures, namely by comparing their price in local currency to that in the global market.

Moreover, the model yields important insights for external sector accounting. It demonstrates that methods used to determine the size of flows, as presented by Graf von Luckner et al. (2023) or Hu et al. (2021), may not equate to net capital flows due to existing crypto stocks, as discussed earlier. The crypto stocks held by residents play a crucial role. When $\sum_{i \in / \alpha_N} w_{B,i,t-1} S_i = 0$, any crypto transaction facilitating a's capital flight affects the country's net foreign asset (NFA) position. Conversely, when $\sum_{i \in / \alpha_N} w_{B,i,t-1} S_i > 0$, so there are residents with crypto holdings that are indifferent between holding cryptocurrency and the local currency, sales of crypto assets can occur without impacting the country's NFA. So the relationship of the associated flow with net capital flows is ambiguous.

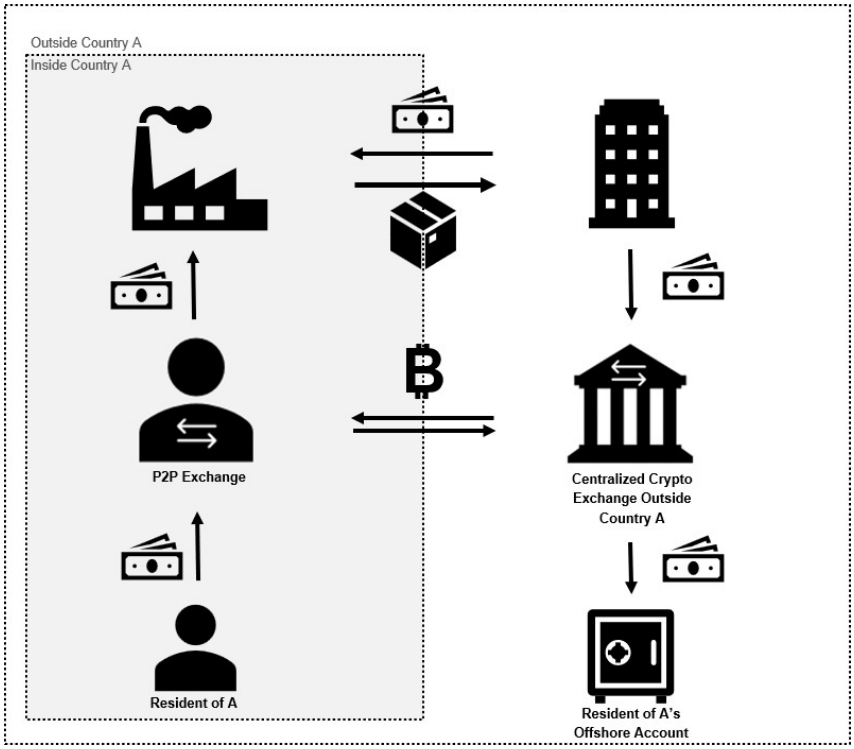
Meanwhile, the relative price of the crypto currency is a less ambiguous macro indicator, containing potentially important information about (1) macro imbalances that spur outflow pressures, which affect e_B via shifts in the demand curve; and (2) the tightness of capital controls. There are two channels through which tighter capital controls affect the relative price of crypto. First, tighter controls make it more expensive to evade restrictions to provide liquidity in crypto markets, hence increasing the cost of supply at the market equilibrium (which enters the model via an increase in θ). Second, holding S and a_N constant, the smaller Q, the more demand there is for crypto vehicle transactions.

The empirical evidence presented in Hu et al. (2021) is a real world example of the phenomenon described in the stylized model's scenario one and two. The authors show that during the period when cryptocurrency transactions were unregulated and China had a USD 50,000 dollar quota on foreign transactions, individuals frequently bought cryptocurrencies

more cheaply in neighboring countries to sell them at a risk free profit in China right after, a behavior captured by the above model.

However, the model's conclusions also hold in countries and at times when capital controls are not based on a quota but take on different forms, which we try to illustrate with scenario three. This is true as long as certain sectors/agents have privileged access to foreign currency. One example for agents predisposed to take on the role of liquidity providers, could indeed be foreign financial firms, which in many instances are excluded from capital controls (AREAER, 2023). Moreover, certain firms can access capital flight channels (such as trade misinvoicing) more easily than others. Crypto markets allow them to monetize these channels on a market place that is widely accessible.

Figure 5: Illustration: Capital Flight via Crypto Vehicle Trades



The case of Argentina serves as an example (see also the discussion in Graf von Luckner, Reinhart and Rogoff, 2023). Since 2019, Argentina has had tight restrictions on external transactions in place, strictly limiting the movement of capital abroad through official channels.

Further, exporters of commodities/agricultural products have typically been required to repatriate proceeds from exports, often at a less favorable exchange rate than the market exchange rate (IMF, 2022b). Commodity exporters thus have an incentive to understate the amounts exported, and repatriate only a portion of the proceeds through the official market. Yet, these firms may still want to move the unreported export proceeds back to Argentina. By purchasing large amounts of crypto assets and moving them into local exchanges, these commodity exporters are able to repatriate their FX proceeds at a more favorable exchange rate. Figure 5 illustrates such a dynamic, and how crypto markets can serve as a match-maker between exporters with illicit access to FX and individuals seeking to move capital abroad.

3.4.1 When B can be mined

Some crypto assets, such as bitcoin, can be mined. This means the stock of B inside the country can change over time, without the purchase and repatriation of B from abroad. In the case of bitcoin, the stock in a country can instead be increased by turning electricity into computing power, which yields mining rewards. Because energy is tradable (in the form of oil, gas or electricity), the marginal increase in energy consumption used for mining can directly affect the country's balance of payments. The marginal increase in energy consumption may either increase the amount of energy imported (in the case of a net energy importing country) or decrease the amount exported (for a net exporting country).

In this setup, the model's conclusion that crypto provides a marketplace for already effectuated capital flight may still apply, depending on how the proceeds from crypto mining are used. In some countries, crypto mining may be used mainly to get around capital controls, while in others (notably those with open financial accounts) crypto mining may be a source of external revenue. In the former case, the main difference to the modeled scenarios is that crypto mining becomes the channel for capital flight (rather than misinvoicing of exports/imports; or the illicit use of quotas for the purchase of crypto).

Incidentally, crypto mining may inadvertently provide individuals a channel to transfer their money abroad at the more favorable official exchange rate (compared to the parallel market rate). This is because energy is typically imported at the official exchange rate, and thus can be purchased at a discount that one can think of as a subsidy financed with a country's foreign reserves. Any agent with the necessary hardware (mining rigs) could thus purchase the energy and mine bitcoin in order to sell it abroad – or domestically at the higher crypto shadow exchange rate. This is in line with anecdotal evidence from Argentina and Lebanon in the early 2020s, where mining activity suddenly increased as capital controls and exchange restrictions became binding and subsidized energy prices made mining especially attractive.[7]

4 Empirical Analysis

The model in section 3 provides a number of direct and indirect hypotheses we seek to corroborate in the data.

Hypothesis 1: In line with the model and scenario 1, in the absence of binding capital controls, the law of one price should hold, and there should be no persistent crypto shadow premia.

Hypothesis 2: In line with scenarios two and three, when capital controls are binding in the context of a non-freely floating exchange rate, relative prices of crypto currencies should increase in the domestic market.

Hypothesis 3: If regulators are aware of crypto markets rendering their imposed capital flow measures less effective, the prevalence of crypto bans should be highest in countries with closed financial accounts.

The different scenarios outlined in section 3 are most relevant for understanding developments in emerging and frontier economies. To apply the insights from the model scenarios to patterns observed in the data, we examine the relative prices of bitcoin on the local vs. the U.S.

