LUISS

Degree Program in Management and Computer Science

Course of Macroeconomics

Uncovering the Currency Price in an Unsustainable Fixed Exchange Rate Regime Using a Stablecoin: The Case of Bolivia

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Abstract

This thesis investigates the efficacy of USDT/BOB rates from peer-to-peer (P2P) crypto markets as a real-time proxy for Bolivia's shadow exchange rate and an indicator of exchange rate pressures. Bolivia's unsustainable fixed exchange rate regime has led to a significant, yet opaque, parallel currency market due to dwindling international reserves and persistent fiscal deficits.

My research employs a novel methodology, combining very high-frequency (minute-level) USDT/BOB P2P market data from Binance, a unique dataset of over 200 street parallel exchange rate quotes extracted from local press using a custom Large Language Model (LLM) pipeline, and official macroeconomic variables. The empirical strategy includes unit root tests, cointegration analysis, Pearson correlations, and event studies from February 2023 to May 2025.

Findings show a near-perfect, cointegrated one-for-one relationship between USDT/BOB P2P rates and the reconstructed street parallel exchange rate, confirming stablecoin markets accurately mirror the true, opaque price of foreign currency in near real-time (Hypothesis H-1). The analysis further reveals the widening parallel market premium is driven by a classic first-generation balance-of-payments crisis mechanism, with a speculative attack identified in Q1 2023 due to FX reserve depletion. Fiscal expansion (public debt) is the dominant long-run determinant of the shadow rate (Hypothesis H-2).

This study provides the first empirical evidence for Bolivia on using stablecoins to uncover shadow exchange rates, extends literature on USDT within P2P market microstructures, and introduces an innovative LLM-based data extraction technique. The results highlight the utility of P2P stablecoin data as a real-time surveillance tool for monitoring currency pressures and informing crisis response in economies with capital controls and fixed exchange rate misalignments. Ultimately, the thesis concludes that the USDT/BOB P2P rate effectively is Bolivia's prevailing shadow exchange rate.

Acknowledgements

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My deepest and most profound gratitude goes to my uncle, Gonzalo Caprirolo. This thesis simply would not have been possible without his exceptional guidance, thorough corrections, and invaluable discussions and explanations. His dedication truly made all the difference.

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To my parents and sister,
whose boundless love, unwavering support,
and gentle push for excellence
have carried me through every challenge;

To my family,
whose steadfast encouragement provided the foundation I needed;

And to friends in Bolivia, Italy, and around the world,
who stood by me in the toughest of times—
this work is dedicated to you.

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1 Introduction

1.1 Context

In 1985, after experiencing one of the worst hyperinflation episodes in Latin American history, Bolivia implemented a "crawling peg" regime that lasted until late 2000s. Starting the transition in 2008, and officially in 2011, the Central Bank of Bolivia (BCB) adopted a fixed exchange rate regime, setting the selling exchange rate stable at 6.96 BOB/USD and the purchase rate at 6.86 BOB/USD (Diaz et al., 2024). The transition to the new exchange rate regime was supported by an export boom where the value and volume of exports increased by 712% and 500% respectively between the years 2000 and 2011. Figure 1.1 shows the historical official USD/BOB exchange rate.

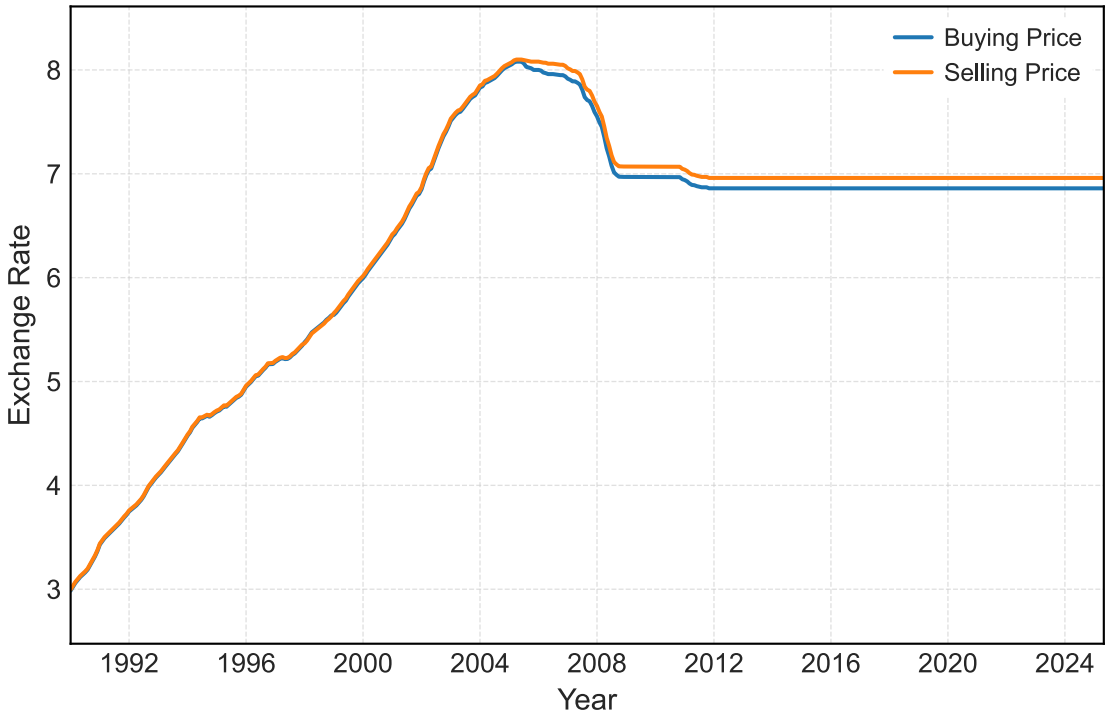
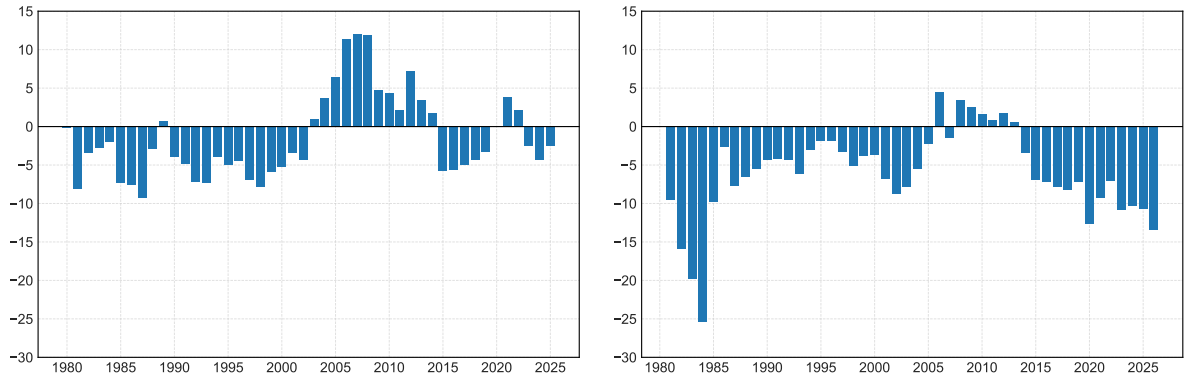


Figure 1.1: Historical price of the boliviano (BOB) in terms of USD
Source: Banco Central de Bolivia (2024a)

The export boom not only facilitated the transition to a fixed exchange rate regime, but resulted in i) hard-currency inflows: between 2008 and 2014, net international reserves averaged 48% of GDP; ii) growing current account surpluses reaching at its peak 11.9% of GDP in 2008 and; iii) average government balance surpluses of 7.2% of GDP in the period 2006–2013—the only period in recent history in which fiscal accounts were in surplus. Figure 1.2 shows the current account balance and the fiscal deficit between 1980 and 2025.



(a) Current account balance (% of GDP)

(b) Government net lending/borrowing (% of GDP)

Figure 1.2: Current account balance and government net lending/borrowing (as % of GDP).
Source: IMF (2025b)

The combination of the fixed exchange rate—a regime that is still in place—and subsidy to fuels allowed Bolivia to control domestic and international prices, achieving exceptional price stability and inflation at controlled levels, becoming one of the lowest in South America and one of the lowest in the World (Banco Central de Bolivia, 2022).

The overall policy was effective, especially until 2014, when export volumes reached their peak after a decade-long export boom (2003-2013) during which the annual export growth averaged 21.5%. However, in 2014, the fiscal situation reversed dramatically, transitioning from a brief surplus period to persistent deficits, averaging 8.3% of GDP annually between 2014 and 2025. As a consequence, net international reserves that were once close to 50% of GDP in 2014, slipped below 4% of GDP in 2024 (Banco Central de Bolivia, 2024a; IMF, 2025b).

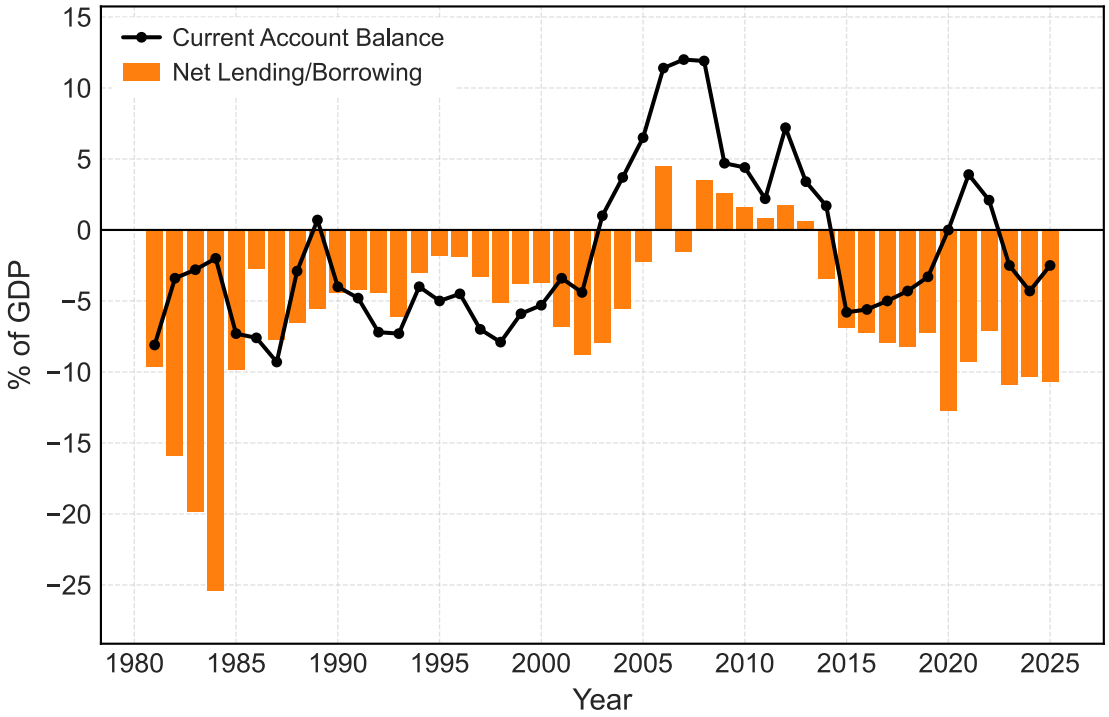


Figure 1.3: Twin deficit (% of GDP)
Source: IMF (2025b)

The combination of persistently low or negative growth of export volume (averaging -3.7% annually from 2015 to 2024), growing fiscal deficits, ongoing fuel subsidies, and strict price controls resulted in the depletion of international reserves. As a result, a parallel currency market emerged in the first quarter of 2023 (Banco Central de Bolivia, 2024a). By May 2024, the price of the currency was 25% above the official exchange rate, and by May 2025, it surged to 150% above, as estimated by this thesis.