[7] For anecdotal evidence, see for example here or here.

market over time. These relative prices can be thought of as a crypto-based shadow exchange rate, i.e. a parallel exchange rate implied by the relative price of the crypto asset:

$$CryptoShadowRate_{\frac{LCU}{USD}} = \frac{BTC_{LCU}}{BTC_{USD}}$$

Where BTC_{USD} and BTC_{LCU} are the prices of Bitcoin, in international markets, quoted in US Dollar (USD); and in the local market, quoted in local currency units (LCU), respectively.

Next, we present a set of examples of countries and their respective crypto shadow exchange rates, starting with countries that have open financial accounts, where no crypto shadow premium should exist, and then moving to economies that were tightening/loosening existing capital controls or introducing new ones. We analyze the effects of these actions on crypto shadow rates and discuss how they align with the model's predictions.

4.0.1 Data

The data used to calculate the crypto shadow exchange rates draw on a range of sources openly accessible online. With one exception (Egypt), we use data from centralized exchanges, which provide less noisy data on crypto prices in local markets. The reduction in noise stems from (A) removing counterparty risks typical in P2P exchanges, since centralized exchanges act as the counterparty to any buyer or seller, and (B) greater liquidity that reduces spreads and facilitates sufficiently deep markets to absorb sudden increases in crypto demand/supply. After sourcing the daily closing price and volume data from available exchanges listed with the data provider *CC Data, formerly knows as Crypto Compare* for the period between January 1, 2019 and July 13, 2023, we further remove exchange-specific noise by calculating the trade-volume weighted average across the prices from different exchanges. For the case of Egypt, where no centralized exchanges exist, we source P2P buy and sell offers data from Binance. The data are made available for download at [insert link to imf.org/...], together with this paper and will

be updated periodically.

4.1 Case Studies

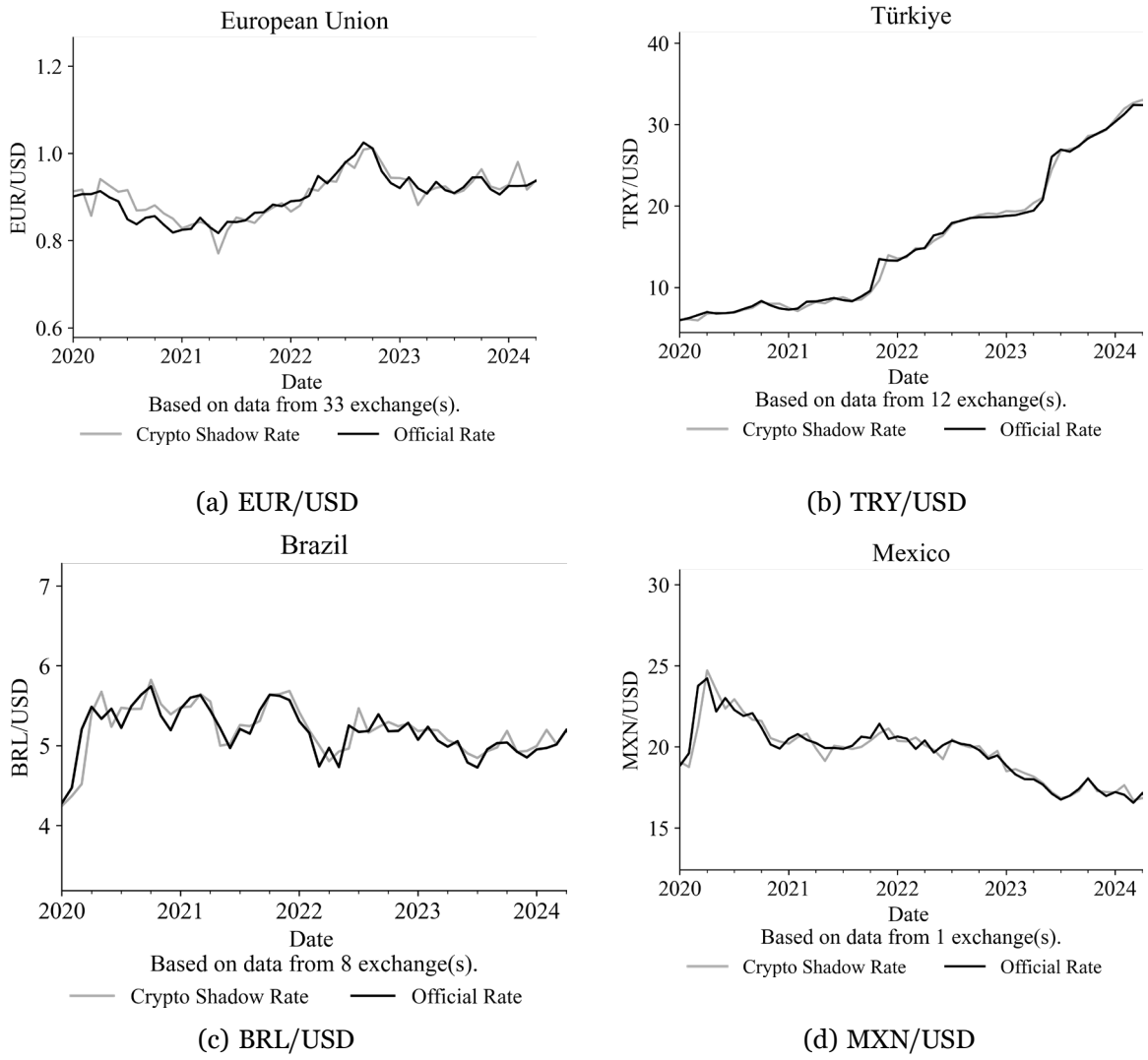
4.1.1 Case One: When external restrictions are limited the law of one price holds

It follows from section 3 that when a country has an open financial account and there are only limited restrictions on external transactions, there should be no significant price premium. When demand for crypto assets exceeds the existing domestic stock, arbitrageurs can use legal channels to move capital abroad, purchase crypto and offer it on the local market until the arbitrage spread is minimal. Figure 6 shows for a selection of economies with relatively open financial accounts (the euro area, Türkiye, Brazil and Mexico) that the price differential between crypto in local currency and in the global market is indeed very small. The law of one price is enforceable by arbitrage traders. Importantly, this holds even during periods of financial stress, as long as regulators allow for free financial flows, as is shown anecdotally via the example of Türkiye (top right corner).

Aside from providing evidence to support hypothesis one, the crypto data from these cases are uninteresting for investigating capital outflow pressures, as there is no reason to believe that official capital flow data are inaccurate. In fact, arbitrage transactions facilitating the crypto vehicle flows would typically be recorded in official financial account data (or in the current/capital account, depending on the country's accounting conventions). A useful example is Brazil, where the central bank publishes estimates of capital in- and outflows made to purchase/sell crypto in its balance of payments statistics (Cardozo et al., 2023).

4.1.2 Case Two: Binding capital controls in the presence of macroeconomic imbalances

Many countries do not have open financial accounts. Instead, countries often impose limitations on free capital flows in support of a managed or pegged exchange rates (Calvo and Reinhart,