The sustained deterioration of the fiscal stance and export performance has lead to repeated credit rating downgrades. In a most recent evaluation of Bolivia's credit, it was stated that:

> "The government will be forced to decide between allocating scarce foreign exchange resources to make interest payments on external debt or pay for essential imports, including fuel, while also maintaining the *boliviano*'s fixed exchange rate." (Moody's Ratings, 2025b)

While access to macroeconomic accounts is possible, even with a delay[1](IMF, 2025a),

[1]The IMF Article IV Consultation for the year 2023—concluded in March 2024—was published in January 2025. The BCB has been publishing monetary aggregates with increasing delays—last information available corresponds to December 2024.

this is not the case of the currency price in the parallel market. The price of the currency in a parallel market is illegal by definition, and there are strict controls about it. Thus, there is no reliable and constant information about the parallel exchange rate.

In contrast to Argentina—a country that faced a similar situation where newspapers and institutions consistently tracked the parallel exchange rate (known as the "Blue Dollar")—Bolivia lacks a source of constant and reliable information. Having an accurate and accessible measurement is crucial for fostering transparency and enabling informed decision-making among all stakeholders.

In the absence of consistent official or media reports on the parallel exchange rate, cryptocurrency prices, particularly stablecoins, offer a reliable alternative. Stablecoins play a novel role in this context: since they operate 24/7 and bypass capital-control frictions, black-market dealers increasingly benchmark local-currency prices against a live USDT quote from centralized exchanges such as Binance (El Deber, 2024b). Indeed, Bolivian attorneys Iver von Borries and Javier Romero Mendizabal have even proposed to introduce Tether's USDT as an index asset for commercial and civil contracts (El Deber, 2024a).

But cryptocurrencies are not exempt of drawbacks and are susceptible of manipulation and can be too volatile to be reliable as exchange rate anchors or stable means of exchange rate. This can be an issue on a local and small market where trading volumes and liquidity are low. While cryptocurrencies such as USDT are stable under normal conditions, the issue is in a small currency market such as in Bolivia, of whether it can be regarded as the stable exchange rate beyond providing information gauging the devaluation pressures in economies in financial distress. The issue is that cryptocurrencies are not widely accepted or used by the whole population, and therefore can be controlled by a small number of individuals having a large share of coins. Their price in the local market can be driven by speculation or serve as means for money laundering.

1.2 Problem Statement and Motivation

Cross-country evidence is mounting that crypto markets do not merely echo parallel rates; they often mirror them in real time. An IMF working paper by Graf von Luckner et al. (2024) shows that in Argentina, Ukraine, Egypt and Nigeria–economies with binding capital controls–persistent "crypto shadow premia" in local Bitcoin prices moved almost one-for-one with black-market parallel exchange rates and spiked within days of new restrictions. The authors found that crypto-based parallel exchange rates contain valuable signals on FX pressures during periods of stress, and even propose using that data as a

real-time indicator for monitoring the build-up of currency devaluation pressures.

Yet four critical blind spots remain in the literature (summarized later in Table 2.2):

1. **Geographical coverage**. Bolivia's fixed-rate regime has been analyzed in conventional macroeconomic literature—analysts have long warned that a depletion of the international reserves could trigger a crisis—but none of these studies incorporate stablecoin evidence as a means of gauging exchange rate pressures.

2. **Asset class and micro-structure.** Existing work focuses on Bitcoin quotations from centralized exchanges. The issue is its use in the context of a small market as a stable source of the price of the domestic currency. Bolivian users transact mainly in USDT on 24/7 peer-to-peer (P2P) markets whose liquidity and spreads differ sharply.

3. **Methodological validation.** No paper has benchmarked stablecoin quotes against the country's own street-cash prices, as published in newspapers, at high frequency.

4. **Macro-feedback channel.** The link between domestic-credit creation, reserve loss and the crypto premium—predicted by Krugman (1979) first-generation model—remains untested for Bolivia.

Bolivia therefore provides a natural laboratory to address these gaps while contributing to delivering policy-relevant transparency at a moment of acute balance-of-payments stress.

1.3 Research Question and Objectives

Lead Research Question

Can stablecoin-denominated boliviano-to-dollar prices observed
in P2P crypto markets serve as an accurate and timely proxy
for Bolivia's shadow exchange rate and/or as an indicator
of exchange rate pressures?

Box 1: Operational Objectives

1. **Directional alignment.** Compute contemporaneous Pearson correlations and linear regressions between monthly USDT/BOB quotes (Binance P2P) and street USD/BOB prices to assess co-movement and confirm the USDT/BOB as a shadow rate of the parallel market.
2. **Reserve-pressure linkage.** Estimate linear regressions of the USDT premium on monthly changes in net international reserves to quantify how reserve depletion translates into crypto-market stress.
3. **Crisis timing.** Embed the USDT-inferred shadow rate into Krugman's balance-of-payments crisis model to find speculative-attack windows and match them with key narrative events.

1.4 Contributions

- **Novel dataset.** First minute-level dataset of USDT/BOB trades (Binance P2P) merged with 200+ street-cash quotes automatically extracted from around 40,000 local-press articles via a custom large-language-model (LLM) pipeline.
- **Methodological innovation.** Combines high-frequency correlation/cointegration tests, reserve-pressure regressions and Krugman-style crisis dating – an approach not previously applied to stablecoin markets.
- **Extension of theory.** Integrates a crypto-inferred shadow rate into Krugman (1979)'s first-generation model.
- **Policy relevance.** Demonstrates—using real-time crypto data—that a speculative attack on the boliviano has already materialized, furnishing officials and analysts with a post-mortem benchmark for assessing crisis-response options.

1.5 Thesis Structure

Chapter 2 surveys exchange-rate regime theory, dual-market evidence and prior crypto-proxy work. Chapter 3 formalizes the BoP-pressure framework and states three testable hypotheses. Chapter 4 details data sources, the LLM-assisted engineering pipeline and

econometric strategy. Chapter 5 presents empirical results–descriptive patterns, correlations and event-study evidence. Chapter 6 synthesizes findings against theory, draws policy implications and flags limitations. Chapter 7 concludes with key take-aways and proposes future research paths.

2 Background and Literature Review

This chapter sets the macroeconomic background and the conceptual stage for the empirical work that follows.

2.1 Bolivia's Background

Bolivia's shift in exchange rate regimes has historically been driven by developments in external trade and unsustainable fiscal deficit monetization. This lead in the past to hyper-inflationary collapse and, most recently, to a balance-of-payments crisis reflected in the depletion of foreign currency reserves and an ongoing currency crisis.

The most severe recent economic crisis in Bolivia took place in the first half of the 80's, culminating in hyperinflation in 1985,—with prices rising more than 60,000%—placing itself as one of the highest in world history at the time (Sachs, 1986). A combination of a global recession, political instability, and financing of the fiscal deficit has been pointed out as being the cause of the crisis. A change of government and a stabilization program put an end to the crisis, leading to a recovery and slow growth period.

The Bolivian government maintained a fixed exchange rate during the Bretton Woods period, up until 1971. It devalued in 1972, but then maintained a fixed exchange rate from 1973 to 1978. After a devaluation in 1979, the government tried again to fix the nominal exchange rate without success in 1980-1981 (Kehoe et al., 2018).

From 1985 to 2008, the BCB implemented a crawling peg mechanism, considered to have been successful at maintaining a competitive exchange rate while keeping balance sheets manageable, despite external shocks (IMF, 2007). This performance was driven by an export boom and fiscal surpluses. Encouraged by recent strong external performance, substantial reserve accumulation, and the expectation that this external boom was permanent, Bolivia transitioned to a fixed exchange rate regime between 2008 and 2011. Officially adpoted in 2011, the Central Bank of Bolivia set the nominal selling exchange

rate fixed at 6.96 BOB/USD and the purchase rate at 6.86 BOB/USD–levels still in force today[1].

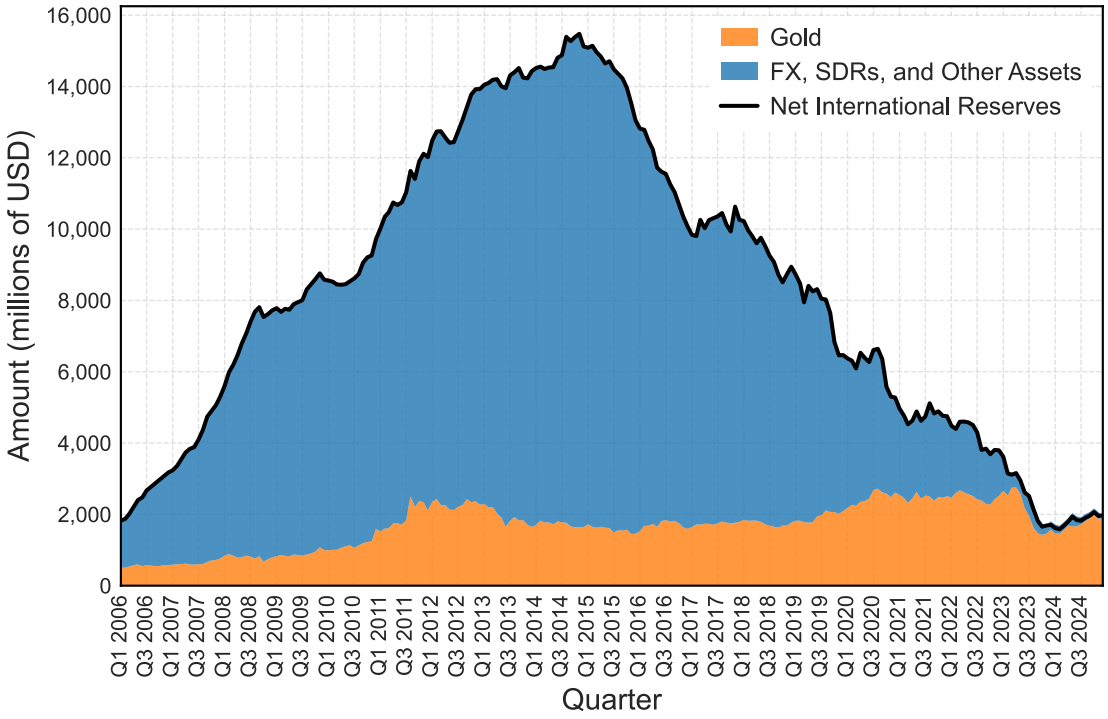


Figure 2.1: Composition of Net International Reserves (in millions of USD)
Source: Banco Central de Bolivia (2024a)