(a) EUR/USD

(b) TRY/USD

(c) BRL/USD

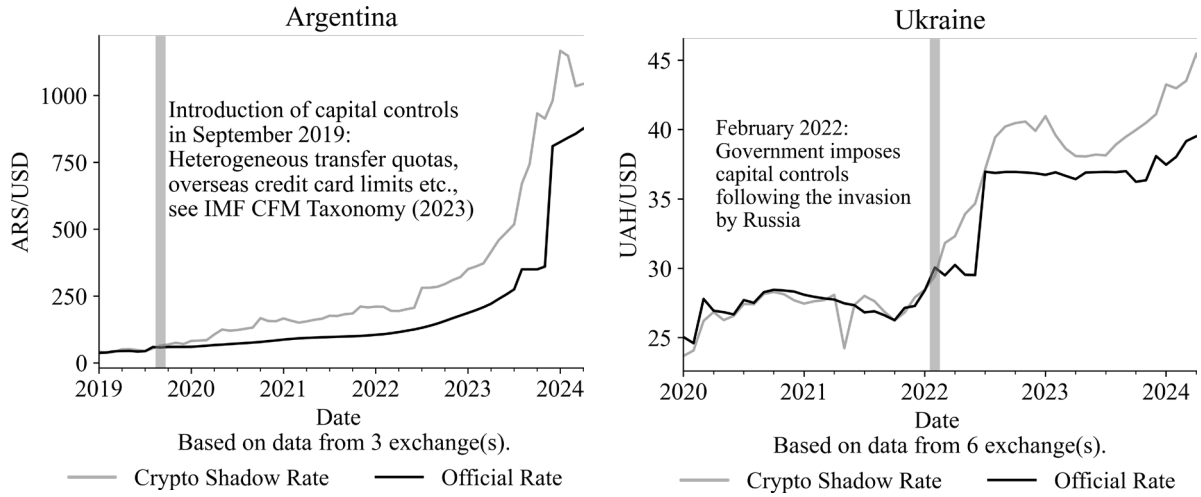
(d) MXN/USD

Figure 6: Crypto Shadow Premia in the Absence of Binding Capital Flow Measures, in Advanced Economies (top l.h.s.) and Emerging Markets (bottom l.h.s. and r.h.s.)

2002; Reinhart and Rogoff, 2 004)). Such controls are typically introduced or tightened in order to reduce demand for foreign currency, particularly when the central bank is not willing/able to supply sufficient foreign currency at the prevailing exchange rate to satisfy de mand. Our model suggests that when restrictions on external transactions are introduced, or suddenly tightened, significant crypto shadow rates should arise (hypothesis 2), reflecting excess demand for foreign currency. In the following, we present four country examples where such a dynamic appears to have been at play:

The first e xample i s A rgentina. Facing s ignificant im balances in th e 20 19 el ection year, the outgoing government reintroduced restrictions and set a narrow band within which the

exchange rate was to be maintained by the central bank (IMF, 2023d). Given Argentina's integration into the global economy, there were a variety of ways in which residents could get around official restrictions, so that a marketplace for capital flight quickly developed in the form of a liquid domestic market for crypto assets. Indeed, Graf von Luckner et al. (2023) document a stark increase in crypto trading in lockstep with the rise of the parallel exchange rate beginning late 2019.



(a) ARS/USD - Sources: Data from CryptoCompare API; Coingecko; Authors' Calculations.

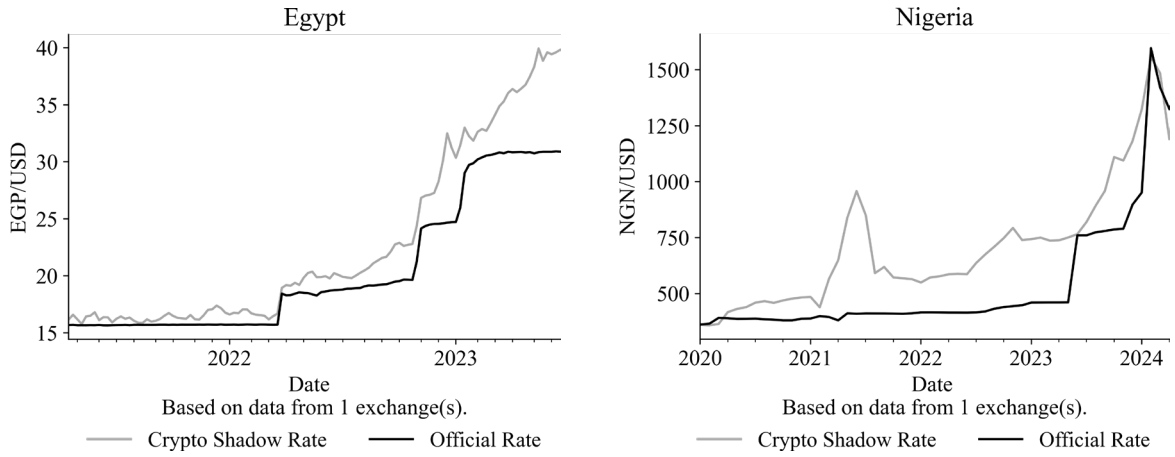
(b) UAH/USD - Sources: Data from CryptoCompare API; Coingecko; Authors' Calculations.

Figure 7: Crypto Shadow Premia in the Presence of Binding Capital Controls Around the Time These Measures are Introduced.)

The Ukraine example from 2022 differs from the Argentine case in that the imbalances in the FX market arose suddenly following the Russian invasion (IMF, 2023b), resulting in a sharp increase in crypto shadow premia. Overall, the dynamics follow the path suggested by the model in section 3 – macroeconomic imbalances in the presence of capital controls led to surging crypto shadow premia. Interestingly, Figure 7b also shows that when implementing a nominal devaluation, the new level of the exchange rate set by the Central Bank coincided with the level where the crypto shadow rate was trading at that time, pointing to the relevance of these data as an implicit parallel exchange rate. Since other parallel exchange rate data are not (systematically) available for many countries, crypto-based parallel exchange rates may contain important information for policymakers in countries with acute FX pressures and may

be a valuable input for their decisions when and to what level to devalue their currencies (see also Reinhart and Rogoff (2004) on parallel rates as a predictors of devaluations).

Two further country cases are Egypt and Nigeria, both of which have seen the presence of parallel exchange rates in the recent past. In both countries, we observe a rise in crypto shadow rates amid signs of excess demand for foreign currency. Both cases also support the notion that these premia can persist even after significant exchange rate devaluations, as long as underlying imbalances and capital controls continue to coexist (Gray, 2020). [8] [9]



(a) EGP/USD - Sources: Data from Binance, via Yadio API; Coingecko; Authors' Calculations.

(b) NGN/USD - Sources: Data from CryptoCompare API; Coingecko; Authors' Calculations.

Figure 8: Crypto Shadow Premia in the Presence of Binding Capital Flow Measures and Macroeconomic Imbalances.

4.1.3 Hypothesis Three: Crypto Bans

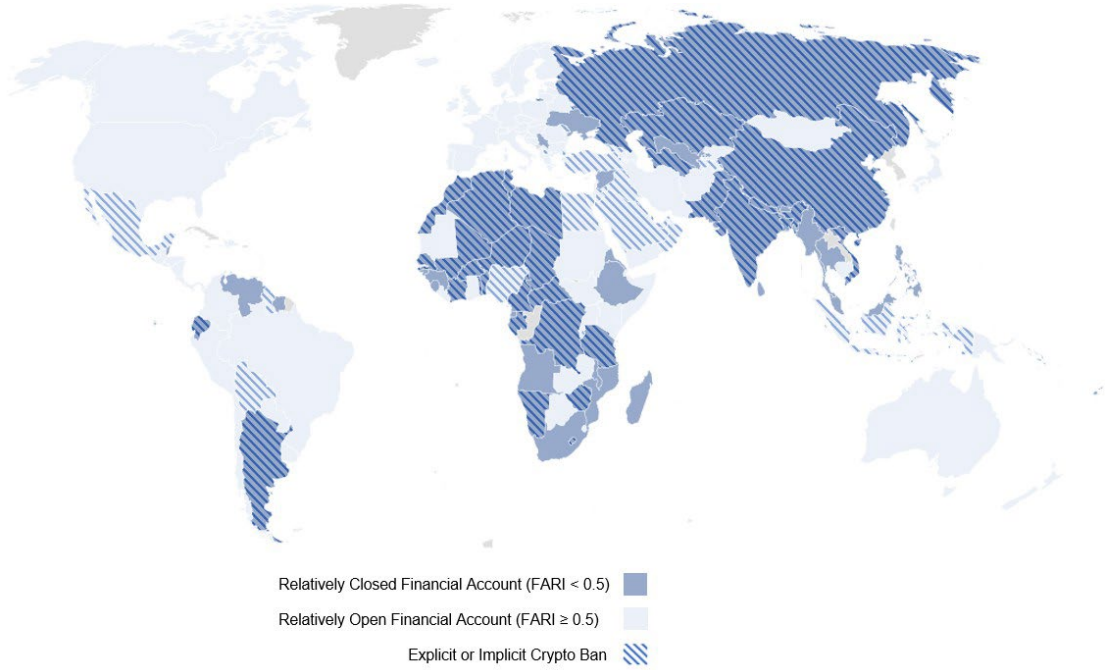
If liquid cryptocurrency markets serve as a marketplace for capital flight channels otherwise accessible only to few, should not governments seeking to restrict capital mobility regulate these markets or even close them down altogether? We investigate this hypothesis by comparing

[8] See Gray (2020) for a detailed discussion on the topic. For more information on the last pre-2020 episode of parallel exchange rates in Egypt refer to the "Arab Republic of Egypt: First Review Under the Extended Arrangement Under the Extended Fund Facility and Requests for Waivers for Nonobservance and Applicability of Performance Criteria-Press Release; Staff Report", published September 26, 2017, available here

[9] Note that Egypt is included here to illustrate an example, where the relative price of Bitcoin data can prove insightful, even when centralized exchanges are banned by law. However it is important to note that P2P data is often more noisy and less consistently available. The data post Q2 2023 in Egypt, is uninsightful because of a sudden drop in the liquidity in these markets.

countries with relatively closed financial accounts (Baba et al., 2024) [10]; with countries that have imposed bans of crypto.[11] Figure 9 shows that indeed, the overlap between countries that have capital controls in place and those that have imposed a ban on crypto assets is striking.

Figure 9: Financial Account Restrictiveness and Crypto Bans



Sources: Authors' illustration based on The Law Library of Congress, *Regulation of Cryptocurrency Around the World: November 2021 Update* ; and forthcoming *IMF Working Paper: New Measures of Capital Flow Restrictions — AREAER Indices* by C. Baba, R. Cervantes, S. Darbar, A. Kokenyne, and V. Zotova.

Sources: Baba et al., 2023; Library of Congress, 2021; News Sources

The binary classification in 9 provides a simplified representation of the range of policy choices both regarding the openness of the financial account and on crypto regulation. [12] Nonetheless, the strong correlation between these two indicators suggests that regulators and policy makers around the world have acted in concordance with the notion that crypto exchanges can add to capital outflow pressures by providing a marketplace for capital flight.

[10] We classify countries as closed, when their openness index (Baba et al. 2023) (ranging from zero to one) is below 0.5.
[11] The data on crypto regulation stems from the Library of congress and is updated by the authors.
[12] Not all crypto bans are created equal; while some countries have imposed severe penalties on crypto-related activities other countries have banned crypto without any enforcement.

5 Policy Implications

The analysis suggests that residents with access to traditional channels for cross-border capital flight can use crypto to sell their access to those residents seeking to move capital abroad. An important takeaway from this analysis is that the channels used to move capital across borders have not changed compared to the pre-crypto era. Instead, existing channels have been reinforced by the ability to monetize capital flight on the crypto market.

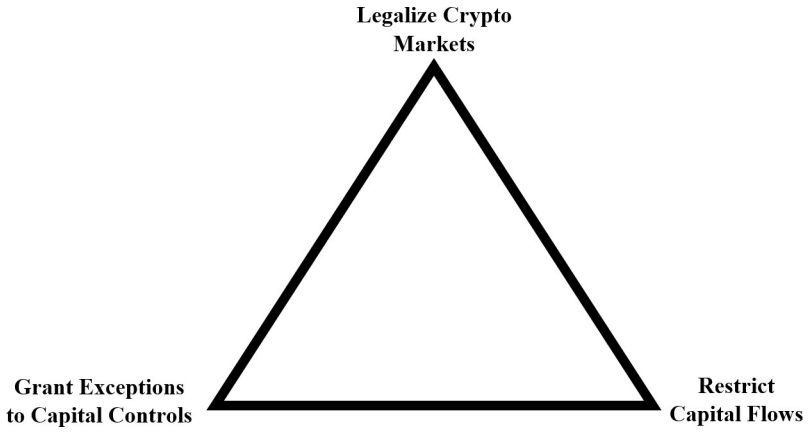
From a policy perspective, recognizing that crypto exchanges have the potential to serve as a marketplace for capital flight has important implications. When there are targeted exceptions to capital controls (such as the exclusion of certain sectors/economic agents), crypto exchanges can amplify the leakages that may occur through these channels, undermining the effectiveness of external restrictions.

In this situation, the first best policy option is generally to address the underlying macroeconomic imbalances, reducing the need for external restrictions, as set out in the IMF's Institutional View (IV)on the Liberalization and Management of Capital Flows (IMF, 2022c). This is especially important in the context of restrictions that may be inconsistent with a country's international commitments, as in the case of trade restrictions, exchange restrictions and multiple currency practices. Moreover, the IV sets out a roadmap for the removal of financial account restrictions in a context of safe liberalization, though full liberalization is not presumed to be an appropriate goal for all countries at all times. If the first best policy option is not available, a second best option may be for policymakers to consider tighter regulation of crypto markets, at least for agents with access to targeted exceptions to controls. This is where crypto assets have significantly altered the world we live in.

Figure 10 illustrates this crypto policy trilemma in economies with macro imbalances: Policymakers can achieve any two of three policy goals. However, achieving all three is not possible. For instance, the relatively wide-spread practice of restricting capital flows coupled

with targeted exemptions from such controls (for example for foreign entities in order to attract FDI) is inconsistent with legalized crypto markets, as we show in the model. Yet, legalized crypto markets are not inconsistent with a restricted financial account, as long as capital controls are comprehensive and effective.

Figure 10: Crypto Policy Trilemma



Our stylized model suggests that in the absence of crypto exchanges, loopholes to capital controls that allow individual agents/firms to make large transfers are likely less consequential, since *sharing* such a loophole with others can be difficult. This is mainly because the illegal nature of the underlying activity would make it hard to enforce contractual obligations between the parties involved. But when there is a liquid crypto exchange, it is easy to share a capital flight channel with others.

Consistent with this, many regulators have reacted with a ban of crypto exchanges (see section 4.1.3). However, a ban is not necessarily the best regulatory approach. After all, even without liquid crypto exchanges, crypto assets can still fulfill the same function. Granted, the matching with a counterparty is rendered more difficult when no centralized exchanges exist, meaning the marketplace for capital flight loses some of its efficiency. Yet, it is worth noting that when banning crypto exchanges, governments also lose potential avenues of regulatory oversight (as well as potential societal benefits related to innovation). When instead

regulating centralized crypto exchanges, imposing Anti-Money-Laundering (AML) and Know-Your-Customer (KYC) regulation, governments have more control over crypto-related flows and can also leverage the data from crypto exchanges to identify leaks and loopholes in the existing capital flow measures, by identifying the individuals that act as liquidity providers in these markets (see also IMF (2022a)) .

The stark overlap between countries managing capital flows and those banning crypto trading indicates that policymakers broadly recognize crypto's role in serving as a market place for capital flight. Yet, as is discussed above, it is not at all clear that banning crypto trading is necessary or optimal, even when a government is seeking to impose capital controls.

The policy implications are somewhat different in the context of crypto mining, however. As discussed in section 3.4.1, crypto mining may create a direct channel for capital flight if foreign currency proceeds are not repatriated (alternatively, it may create a source of FX revenue from repatriated crypto exports). The risk of FX leakages from sales of mined crypto highlight the fiscal cost of energy subsidies, strengthening the case for replacing such subsidies with more targeted social assistance mechanisms. If this first-best policy of phasing out subsidies is not available, then limiting crypto mining operations may be advisable. Not doing so may inadvertently allow the individuals engaged in mining access to a subsidized exchange rate. Negative externalities related to the environment only exacerbate the costs that agents using subsidized energy to mine crypto are imposing on a country (and the world).