[1]For a more detailed account of Bolivia's economic history, see Kehoe et al. (2018)

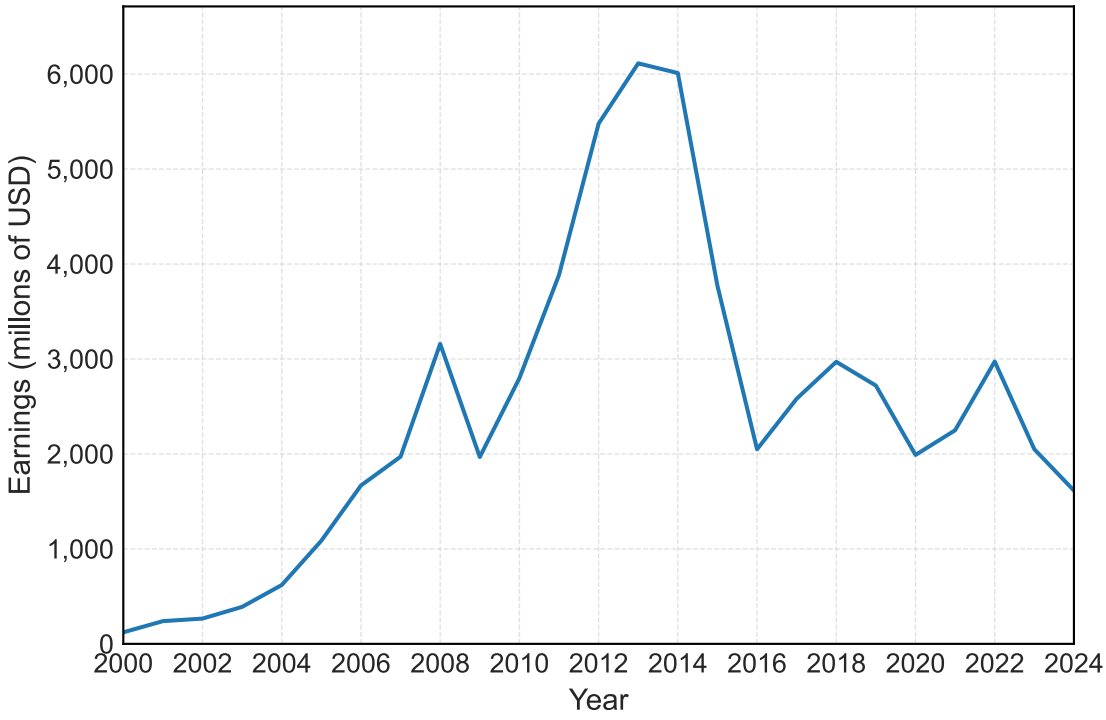


Figure 2.2: Natural gas exports earnings (in millions of USD)
Source: Instituto Nacional de Estadística (2025)

he growth of commodity prices slowed down in 2014, while public spending continued to climb. Net international reserves (NIR) peaked at US$15 billion in 2014 and have fallen since by roughly 87%, just below US$2 billion in December 2024 (Banco Central de Bolivia, 2024a).

With gas income shrinking due to extinction of existing capacity, the fiscal balance flipped from a surplus of 0.6% of GDP in 2013 to a deficit of 10.3% in 2024 (see Figure 1.2). Public debt more than doubled from 36.1% to 95% (IMF, 2025b).

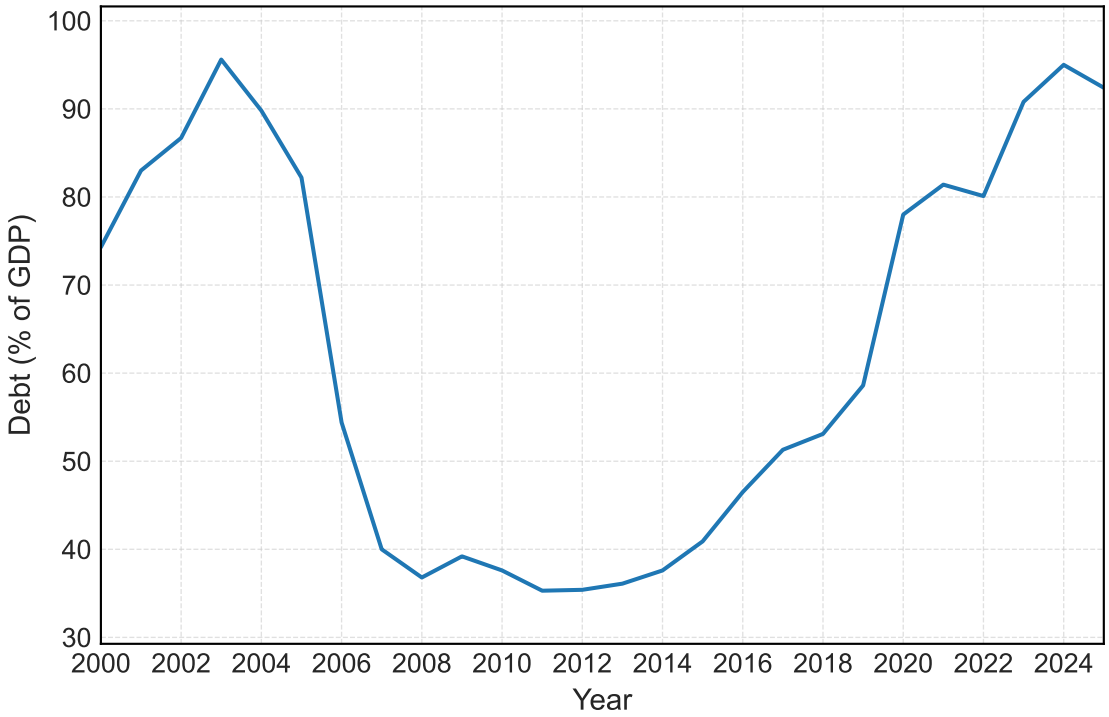


Figure 2.3: Public debt (as % of GDP)
Source: IMF (2025b)

Another important factor are subsidies to fuel imports, which have become a structural drain to reserves and an important driver of fiscal deficit. Only in 2024 Bolivia spent US$2.3 billion subsidizing diesel and gasoline, while the retail price per liter remained frozen near Bs 3.74[2] (Los Tiempos, 2025).

[2]US$0.54 per liter at the official exchange rate; US$0.21 per liter based on the USDT exchange rate as of May 19, 2025. For comparison, the global average on the same date was US$1.26 per liter (GlobalPetrolPrices.com, 2025).

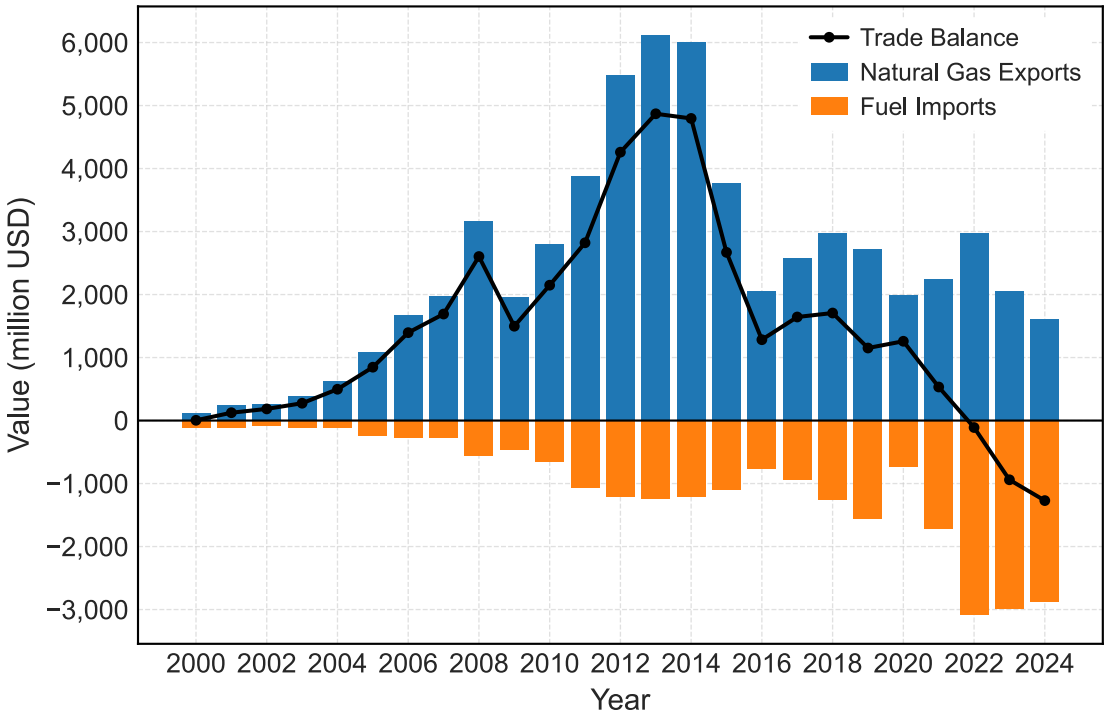


Figure 2.4: Fuel trade balance (in millions of USD)
Source: Instituto Nacional de Estadística (2025)

The fixed exchange rate regime used to be the centre-piece of the stability narrative, but is not anymore with the depletion of the international reserves and the emergence of a parallel exchange market. Despite the fixed exchange rate, in April 2025, the annualized inflation rate reached 15%—its highest level since June 2008, when inflation hit 17% amid the global commodity price boom that preceded the financial crisis later that year (Banco Central de Bolivia, 2025).

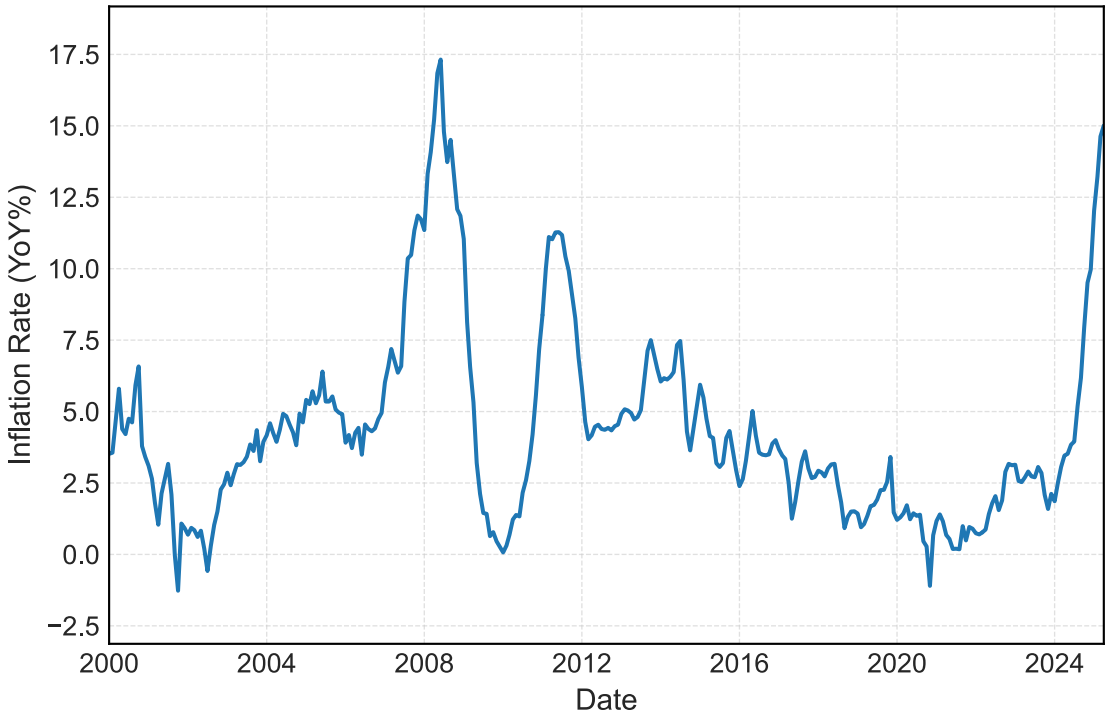


Figure 2.5: Annualized Inflation Rate
Source: Instituto Nacional de Estadística (2025)

The overall macroeconomic deterioration and lack of political willingness to adjust economic policy has also been reflected in the evolution of the deteriorating country's credit ratings.

Agency	Last Review Date	Long-Term Rating		Short-Term Rating	
		Foreign	Local	Foreign	Local
Moody's	17 Apr 2025	Ca (↓)	Ca (↓)	–	–
S&P	04 Oct 2024	CCC+ (-)	CCC+ (-)	C (-)	C (-)
Fitch	24 Jan 2025	CCC- (↓)	CCC- (↓)	C (-)	C (-)

Table 2.1: Sovereign ratings for Bolivia by agency, as of latest review
Sources: Moody's Ratings (2025a); S&P Global Ratings (2025); Fitch Ratings (2025).
Note: (↓) indicates downgrade; (-) indicates stable outlook.
All accessed on 2 May 2025.

2.1.1 Policy Echoes of the 1970s

The policy mix implemented in Bolivia today mirrors the policies that were implemented in the 1970s (Kehoe et al., 2018):

- Nationalized enterprises in strategic sectors (oil and energy).

- Economy based on the role of the state as the producer, where the surplus generated by strategic industries is used (or supposed to be used) to finance other enterprises.
- Lack of independence of the central bank.
- Fixed exchange rate regime and and an overvalued local currency.
- Increasing fiscal deficits, due to subsidies, raw material price-dependent revenue of the government, and an increase in the deficit of public enterprises.
- Fall in reserves due to an expansion in domestic credit financed by the central bank.

According to Kehoe et al. (2018),the economic policy mix was very similar to that of the 1970s, and foresaw it evolving into a balance of payments crisis. In fact, most recent data indicates that Bolivia is undergoing a balance of payments crisis.

2.1.2 Political Instability

Bolivia has been ruled almost uninterruptedly by a single political party, the Movement to Socialism (MAS), for the past 17 years, from 2006 to the present. This continuity was briefly disrupted in 2019 due to allegations of electoral fraud. A single individual governed the country for 13 years, enjoying significant political hegemony. More recently, internal power struggles between the former president and his successor—previously his Minister of Economy—have intensified political instability. This instability has grown particularly acute since 2023, due to a growing disagreement on who will be the MAS' presidential candidate in 2025. This political instability has been exacerbated by the collapse in exports, severe depletion of international reserves, and an inability to sustain fuel imports, leading to growing inflation.

As a result of the political disputes within the ruling party, institutional risk has risen significantly. On 26 June 2024 armored units briefly surrounded the Palacio Quemado in what officials labeled an attempted coup; Army-Commander Gen. Juan José Zúñiga was arrested within hours. Zúñiga later alleged that President Arce had actually requested the mobilization as a "self-coup", a claim the government denied but opposition leaders echoed (Journal of Democracy, 2024). This episode highlighted governance fragility and triggered an immediate spike in the exchange rate in the black market.

Political tension did not fade afterwards. Since then, the country has been facing recurrent protest waves and road blockades, many of which repeatedly affecting the flow of fuel and food, further damaging the country's already fragile economy (Reuters, 2024).

2.1.3 Reserves End-Game Measures

In response to the collapse in foreign reserves and the emergence of a parallel exchange market in the first quarter of 2023, the Bolivian parliament approved the so-called *Ley del Oro* ("Gold Law") in May 2023. This legislation authorized the BCB to sell or pawn part of its gold holdings provided the total stock did not fall below 22 tonnes (Estado Plurinacional de Bolivia, 2023). By December 2024, official reports indicated that gold reserves had already reached this legal minimum.

Meanwhile, commercial banks facing tight Foreign Exchange (FX) liquidity, claiming not to have received any FX assets since April 2024, have imposed severe rationing, rendering debit and credit cards virtually useless outside of the country (La Razón, 2025a).

On 14 March 2025 the Bolivian financial-sector regulator ASFI issued Resolution 216/2025 (Circular 857), redesigning the fee regulation for cross-border payments. The measure authorizes banks to add a *Comisión Máxima Variable* (CMV)—a percentage updated each business day from a 30-day, volume-weighted average of the banking system's USD buying rate relative to the official Bs 6.86 benchmark—to any foreign-trade transaction. Once a customer's combined debit- or credit-card spending abroad reaches USD$100 in a calendar month, the bank must switch from the fixed official rate to this CMV-adjusted "dólar tarjeta". Operationally, the exchange rate becomes Bs $6.97 \times (1 + \text{CMV})$; purchases below the threshold continue at the official rate (Autoridad de Supervisión del Sistema Financiero, 2025).

With reserves perilously low and the boliviano still fixed, black-market agents quote the exchange rate at a 150% premium over the official rate. As such, Bolivia exemplifies the moment when a fixed rate collides with fundamentals–a clash that re-opens the classic fixed-versus-flexible dilemma analyzed in the next section.

2.2 Fixed vs. Flexible Exchange Rate Regimes

The choice between a *fixed* and a *flexible* exchange-rate regime is one of the oldest macroeconomic dilemmas in the road for open economies. It is, in essence, a decision about how adjustment costs are distributed—between the exchange rate, domestic prices, monetary autonomy, fiscal policy, and international reserves.

2.2.1 Conceptual Foundations

There is a large variety of exchange rate regimes, which can be divided into three large groups: floating exchange rate regimes, soft peg regimes, and hard peg regimes. But more simply put, the classic discussion regarding exchange rates is reduced to the comparison between the two extremes: *fixed* or *floating* exchange rates.

In a *fixed* or *pegged* exchange rate regime, the central bank establishes buying and selling rates for its currency in terms of a foreign currency (usually USD or EUR), and promises to trade in unlimited amounts at that rate (Obstfeld et al., 2005).

In a *flexible* or *floating* regime instead, the exchange rate is market-determined. The central bank may still intervene, but has no obligation to defend a specific level.

The Mundell–Fleming model explains why the exchange-rate arrangement matters for the *Macroeconomic Trilemma* (also known as the *Impossible Trinity*), which indicates that it is impossible to simultaneously have (Obstfeld et al., 2005):

1. Free capital mobility
2. Independent monetary policy
3. Fixed exchange rate

Having international mobility of capital, it is difficult to maintain the exchange rate parity without becoming vulnerable to speculative attacks, which can then lead to balance-of-payments crises (Terra, 2015).

Another important issue concerning the choice of exchange rate regime is the consistency with fiscal policy or its alignment. In general, the more rigid the exchange rate regime, the more disciplined the fiscal deficit must be. In particular, a fixed exchange rate requires strict fiscal discipline and credible central bank independence.

2.2.2 Balance-of-Payments Crises

The difficulty of maintaining the value of a currency under a fixed exchange rate (or a crawling rate regime) due to a reduction, and then exhaustion of foreign international reserves is regarded as one of the causes of a balance-of-payments (BoP) crisis. This also takes place when a country faces significant difficulties in meeting its financial obligations, including external debt repayment, and import of goods and services.

The literature distinguishes between "traditional" (first generation) and "modern" balance-of-payments crises (Pattillo et al., 2000):

1. In first-generation crises, the imbalance is given by a deterioration of macroeconomic fundamentals, such as a fiscal deficit financed through money creation, that eventually leads to the abandonment of the exchange rate peg.

2. Modern BoP crises point issues such as speculative attacks, contagion and weakness in domestic financial markets to be the more relevant causes.

The case of the undergoing unsustainability of the fixed exchange rate regime in Bolivia corresponds to a deterioration of fundamentals, as explained by Krugman's first-generation BoP crisis model.

Krugman (1979) indicates that when a central bank finances persistent fiscal deficits under a fixed exchange rate, international reserves fall one-for-one with domestic-credit creation. Private agents anticipate the moment reserves will run out by comparing the official peg with a *shadow exchange rate*—the rate that would prevail if the currency were allowed to float immediately. A speculative attack occurs when the two rates coincide, forcing a devaluation while some reserves are still in the vault (Pattillo et al., 2000)

2.3 Parallel Markets

As stated before, implementing a fixed exchange rate regime means that the central bank needs to ensure that demand and supply for FX against the domestic currency are balanced overtime. If the central bank has ample FX reserves, and maintains a stable FX flow, then managing a fixed exchange rate policy may be relatively straightforward (Gray, 2021).

Central banks might find that they are no longer able to maintain the fixed exchange rate because it can no longer ensure that supply of FX is sufficient to meet demand at the set price. This could be a result of excessive fiscal stimulus, monetary financing, or economic shocks, leading to the surge of a parallel exchange rate (Gray, 2021).

Sometimes central banks maintain an overvalued official exchange rate and attempt to restrict demand administratively through measures such as: prioritizing certain transactions, rationing FX, allowing queues to develop, setting ceilings for, or even prohibiting, certain current payments, or determining two or more "official" rates (Gray, 2021). Most or all of these measures have been implemented by the Central Bank of Bolivia.

Maintaining an overvalued official exchange rate that diverges substantially from a market-clearing rate will lead to significant distortions in the economy, and to a lower GDP growth. Moreover, the overvalued official exchange rate will generate excess demand (due to rent-seeking practices and other factors) that cannot be cleared as long as the exchange rate remains overvalued (Gray, 2021).