Another important implication of our findings is that crypto volumes alone typically reveal little about the magnitude of capital flight, especially in countries with tight external restrictions. Conversely, the relative price of crypto assets is found to contain insightful information about (a) the strength of the demand for foreign exchange, which can be regarded as a proxy for underlying macroeconomic imbalances; and (b) the marginal cost of capital flight, which is, in turn, an indicator of how tight existing controls are. Data on crypto-based shadow exchange rates provide valuable information above and beyond what is available in existing databases on

capital controls (such as the IMF's *Taxonomy of Capital Flow Management Measures*; or the IMF's AREAER), and measures of financial account openness. This is especially true because crypto-based FX premia are observed at the daily frequency and available in real time. By contrast, existing databases often require the time-intensive analysis of new laws and regulations and have difficulty capturing cases where there is a difference between what is put forward *de jure* and what is enforced *de facto* (Ilzetzki et al., 2019).

Alternative market-based measures, such as parallel (or black market) cash exchange rates, are often also available in real time. However, these data tend to be easy to manipulate and poorly documented since the underlying transactions are illegal. For these reasons, crypto-based FX premia can, at least for some countries, fill an important gap and provide real-time and hard-to-manipulate data on the presence and intensity of capital controls, as well as the demand for capital flight.[13]

In addition, our analysis helps clarify when and how crypto vehicle trades affect a country's net foreign asset position. Specifically, it illustrates that whenever residents exchange crypto assets to move their money abroad, the movement of capital across borders generally has already occurred via traditional channels *before* the crypto vehicle trade takes place. As such, the underlying crypto transaction *per se* does not affect the country's net foreign asset position. From the narrow perspective of accounting for crypto-related transactions in external accounts, our work hence soothes concerns that a growing use of crypto assets makes standard balance-of-payment statistics less accurate (Akbalik et al., 2021; Hu et al., 2021; IMF, 2023c,a; He et al., 2022; Graf von Luckner et al., 2023). That said, if the use of crypto assets propels an overall increase in capital flight (via the traditional channels), this may still increase inaccuracies in external statistics, which could be reflected in increase net errors and omissions.[14]

[13] It is important to recognize that not every instance of a premia in relative prices of crypto indicate the existence of otherwise unrevealed capital controls, because other factors can contribute to the difference in prices. Indeed, other than capital controls; illiquid/shallow crypto markets can also be a factor driving premia in relative crypto prices. Moreover, exchange-specific events, can temporarily lead to idiosyncratic price changes. Hence, only when reflected in liquid markets featuring multiple exchanges should crypto shadow exchange rate premia be seen as evidence for capital controls and pressure on capital flows.

[14] As is discussed in Cuddington (1986), the type of capital flight we focus on in this paper would typically

6 Conclusion

This paper has laid out the mechanisms by which crypto markets can undermine restrictions to external transactions and exchange rate policies. Our findings suggest that crypto markets match counterparts to buy and sell FX, but do not provide a novel channel for capital flight. By serving as a marketplace for capital flight, crypto exchanges can amplify the incentives for using traditional channels to evade capital controls.

Our stylized model shows how crypto exchanges can serve as platforms to efficiently "trade" access to cross-border capital flight channels. The model demonstrates that excess demand for FX amid binding external restrictions lead to the emergence of persistent crypto "shadow" premia relative to global market prices for the same assets. Further, the model also explains why crypto trading volumes do not necessarily correlate with cross border capital flows.

Analyzing crypto price data from centralized exchanges over 2019-2023, we provide supporting case study evidence from economies that introduced or tightened capital flow measures. Results align with the model's predictions of near price parity under open financial accounts, in contrast to sizable and persistent premia when controls are binding. The timing of divergence in the crypto shadow exchange rates coincides with policy changes to restrict capital flows.

The analysis has several important policy implications. We find that data on crypto-based parallel exchange rates contain valuable signals on FX pressures during periods of stress, especially in near-crisis situations. We propose using these data as a real-time indicator for monitoring the build-up of currency devaluation pressures. These data can complement existing metrics to gauge *de jure* and *de facto* financial openness such as the IMF's *Taxonomy of Capital Flow Management Measures* and the AREAER database. The dataset described in this paper is made available on the IMF website and will be updated periodically.

This paper also distils the associated regulatory trade-offs that policymakers face regarding

not be expected to increase net errors and omissions because "neither the outflow of goods nor the increase in domestic holdings of assets abroad will be recorded in the balance of payments."

crypto asset markets, which are found to be an important complement to macro policy settings. Finally, we discuss the implications for balance of payments accounting principles, where the finding that crypto is not mainly a new *channel* for capital flight reduces concerns around the accuracy of BoP statistics.

There are several promising areas for further research. Future work could pursue panel data regression approaches to systematically analyze the relationships between the dynamics of crypto-based FX premia, capital control measures, and macroeconomic fundamentals. The present paper also provides valuable insights regarding the drivers of crypto-based cross border flows, which are likely to be linked to capital flight pressures. Further, a more in-depth analysis of how regulatory responses across countries have differed (not all crypto bans are alike), as well as an analysis on what has driven the heterogeneity in policy responses to capital flight in the age of crypto assets would be promising areas for future research.

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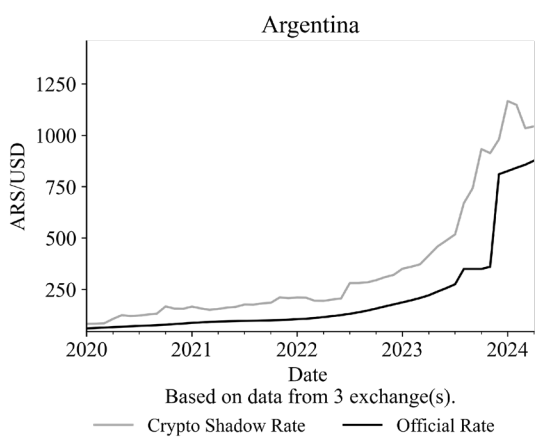
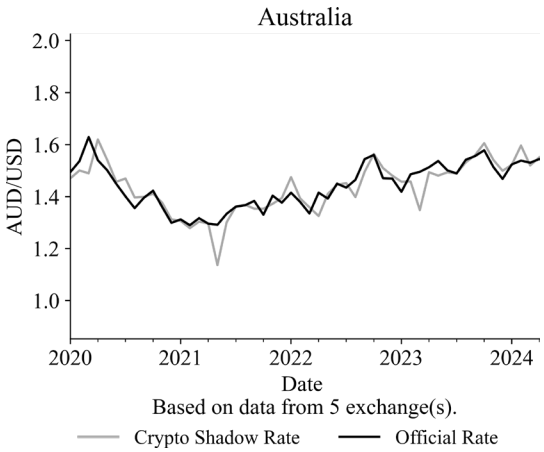
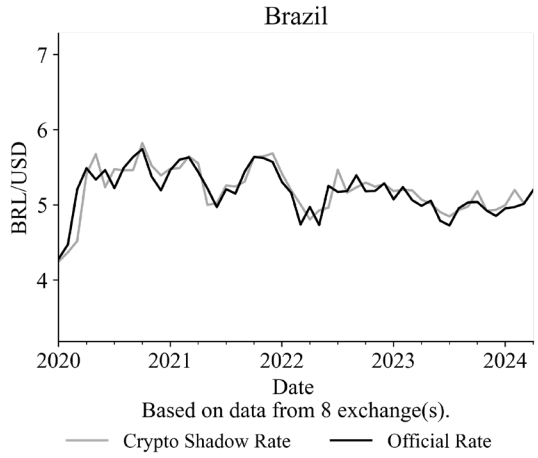
A Appendix