2.4 Uncovering the price of currency and exchange rate pressures in an unsustainable fixed exchange rate regime

With the parallel exchange rate being illegal by definition, there is no official source for the parallel market, therefore agents must rely on either newspaper reports that don't offer frequent nor precise information, or on proxies.

Over the last years, Argentina also experimented an economic crisis with a parallel exchange rate present. Over time, websites (mainly from newspapers) started to appear that reported the price of the many official exchange rates, as well as the black-market price on the streets—the so-called "dólar blue"–updated daily[3].

But in Bolivia, no newspaper nor third-party source offers continuous, daily information about the black-market price of the USD on the streets. It may be due to lack of resources, trustable sources, or simply that it is just easier to report the fluctuations of the USDT/BOB as a good enough approximation of the parallel exchange rate in terms of USD/BOB. Even then, information is not provided daily.

Instead, websites such as bolivianblue.net or others[4] that track the USDT/BOB quotation from Binance, are used as a mirror for the black-market price of the USD/BOB pair.

With no other proxy readily available, it is necessary to confirm if, effectively, the USDT/BOB pair is a reliable proxy for the black-market price of the USD in Bolivia.

2.5 The Usefulness of Stablecoins

Stablecoins are crypto-tokens that promise a one-to-one redemption into an established fiat currency, as is the case of USDT (by Tether Ltd.). These stablecoins allow users to

[3]Examples include newspapers such as La Nación, or dedicated websites such as DolarHoy
[4]dolarboliviahoy.com or dolarbluebolivia.click, among many others.

more easily trade them for other cryptocurrency or to use them as an alternative method of payment.

Mainly through centralized exchange platforms, users can acquire these stablecoins with fiat currency, either through regular payment channels (debit/credit cards, bank deposits, etc.)1, or through peer-to-peer (P2P) trades, without bank intermediation, making them a natural conduit for circumvention of capital controls in emerging markets.

In countries with restricted access to FX, stablecoins have proven to be an attractive channel for capital flight, as explained by Graf von Luckner et al. (2024). Their research suggests that the *crypto FX premium* can be interpreted as a "shadow exchange rate" that reflects the imbalances in the supply and demand for FX.

Not only are stablecoins used as hedging instruments against exchange rate and inflation risks, but they also allow local residents to purchase these assets locally in order to exchange them for foreign currencies abroad (a so-called crypto vehicle trade) (Graf von Luckner et al., 2024). The authors also find that crypto markets do not provide a novel channel for capital flight, they just serve as a marketplace for capital flight.

As expected, Bolivia has seen a massive increase in the usage of stablecoins (mainly USDT) serving as a safe-haven currency, but also as the only reliable payment channel for international transactions. In a very short period of time, the crypto panorama in Bolivia has changed drastically, pushing all agents to transact with cryptocurrencies, including state-owned companies (Reuters, 2025; La Razón, 2025b).

Before 2024, Bolivia maintained one of the strictest prohibitions on cryptocurrencies in Latin America. Beginning in 2014, the Central Bank of Bolivia warned against all crypto use, and on December 15, 2020 it formalized a total ban on financial institutions processing any crypto transactions (Banco Central de Bolivia, 2014, 2020). Nonetheless, P2P transactions were still happening underground.

In June 2024, the BCB revoked the 2020 prohibition, authorizing regulated financial institutions to use and trade cryptocurrencies and stablecoins. Transactions must be intermediated by banks or authorized entities, while direct peer-to-peer use remains unregulated (Banco Central de Bolivia, 2024b).

Binance has been the most established exchange in Bolivia, even before the crisis[5], serving as the principal source of information for the live USDT/BOB quote[6]. Given that the exchange is open 24/7, then it makes the USDT/BOB premium a continuous price, unlike

[5]Binance added support for the Bolivian Boliviano (BOB) in October 2020 (Binance, 2020)

[6]Websites dedicated to track the USDT/BOB pair and newspapers that refer to it use only Binance as a source.

black-market quotes that are rarely reported by the local press.

Foreign fintech companies have been the bridge between USDT and its usage for regular international transactions, such as crypto-friendly international banks that allow Bolivian individuals and businesses to create an account[7], or fintech companies that support both cryptocurrencies and fiat transactions (SWIFT transfers, credit/debit cards)[8]. It is important to note though, that agents will incur in additional fees when using these platforms.

On the other hand, Bolivian banks have also started to include stablecoins to their offer, now allowing users and businesses to buy USDTs through them, and to perform SWIFT transfers with USDTs. Given that these banks do not offer access to your wallet, nor transfers to other crypto wallets, and the lack of transparency and regulation, it might just be a legal workaround to the official exchange rate (and not actually a cryptocurrency implementation) (Banco BISA, 2025; Banco de Crédito de Bolivia, 2025). It is also important to note that banks quote higher prices for the sale of USDT and much bigger spreads than regular exchanges (plus additional fees per transaction).

The trading environment for cryptocurrencies in this setting raises important questions about how the market functions and the reliability of quoted prices. Specifically, it is unclear whether those quotations merely reflect underlying exchange-rate pressures or if they also incorporate other distortions—such as liquidity constraints, regulatory uncertainties, and transaction-cost differentials.

2.6 Research Gap and Qualitative Hypothesis Leads

The preceding sections indicate that (i) Bolivia currently meets every textbook symptom of a first-generation type of balance of payments crisis with an unsustainable fixed exchange rate regime, (ii) there is a lack of reliable information of the price of the currency as the parallel exchange rate is presented infrequently and imprecisely, and (iii) stablecoin exchange information together with sporadic black market quotations offer the possibility to capture the price of the currency through a new, high-frequency lens that has not yet been applied to this country.

[7]For example, Towerbank.
[8]Popular platforms include Meru, RedotPay, or Nebeus.

2.6.1 Where the Literature Stops

Dimension	What studies already cover	What is still missing
Geography	Crypto shadow rates effectiveness in the EU, Turkey, Brazil, Mexico, Argentina, Ukraine (Graf von Luckner et al., 2024).	No analysis has been made for Bolivia using cryptocurrencies.
Methodology	Unofficial rate surveys.	Stable-coin premiums rarely merged with official balance-sheet data; no use of LLMs to extract parallel exchange rate reports.
Microstructure	Crypto studies focus on Bitcoin and centralized exchanges (Graf von Luckner et al., 2024).	No work on USDT/local-fiat pairs or their depth as an indicator of exchange rate pressure.
Policy feedback	Policy incoherence framed in theory (Blanchard et al., 2021; Krugman, 1979; Gray, 2021; Graf von Luckner et al., 2024).	No empirical link between Bolivia's widening deficit, reserve loss and crypto premium.

Table 2.2: Literature gaps by dimension for Bolivia's dual-exchange rate system

2.6.2 Specific Empirical Blind Spots

Validation of stablecoin data. Bolivia's stablecoin series have never been benchmarked against its own black-market quotes.

Timing of speculative pressure. Reported parallel exchange rate data miss intraday or event stress. We do not know whether the first withdrawal caps, the Gold Law, the June 2024 coup attempt or other events mattered most.

Role of monetary financing. No study tests whether domestic-credit growth leads the crypto premium as Krugman's model predicts.

2.6.3 Qualitative hypothesis leads

The identified gaps motivate two narrative hypotheses that in Chapter 3 are presented as formal, testable statements. The hypotheses are as follows:

H-1 (Shadow-rate convergence). The USDT/BOB premium and the black-market cash premium share a long-run equilibrium. Divergence episodes are short-lived and coincide with periods of reporting blackouts or physical cash shortages.

H-2 (Credit-driven pressure). Growth in central-bank domestic credit through monetization of fiscal deficits precedes widening of the crypto premium, consistent with Krugman's reserve-drain mechanism.

By merging Bolivia's balance-sheet data with minute-level stablecoin quotes and LLM-extracted black-market cash quotes, the thesis offers the first real-time map for testing the deterioration of fundamentals and of speculative pressures on the boliviano peg.

3 Theoretical Framework

This chapter lays out the conceptual scaffolding that connects Bolivia's exhausted-peg reality with the empirical tests that follow.

3.1 First-Generation BoP Crises: Krugman (1979)

Krugman (1979)'s first-generation model of balance-of-payments (BoP) crises explains how a country with a fixed exchange rate, facing persistent fiscal deficits financed by domestic credit creation, will inevitably experience a speculative attack that forces the abandonment of the peg. The Bolivian case, characterized by reserve depletion and widening fiscal deficits, aligns with the preconditions described in this model.

Krugman's model is typically set in a small open economy context with the following core assumptions:

- Purchasing Power Parity (PPP) holds, meaning the domestic price level (P) is linked to the foreign price level (P^*) by the nominal exchange rate (s, defined as domestic currency units per unit of foreign currency). Assuming the foreign price level P^* is constant and normalized to one ($P^* = 1$), the domestic price level equals the exchange rate ($P = s$).
- The economy produces a single tradable good, and output (Y) is at its full employment level.
- Residents hold their wealth (W) in two types of assets: domestic money (M) and foreign assets (F), both of which bear zero nominal interest for simplicity in the original model. Real private wealth is thus $W = M/P + F$[1].
- The demand for real domestic money balances (M/P) is a function of the expected rate of inflation π and real wealth (W). In this model π is also the expected rate

[1]Foreigners are assumed not to hold the domestic currency, so M is entirely in the residents' hands.

of depreciation of the currency. The portfolio balance equation:

$$\frac{M}{P} = L(\pi)W \tag{3.1}$$

where $L_1 < 0$, indicating that a higher expected depreciation reduces the demand for domestic money. Under a credible fixed exchange rate, the expected depreciation π is zero.

The crisis in Krugman's model is not a result of irrational speculation but a predictable outcome of inconsistent government policies, mainly being the government running persistent fiscal deficits ($G - T$) and financing them by creating domestic money (domestic credit expansion, $\dot{D} > 0$) while simultaneously committing to maintain a fixed exchange rate ($\bar{s}$, which implies a fixed price level $\bar{P}$).

This policy mix leads to a steady depletion of the central bank's international reserves (R). As the government injects domestic credit into the economy, agents—finding themselves with excess domestic money balances at the prevailing fixed exchange rate—will exchange this surplus domestic currency for foreign currency at the central bank. This process causes international reserves to fall. The government's budget constraint under a fixed price level $\bar{P}$ can be written as $\dot{M}/\bar{P} + \dot{R} = G - T$, where $\dot{M}$ is the total change in money supply and $\dot{R}$ is the change in reserves[2].

Rational economic agents, including speculators, anticipate the eventual exhaustion of reserves and the collapse of the fixed exchange rate regime. They continuously assess the viability of the peg by comparing the official exchange rate ($\bar{s}$) with the "shadow exchange rate" (s_{shadow}). The shadow exchange rate is the floating exchange rate that would prevail in the market if the central bank were to abandon de peg and allow the currency to float, given the current fundamentals. Krugman shows that under a flexible rate regime, this shadow rate would be determined by the equation $P_{shadow} = s_{shadow} = M_{nominal} \cdot G(F_{private})$, where $M_{nominal}$ is the nominal money supply and $G(F_{private})$ captures the relationship between foreign asset holdings and the price level on the economy's stable dynamic path.

A crucial insight from the model is that the speculative attack—a sudden and massive purchase of the central bank's remaining foreign reserves by speculators—occurs *before* reserves are fully depleted. If speculators were to wait until reserves hit zero, the transition to a floating regime would cause an abrupt depreciation of the currency (a jump in s), inflicting a windfall capital loss on holders of domestic currency. To avoid such losses,

[2]In short, every dollar of deficit has to be financed by either printing new base money ($\dot{M}$) or by running down reserves ($\dot{R} < 0$).

speculators will attack the currency when they foresee that the shadow exchange rate is about to depreciate beyond the officially fixed rate.

The timing of this speculative attack is precise: it happens when the remaining stock of the international reserves (R_{crit}) is exactly at the level where, if these reserves are all sold by the central bank, the resulting post-crisis floating exchange rate (the shadow rate) will equal the previously fixed exchange rate ($\bar{s}$). This condition ensures that there are no unexploited arbitrage opportunities or discontinuous jumps in the exchange rate at the moment of the crisis itself. Krugman (1979, eq. 20) formalizes this crisis condition as:

$$1 = [L(0)W - R_{crit}] \cdot G[W - L(0)W + R_{crit}] \tag{3.2}$$

Here, $L(0)W$ represents the real domestic money holdings before the attack (assuming $\pi = 0$ under the peg), R_{crit} is the amount of real reserves (in units of real domestic money, or scaled by $\bar{P}$) acquired by speculators from the central bank (which is equal to the government's remaining stock at the moment of the attack), $W - L(0)W$ are initial private foreign asset holdings, and $G[\cdot]$ is the function derived from the flexible exchange rate regime that determines the price level. The term $[L(0) - R_{crit}]$ is the post-attack real money supply in the hands of the public, and $[W - L(0)W + R_{crit}]$ are the post-attack private foreign asset holdings. The equation states that the attack occurs when these post-attack asset levels result in a shadow price level (via function G) that, when scaled by the post-attack real money, equals the pre-existing price level (normalized to 1 in this specific formulation of the equation, implying $P'/\bar{P} = 1$).

The outcome of this speculative attack is the depletion of the central bank's (willingness to use its) reserves, forcing the monetary authorities to abandon the fixed exchange rate. Subsequently, the currency devalues and is allowed to float, with its value determined by market forces and underlying fundamentals.

4 Methodology

4.1 Data Sources

#	Ticker / Dataset	Start	Frequency	Provider
1	USDT/BOB	2023–10–30	every 5 min	Binance API[1]
2	USD/BOB Official	1990–01–01	daily (weekdays)	BCB
3	USD/BOB Parallel	2023–02–08	$\approx$ 3 days	Local newspapers[2]
4	USD/BOB Tarjeta	2025–03–14	daily (weekdays)	BMSC website
5	USDT/ARS	2023–04–13	daily	Binance API; TradingView[3]
6	USD/ARS Official	2006–02–21	daily (weekdays)	TradingView
7	USD/ARS Parallel	2011–01–03	daily (weekdays)	DolarHoy

[1] Binance API data collected from 2024–09–11. Missing data collected from CriptoYA, bolivian-blue.com, and dolarbluebolivia.click.
[2] Newspapers: Agencia de Noticias Fides, Ahoradigital, Brújula Digital, Economy, El Deber, El Diario, Erbol, Los Tiempos, Opinion, Oxígeno, and Red Uno.
[3] TradingView provides data from Binance and Bitso.

Table 4.1: Summary of FX datasets and tickers

Besides collecting information about USDT/BOB and USD/BOB pairs, Argentina's well documented "blue dollar" serves as an external validity check: if the proposed cointegration framework is valid in Argentina, its usefulness for assessing the case of Bolivia increases. For that purpose, also data about USDT/ARS and USD/ARS was collected.

4.1.1 Crypto peer-to-peer (P2P) markets

Bolivia's capital-controlled banking system entices agents towards engaging in over-the-counter (OTC) stablecoin desks on Binance[1]. Even though Binance's P2P platform is

[1]Other competitiors have entered the Bolivian market recently, such as El Dorado P2P or Bybit, but their market share remains too small to provide any valuable information.

online 24/7, information has been recorded only from 7:00–23:59 (GMT-4), which is when the market is more active[2].

Binance's P2P page, just like any other exchange, allows verified users to post adverts to buy or sell a determined cryptocurrency for a fiat currency. The user then is free to choose the volume to offer, the price, and the payment methods (for the fiat currency). This mechanism allows for free-market mechanics to develop, and for prices to fully fluctuate according to supply and demand.

Although we lack data on executed P2P transactions, the continuous stream of bid and ask quotes nonetheless furnishes a highly reliable proxy for the market price. Given that each row represents an advert, ordered according only to the price, then the market price cannot be determined by just the price of the first advert. Therefore, the volume and the order of adverts should be considered together. This is carried out by using a customized volume-weighted average price formula, detailed in the upcoming Section 4.2. Section 4.3 explains in detail the filtration process to eliminate any purposefully misleading advert.

In the case of Argentinian USDT/ARS quotes, data was also collected from Binance's API with the same methods. As a backup, and to complete the series, data is obtained from TradingView (b).

4.1.2 Official exchange rate series

Bolivia's official exchange rate is listed on a monthly basis in the Central Bank of Bolivia's quarterly reports (Banco Central de Bolivia, 2024a). In the case of Argentina, series are provided by TradingView (a).

4.1.3 Parallel exchange rate series

Argentina's "blue dollar"—a term that refers to the parallel exchange rate—has existed in one form or another since the early 2000s and, because its premium became a key indicator of the market sentiment, newspapers and specialized websites began tracking and publishing it in real time, steadily improving both the frequency and accuracy of their reporting. That's why Argentina serves as an ideal benchmark for validating the link between crypto prices and parallel exchange rates. The far more comprehensive "blue dollar" data enables us to rigorously cross-check and strengthen our findings.

[2]Due to technical limitations, Bolivian banks might not process immediately bank transfers made after midnight. Therefore, regular P2P activity in cryptocurrency exchanges is reduced, if not stopped completely, until around 6:00.

4.1.4 Limitations

Binance's P2P platform does not expose historical trade executions or adverts record through its public API[3], so this analysis must rely solely on the quotes actively scraped and on the secondary series from other sources—none of which extend back to the onset of Bolivia's recent reserve stress. Without access to actual transaction logs, it is not possible determine the precise quantities traded at each price level or reconstruct the true time-series of executed volume and demand. Consequently, the proposed solution offers only an approximation of market activity, rather than a definitive measure of transaction flow at any given moment.

The other source, Bolivian newspapers, do not provide daily reports of the street exchange rates. While on average, data is available every three days, frequency of reports depends on the volatility of the market—during stable periods of time, updates are less frequent.

4.2 Data-Engineering Architecture

This section documents the end-to-end processing that turns raw web endpoints and off-chain quotes into tidy, analysis-ready data.

4.2.1 End-to-End Pipeline

A dedicated Ubuntu VPS (1 vCPU, 1GB RAM) runs a `main.py` orchestrator script running the schedule detailed in Table 4.2.

[3]Because Binance's P2P trades occur off-chain, they leave no public on-chain footprint, there simply isn't an external ledger to verify executed transactions.

Time window[1]	Task
07:00 – 23:59	`binance_request()` every 5 min
≥ 17:00	`dolar_hoy_scraper()` every hour, until first success
	`cmv_request()` every hour, until first success
23:59	`tradingview_request()` (all tickers)[2]
	`calculate_daily_averages()`[3]
	`calculate_x_period_averages()`[3,4]
	`newspaper_scraper()`[5]

[1] Using local Bolivian time-zone GMT-04.
[2] Tickers: USDARS:FX_IDC, USDTARS:BINANCE, USDTARS:BITSO.
[3] From the `data_processing` module.
[4] For monthly and quarterly averages.
[5] From the `newspaper_processing` module.

Table 4.2: ETL tasks schedule

All raw and clean data is stored in a single MongoDB instance, across multiple collections (one per ticker). Figure A.1 is an overview flowchart of the entire pipeline.

Every function has robust error-catching features so that a single failure does not interrupt the rest of the tasks.

4.2.2 Real-time Binance P2P Capture

The Binance P2P routine (`binance_request()`) queries the POST endpoint twice per pair—first the *sell* side, then the *buy* side—for USDT/BOB and USDT/ARS:

1. Iterates over advert pages.
2. Applies a per-ad filter (first-stage)—according to rules detailed in Section 4.3.
3. Passes the complete data for each pair into `aggregate_raw_data()`, which:
   (a) Merges the current 5-minute buy and sell data.
   (b) Applies a second-stage filter—detailed in Section 4.3.
   (c) Computes PVWAP, spread, volume, limit order book.
4. Stores raw and processed data into the database.

Since relying solely on the first advert won't produce a true market quote, I compute the

position-and-volume weighted average price (PVWAP) as follows:

$$\text{PVWAP} = \frac{\sum_{i=1}^{n} p_i \, v_i \, w_i}{\sum_{i=1}^{n} v_i \, w_i} \qquad w_i = \frac{1}{\text{pos}_i} \tag{4.1}$$

p_i	price of advert i,
v_i	volume of advert i,
w_i	weight of advert i,
pos_i	position of advert i,
$i = 1, \ldots, n$	index of adverts,
n	total number of adverts.

Correspondingly, denoting the sell-side PVWAP as S, and the buy-side PVWAP as B, the percentage spread between them is computed as:

$$\text{Spread} = \frac{S - B}{\big(S + B\big)/2} \times 100 \tag{4.2}$$

A relevant measure of the volume is not the total volume offered, because it would include amounts quoted at very different price levels. Instead, a more realistic measure of volume for each side is computed as follows:

$$V_{\text{sell}} = \sum_{\substack{i=1 \\ 0<p_i<S(1+0.01)}}^{n} v_i \quad , \quad V_{\text{buy}} = \sum_{\substack{j=1 \\ p_j>B(1-0.01)}}^{m} v_j \tag{4.3}$$

Finally, the limit order book (LOB) is the price-ordered record of the sell and buy adverts, arranged from the cheapest ask upward and from the highest bid downward. At each price level the book shows the quantity of USDT available and the cumulative volume up to that point. Plotting the cumulative volume against the price points produces the liquidity depth chart, which indicates how much volume can be traded before the price moves beyond a chosen threshold.

4.2.3 USD/BOB Bank Exchange Rate Capture

Banco Mercantil Santa Cruz (BMSC) publishes each business day the *Comisión Máxima Variable* (CMV) fixed by the financial-sector supervisor ASFI. Under the regulation, the CMV is simply the percentage by which the banking system's recent, volume-weighted

average USD buying rate exceeds the official buying rate of Bs 6.86 per dollar. The complete formula can be found in Appendix B.