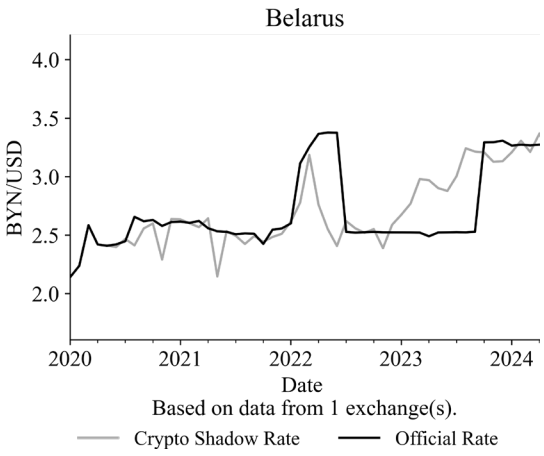
A.1 Crypto Shadow Rates

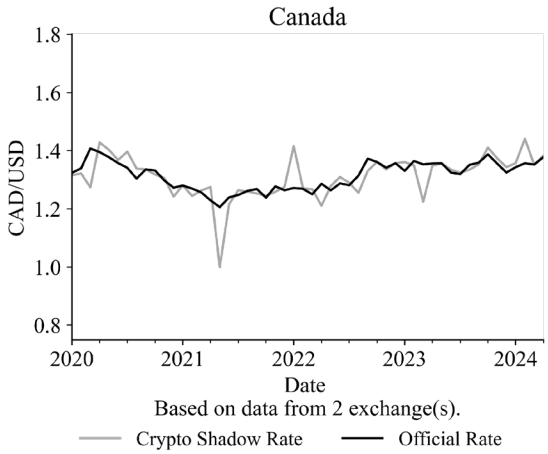
In this section, we present crypto shadow rates and official exchange rates for all thirty economies for which we have continuous data from centralized exchanges since January 2020.

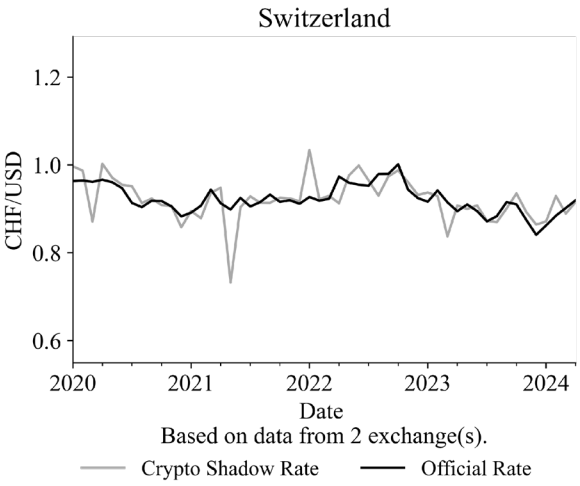









Canada
CAD/USD
1.8
1.6
1.4
1.2
1.0
0.8
2020
2021
2022
2023
2024
Date
Based on data from 2 exchange(s).
Crypto Shadow Rate
Official Rate


Switzerland
CHF/USD
1.2
1.0
0.8
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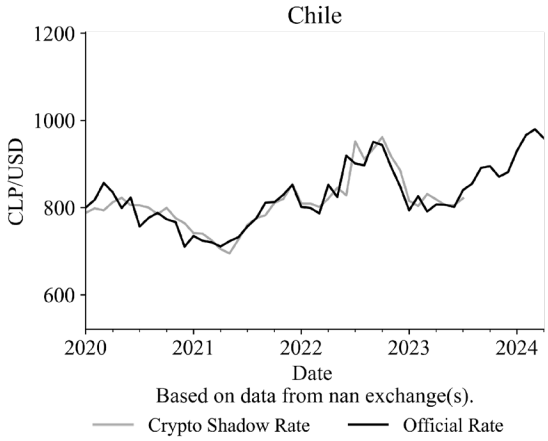
2020
2021
2022
2023
2024
Date
Based on data from 2 exchange(s).
Crypto Shadow Rate
Official Rate


Chile
CLP/USD
1200
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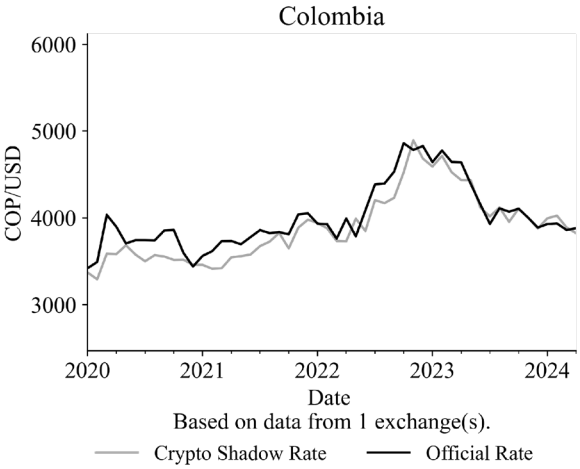
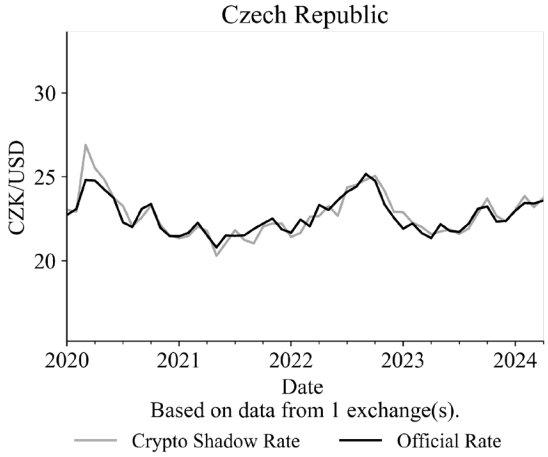
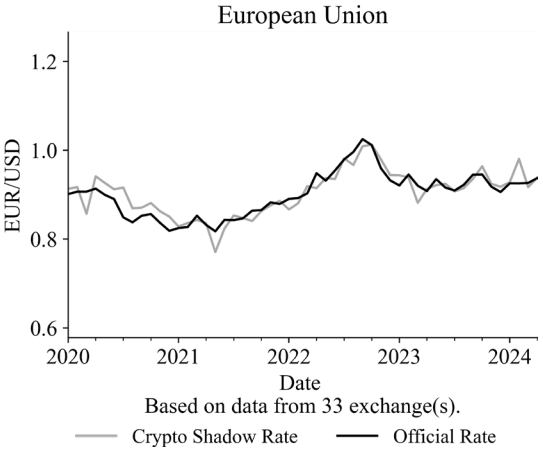
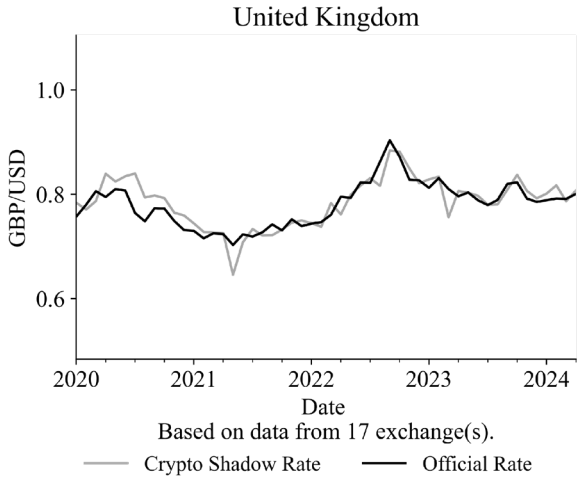
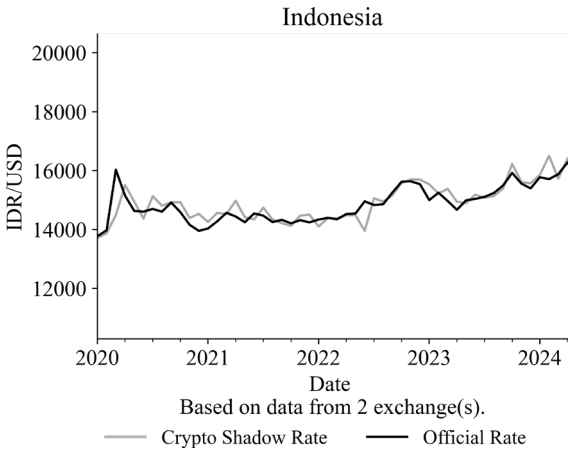
2024
Date
Based on data from nan exchange(s).
Crypto Shadow Rate
Official Rate