To obtain the bank's operative exchange rate for outgoing transfers or card transactions, BMSC (or any other bank) computes the following formula, using the official selling rate:

$$\text{Bank Exchange Rate}_t = 6.97 \times (1 + \text{CMV}_t) \tag{4.4}$$

This produces the rate customers effectively face on day t.

The function `cmv_request()` runs hourly starting at 17:00—a reasonable time by which the bank is expected to have published the day's update. It accesses the bank's "Tasas y Tarifario" section, downloads the latest PDF, and checks whether a new entry for the current date is available. If found, it extracts the CMV value, computes the corresponding bank exchange rate (commonly referred to as the *dólar tarjeta*), and stores the results in the database. If the PDF has not yet been updated, the function waits and retries in the next hourly cycle.

4.2.4 USD/ARS Parallel Capture

Argentina's "blue dollar" (USDT/ARS parallel) series is gathered from DolarHoy, one of the longest-running websites that publishes the cash-street rate every business day.

The function `dolar_hoy_scraper()` queries the website once an hour after 17:00, sending a request until a new value is detected. Although DolarHoy offers both buy and sell quotes daily, historical data is offered only for sell quotes. Consequently the thesis adopts the daily sell rate as a proxy for the USD/ARS parallel exchange rate. This choice ensures consistency over time and aligns with market convention, where the sell-side typically reflects retail access to foreign currency.

4.2.5 TradingView Capture

The open-source library `tvDatafeed` provides a streamlined interface for accessing TradingView data and serves as a practical alternative to building a custom scraper for the Central Bank of Argentina (BCRA)'s website when retrieving Argentina's official exchange rate. In addition to the USD/ARS official rate, TradingView offers historical OHLC data—with its corresponding volume—for the USDT/ARS pairs traded on Binance and Bitso, making it a convenient and consistent source of historical information.

As of January 7, 2025, the custom Binance scraper has replaced TradingView as the primary source for USDT/ARS quotations, since it provides the complete raw data. Nonetheless, the TradingView data remains valuable for historical backfilling and as a fallback mechanism in the event that the custom pipeline fails to capture prices on a given day.

The `tradingview_request()` function—that integrates `tvDatafeed`—runs once daily after 23:59, collecting and storing the latest daily bar for each relevant ticker in the database.

4.2.6 Newspaper Scrape and Two-Stage LLM Processing

After collecting the data from TradingView, `newspaper_scraper()` orchestrates the data scraping from each of the newspaper's economy section:

1. **Backfill logic.** The first-ever run scrapes back to 1 Sep 2022. Subsequent runs fetch only new articles after the latest timestamp in MongoDB.
2. **Per-newspaper scrapers.** Since every newspaper has a different logic and structure built-into their website, a custom scraper has been developed for each. These scrapers collect the title, date, URL, and full text from the articles. Each document is inserted into MongoDB with flags to keep track of the LLM-processing stages.

At a later time, manually, and on more powerful hardware[4], `newspaper_llm_processing()` applies a two-pass filter:

Stage 1 – Binary classification. A lightweight Llama-3.1 (8B) model performs a binary classification: *Does the article mention the parallel exchange rate?* Its blend of speed and accuracy makes it ideal for screening thousands of articles.

Stage 2 – Quote extraction. Positively-flagged articles are then fed to the more capable—but slower—`DeepSeek-R1 (14B)` model, which parses each article to extract both (1) a `hint_type` and (2) the specific quote for the parallel exchange rate[5]. The

[4]Because large-language-model (LLM) inference is computationally intensive, these steps are offloaded to a Macbook Pro 14" (M1 Pro, 16GB unified memory). Even so, Stage 1 takes between 3-6s per article, Stage 2 between 30-45s.

[5]With higher-end GPUs, an even larger model could cut inference times and further lower false positives, thereby shrinking the subsequent manual workload.

`hint_type` denotes whether the article indicates that the parallel exchange rate is *above*, *below*, or *exactly* at the quoted price. Finally, the model also extracts the quoted value itself.

Human review. Finally, `newspaper_reviewing()` presents the small set of Stage-2 outputs for manual validation, allowing the user to accept the extracted quote and hint type, edit either, or reject the article altogether. The user also evaluates the date to which that quote actually refers (since an article published on, say, May 10, may be reporting the parallel rate from May 9 or earlier). Observations approved here are then processed as explained in Section 4.3.2.

Figure A.2 reveals the newspaper scraping process in more detail. Figure A.3 explains the LLM extraction process.

4.3 Data Cleaning and Validation

Mention cleaning of USDT/BOB, but also the validation process for USD/BOB parallel, and its complications.

4.3.1 USDT/BOB Cleaning

Some Binance P2P for USDT/BOB exhibit implausible pricing and volume patterns—particularly after the attempted coup, when increased public awareness may have prompted attempts (potentially by government actors) to push the stablecoin price toward the official peg. To eliminate this anomalies, each advert passes through a first-stage filter comprised of nine rule-based criteria during the scraping process. Any advert meeting one or more of these conditions is discarded, but the criteria are designed as set to collectively target manipulative or fake listings:

1. Total available volume < 100 USDT;
2. Quoted price ≤ 6.96 BOB/USDT – filters adverts at or below the fixed official rate;
3. Single-transaction limit < 100 USDT[6];
4. Seller orders < 20 completed in the past 30 days;

[6]While some legitimate adverts allow narrow bands, listings imposing tight limits (e.g. 55–56 USDT) are often linked to price manipulation; enforcing a 100 USDT minimum helps exclude these suspicious offers.

5. Seller last online $>$ 12 hours ago[7];
6. Monthly completion rate $<$ 75%;
7. Positive feedback $<$ 95%;
8. Payment method contains Banco Fassil[8] or Tigo Money[9].
9. Username on custom blacklist (see below).

After the scraping process is completed, adverts that have passed these combined rules enter the `aggregate_raw_data()` function, where a second-stage IQR filter removes any remaining outliers: prices below $Q1 - 1.5 \times IQR$ or above $Q3 + 1.5 \times IQR$ are discarded. The surviving set then yields the 5-minute PVWAP, spread, and depth measures (Section 4.2.2).

Although brief bid $>$ ask inversions can occur during extreme volatility, they are uncommon. More often, repeated or persistent inverted spreads signal deliberate price manipulation. When such patterns are detected, the specific advert is reviewed manually. If deemed manipulative, its advertiser is added to a blacklist, and all raw entries from that user are reprocessed or purged from the cleaned series. This procedure—triggered only as needed—ensures that geniuine market movements remain intact while intentional anomalies are removed.

In future work, a simple machine-learning classifier trained on manually-flagged adverts could replace the ad-hoc blacklist review, further reducing any residual manipulation.

4.3.2 Continuous Street-Rate Series Construction

Newspaper reports on the parallel USD/BOB rate arrive in two incompatible formats: exact point quotes (e.g., "Bs15 per USD") and qualitative, one–sided hints (e.g., "above Bs 11" or "just under Bs 12"). For econometric work that follows, we require a single, gap–free daily series. The algorithm below converts the raw, irregular material into a smoothed, analytically tractable parallel exchange rate.

[7]Filters out listings left active by inactive accounts—ads unlikely to reflect genuinely available liquidity.

[8]Fassil Bank has been under government intervention and in liquidation since April 26, 2023 (Reuters, 2023).

[9]Tigo Money is a Bolivian mobile-payment service rarely used for P2P crypto trades; its appearance often flags as a non-geniune advert.

Because newspapers rarely provide both bounds of a range, we translate each qualitative cue into a conservative one–boliviano band:

$$> \text{ Bs } a \;\rightarrow\; [a,\, a+1], \qquad < \text{ Bs } b \;\rightarrow\; [b-1,\, b]$$

This convention preserves the information that the price exceeds a (or falls short of b) without claiming spurious precision. The synthetic bounds form the observations $q_{d,i}^{\min}$ and $q_{d,i}^{\max}$ used in the next step.

Daily interval consolidation. When executing `calculate_daily_averages()`, all newspaper mentions on calendar date d are aggregated into one bounding interval:

$$L_d = \min_i q_{d,i}^{\min}, \quad U_d = \max_i q_{d,i}^{\max}, \qquad d = 1, \ldots, D$$

If the single quote on day d is exact, then $L_d = U_d$ and the interval collapses to a point.

Mind-point interpolation. Mid-points $m_d = (L_d + U_d)/2$ are used as anchors for a linear interpolation that fills dates with no press coverage. Using pandas' linear interpolation, we obtain continuous sequence m_t at the daily frequency. This operation irons out high-frequency "jitter" arising both from the alternation between exact and interval quotes and from the infrequent, heterogeneous reporting across multiple newspapers.

Multi-pass rolling smoothing. Residual micro-jumps are attenuated with a centred, 5-day rolling mean applied three consecutive times. The resulting curve—our *Street Synthetic Rate (SSR)*, which we will hereafter refer to as the *street parallel exchange rate*—balances fidelity to genuine price moves against the risk of over-reacting to sparse or qualitative reportage.

Figures 4.1 and 4.2 show, respectively, (i) the raw daily intervals with their linear-interpolated backbone and (ii) the final SSR overlay. In Figure 4.3, we provide a zoomed-in view of a short window from Figure 4.2 to highlight how the SSR removes high-frequency noise.