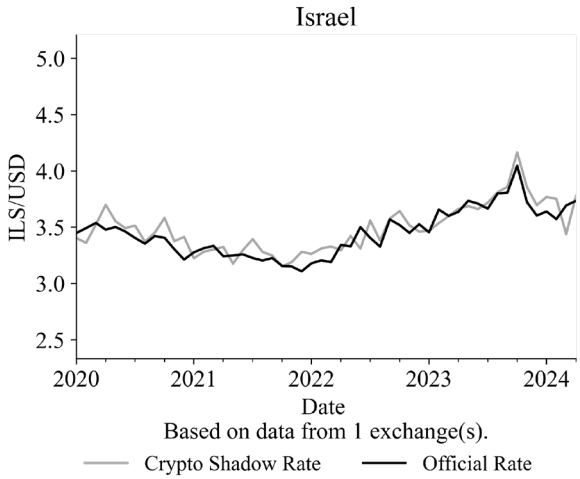

Colombia
COP/USD
6000
5000
4000
3000
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate

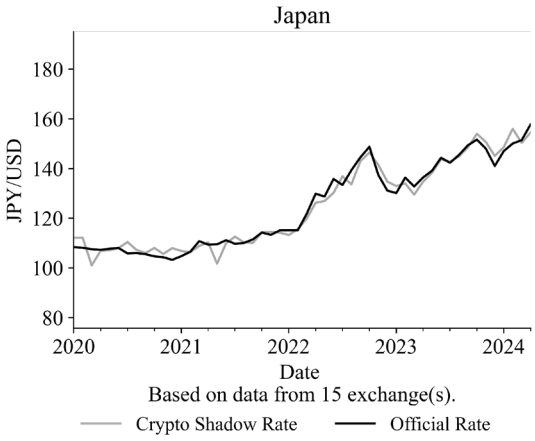

Czech Republic
CZK/USD
30
25
20
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate

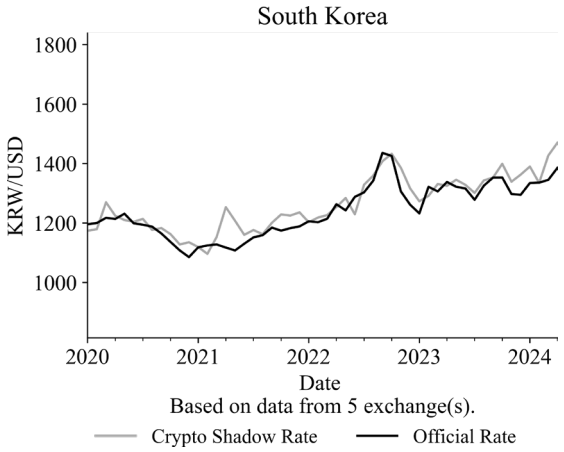

European Union
EUR/USD
1.2
1.0
0.8
0.6
2020
2021
2022
2023
2024
Date
Based on data from 33 exchange(s).
Crypto Shadow Rate
Official Rate

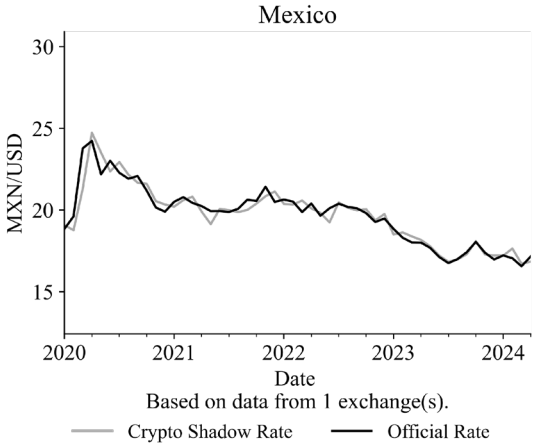

United Kingdom
GBP/USD
1.0
0.8
0.6
2020
2021
2022
2023
2024
Date
Based on data from 17 exchange(s).
Crypto Shadow Rate
Official Rate

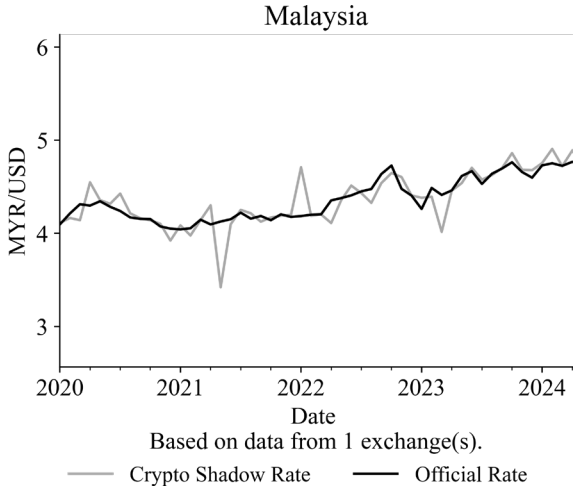

Indonesia
IDR/USD
20000
18000
16000
14000
12000
2020
2021
2022
2023
2024
Date
Based on data from 2 exchange(s).
Crypto Shadow Rate
Official Rate

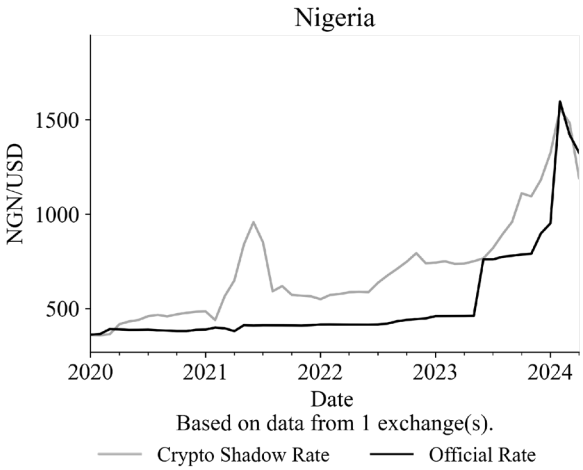

Israel
ILS/USD
5.0
4.5
4.0
3.5
3.0
2.5
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate

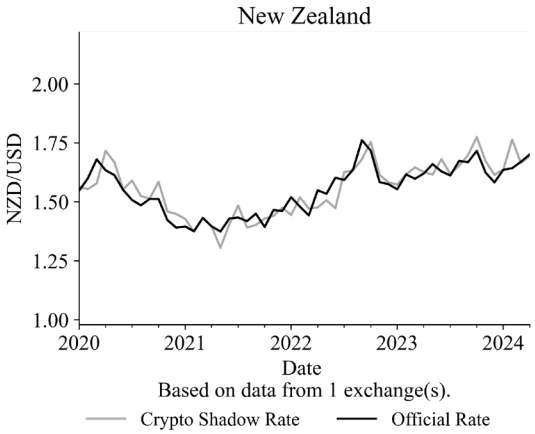

Japan
JPY/USD
180
160
140
120
100
80
2020
2021
2022
2023
2024
Date
Based on data from 15 exchange(s).
Crypto Shadow Rate
Official Rate

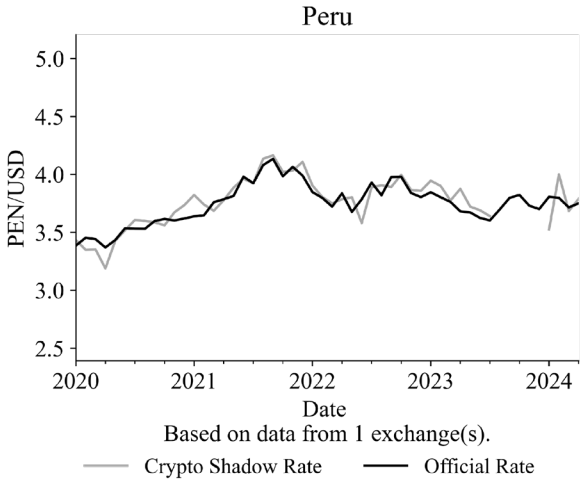

South Korea
KRW/USD
1800
1600
1400
1200
1000
2020
2021
2022
2023
2024
Date
Based on data from 5 exchange(s).
Crypto Shadow Rate
Official Rate

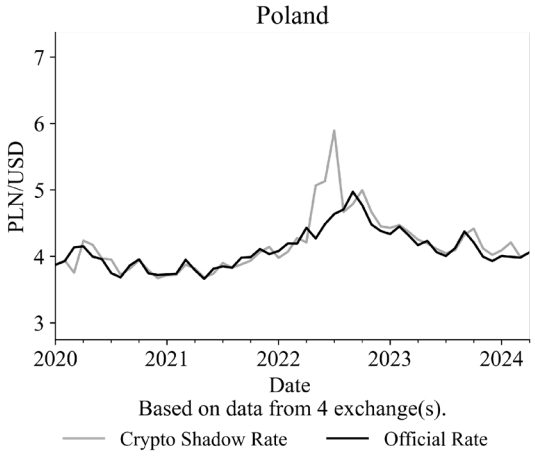

Mexico
MXN/USD
30
25
20
15
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate

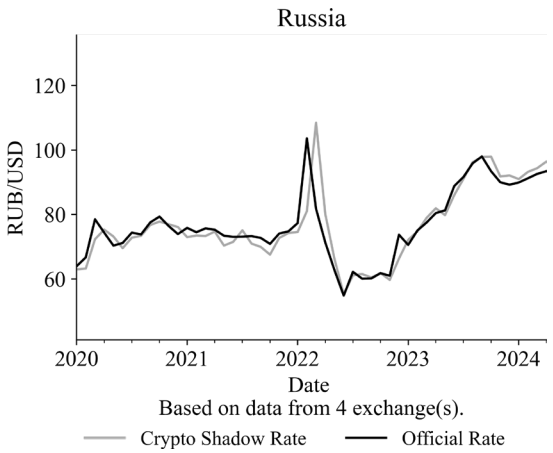

Malaysia
MYR/USD
6
5
4
3
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate

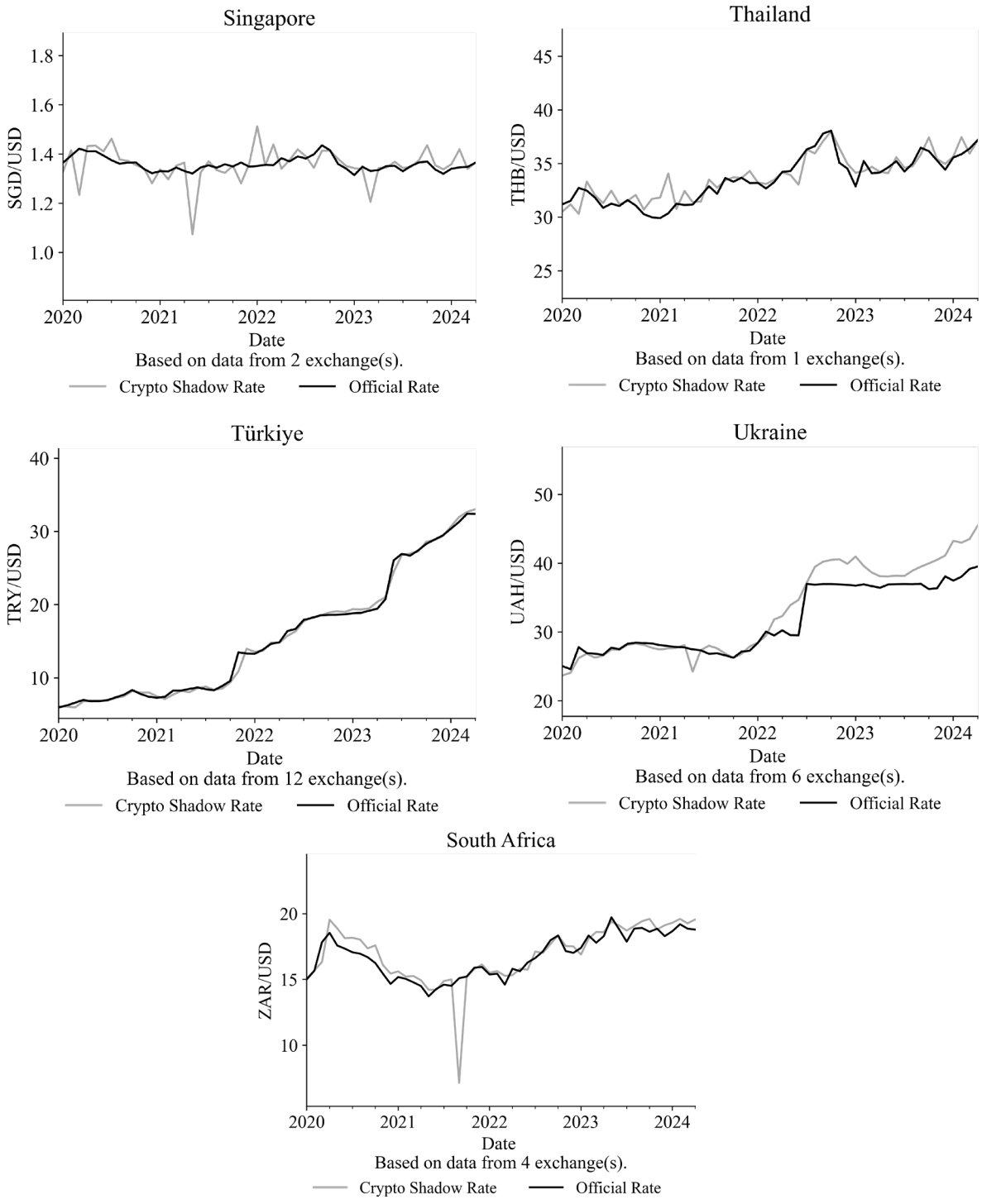

Nigeria
NGN/USD
1500
1000
500
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate


New Zealand
NZD/USD
2.00
1.75
1.50
1.25
1.00
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate


Peru
PEN/USD
5.0
4.5
4.0
3.5
3.0
2.5
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate


Poland
PLN/USD
7
6
5
4
3
2020
2021
2022
2023
2024
Date
Based on data from 4 exchange(s).
Crypto Shadow Rate
Official Rate


Russia
RUB/USD
120
100
80
60
2020
2021
2022
2023
2024
Date
Based on data from 4 exchange(s).
Crypto Shadow Rate
Official Rate


Singapore
SGD/USD
1.8
1.6
1.4
1.2
1.0
2020
2021
2022
2023
2024
Date
Based on data from 2 exchange(s).
Crypto Shadow Rate
Official Rate
Thailand
THB/USD
45
40
35
30
25
2020
2021
2022
2023
2024
Date
Based on data from 1 exchange(s).
Crypto Shadow Rate
Official Rate
Türkiye
TRY/USD
40
30
20
10
2020
2021
2022
2023
2024
Date
Based on data from 12 exchange(s).
Crypto Shadow Rate
Official Rate
Ukraine
UAH/USD
50
40
30
20
2020
2021
2022
2023
2024
Date
Based on data from 6 exchange(s).
Crypto Shadow Rate
Official Rate
South Africa
ZAR/USD
20
15
10
2020
2021
2022
2023
2024
Date
Based on data from 4 exchange(s).
Crypto Shadow Rate
Official Rate