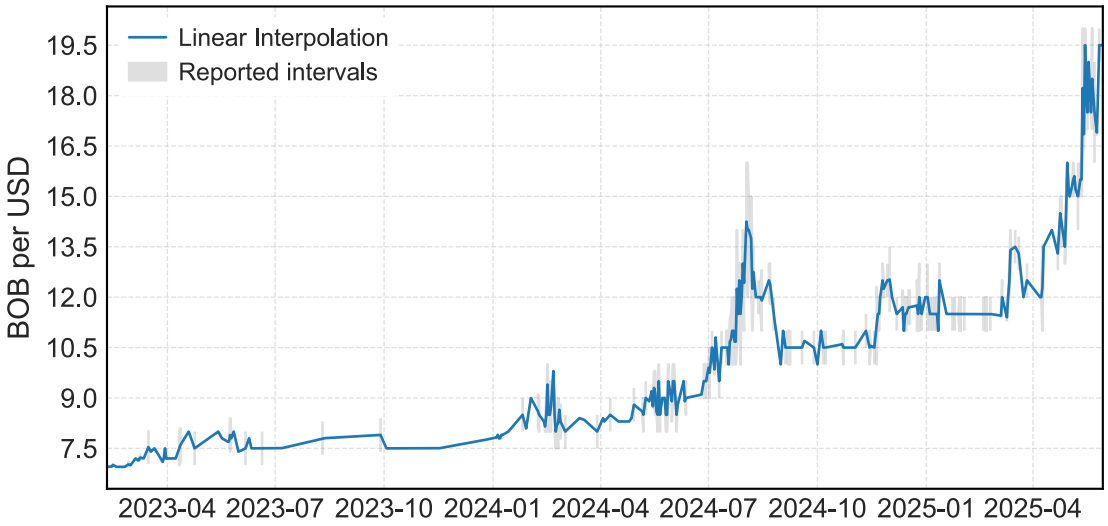


Figure 4.1: Linear interpolation on newspaper parallel exchange rate quotes

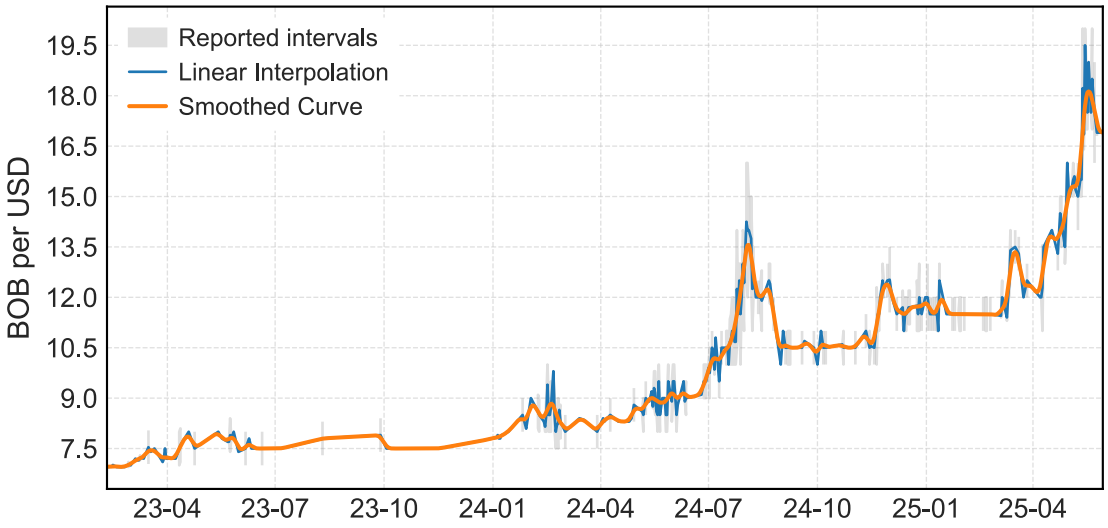


Figure 4.2: Smoothed linear interpolation compared

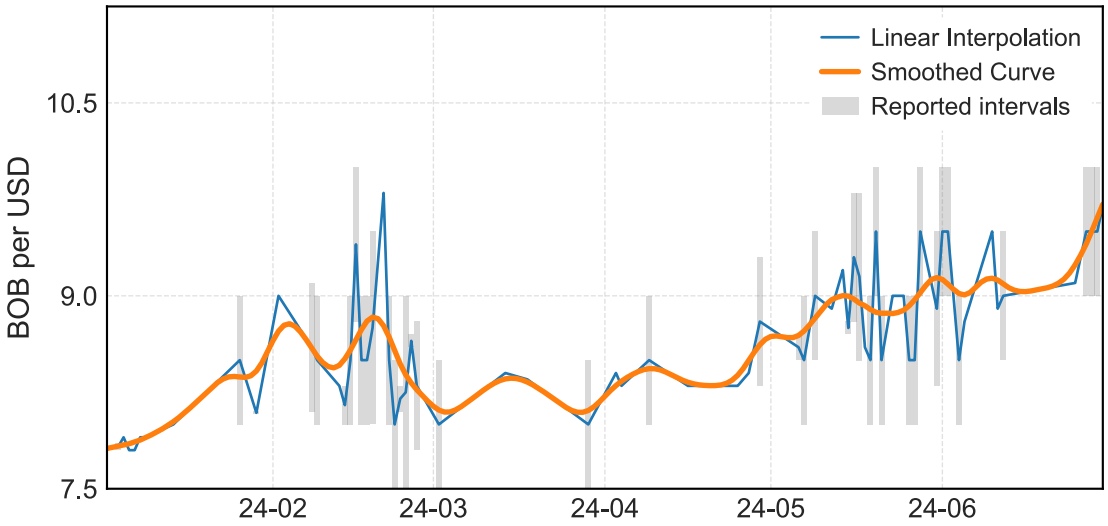


Figure 4.3: Zoomed-in series compared

4.4 Empirical Strategy

Economic time series typically exhibit non-stationarity, which can lead to spurious regression results. To reliably investigate long-run relationships in the data, we need to follow a two-step empirical strategy recommended by Mills (2019):

1. **Unit-root testing.** We begin by verifying the stationarity of each time series using the Augmented Dickey-Fuller (ADF) test. A constant term is included in the test regression, reflecting the fact the series appear to fluctuate around non-zero means without a clear trend. Lag lengths are selected automatically based on the Akaike Information Criterion (AIC) to account for serial correlation.

2. **Cointegration analysis.** For variables to be integrated of order one (I(1)), we employ the Engle-Granger two-step procedure to test for cointegration. Specifically, we first estimate an ordinary least squares (OLS) regression of the dependent variable y_t on the independent variable x_t in levels. Next, we apply the ADF test to the residuals of this regression. Rejection of the null hypothesis (indicating no unit root in the residuals) confirms cointegration. In practical terms, cointegration justifies performing regressions directly in levels rather than log-returns, facilitating clearer and more intuitive interpretations.

Confirming cointegration allows us to confidently estimate linear relationships using OLS. Specifically, we investigate the relationships between USDT/BOB and the street

USD/BOB parallel exchange rate, as well as between FX reserves and the parallel exchange rate.

5 Empirical Analysis and Results

5.1 Data Preparation and Descriptive Statistics

5.1.1 Coverage

The empirical work realies on three blocks of data: (i) high-frequency quotes for the crypto-denominated USDT/BOB rate, (ii) manually curated observations of the street parallel USD/BOB rate, and (iii) monthly macro-fundamentals (international reserves and public debt). Table 5.1 summarizes their respective sample windows; the construction details follow.

USDT/BOB (Binance P2P). The core sample covers 11 October 2023–30 May 2025 (598 calendar days). Intraday quotes are scraped every five minutes from Binance's P2P marketplace between 07:00 and 13:59 local time and then averaged into a single daily rate.

Since the scraper reached full automation on 11 September 2024, it has generated about 30,000 individual quotes—roughly 115 per day. While the quality of the collected data is high, some interruptions in continuity occurred between September 2024 and December 2024, after which data collection became stable and uninterrupted. Early gaps caused by the beta version of the scraper (10 Oct. 2023–11 Sep. 2024), as well as any later interruptions, were back-filled with data from three independent USDT/BOB trackers[1]. When multiple quotes were available for the same day, their values were averaged to create a composite estimate.

USD/BOB (parallel market). The street USD/BOB exchange rate is reconstructed from approximately 40,000 articles scraped from the economy sections of major Bolivian

[1] CriptoYA, bolivianblue.com, and dolarbluebolivia.click

newspapers. After processing with LLMs, the dataset yields 256 daily observations between 8 February 2023 and 30 May 2025—an average frequency of one quote very 3.28 days. The longest gap without a valid observation spans 49 days (10 August 2023 to 28 September 2023).

Fundamental variables. Monthly international reserves data come from the Central Bank of Bolivia (BCB). The analysis focuses on the foreign exchange (FX) component, as it can be deployed immediately to defend the boliviano; gold holdings are less liquid and are discussed separately where relevant. FX-reserve observations are available up to April 2024.

Public debt is proxied by the sum of BCB's "*credit to the public sector*" and "*credit to the private sector*". Because the disaggregated debt series end in December 2024, any analysis that includes debt necessarily shortens the estimation window to that date.

5.1.2 Transformation

Although the USDT/BOB series is available at five-minute intervals, the empirical analysis that follows is conducted at a monthly frequency, using end-of-month observations of all variables. The main reason is the street (parallel) USD/BOB rate: its sparse and irregular reporting introduces high-frequency noise that can distort day-to-day comparisons. Aligning every variable to a common, lower frequency therefore minimizes measurement error and facilitates direct regressions.

Accordingly, the USDT/BOB and USD/BOB (parallel) rates are both sampled at month-end; FX-reserves and public debt are already published in monthly intervals by the Central Bank of Bolivia. Public debt figures are converted to U.S. dollars using the official exchange rate.

5.1.3 Descriptive Statistics

Table 5.1 condenses the key series of the datasets that feed the rest of the empirical work, while Figure 5.1 visualizes the raw, daily exchange rate behavior. The discussion below walks through each panel in turn.

Panel A – Daily exchange rates (raw sample). The five-minute Binance quotes average Bs 10.11 per USDT over the full 598-day window, whereas the newspaper-derived

street rate averages Bs 9.56 per USD over the 842-day window.

While we observe that the average quotes differ (a 5.7% crypto premium), we can't compare them directly since the newspaper-derived street rate data covers a longer time range.

Despite coming from very different micro-sources, the two series display nearly identical dispersion (standard deviations of 2.27 vs 2.35). Visual inspection of Figure 5.1 shows that most of the apparent deviations occur in short-lived spikes, which could be attributed to the inexact reporting of newspapers.

Because these daily series contain micro-noise, they are not used directly for the formal econometrics that follow; instead they motivate the monthly aggregation strategy explained in Section 5.1.2.

Figure 5.2 provides additional context for the street-rate series. The top panel restates parallel exchange rate, while the bottom panel plots the number of newspaper articles reporting the exchange rate each month.

Report counts are highly uneven: coverage is sparse for most of 2023 (often fewer than five quotes per month) but rises sharply in mid-2024 as dollar-shortage stories dominate the economic pages. This heterogeneity helps explain the short-lived price jumps seen in Figure 5.1: when article frequency is low, a single outlier quote can shift the daily line.

Panel B – Monthly exchange rates. Once both series are synchronized to end-of-month values and trimmed to the common window Oct 2023–May 2025, the differences mentioned before almost vanish: the mean USDT/BOB rises slightly to 10.34 while the street USD/BOB climbs to 10.5, narrowing the average premium to just 20 cents (1.9%). Their standard deviations also converge (2.56 vs 2.53). The near-equality of minima and maxima underscores the visual impression that, at a monthly frequency, the two series move as a single process—an observation tested formally in Section 5.2.

Panel C – Monthly macroeconomic variables. The data extends the horizon back to February 2023 to exploit all parallel exchange rate data. Two facts are worth retaining:

1. **Reserves drain.** FX reserves average USD 301 million but with a hefty standard deviation of USD 137 million and a low of USD 87 million—evidence of the Krugman-style rundown that motivates Hypothesis 3.

2. **Debt build-up.** Public debt trends upward (mean USD 44.7 billion, max USD 50.4 billion), providing a second potential pressure point on the peg.

	Mean	St. Dev.	Min	Max	Obs.
Panel A: Daily exchange rates					
USDT/BOB (Binance P2P)	10.11	2.27	7.18	18.16	598
USD/BOB (Parallel)[1]	9.56	2.35	6.95	18.13	842
Panel B: Monthly exchange rates (trimmed, 20 obs.)[2]					
USDT/BOB (Binance P2P)	10.34	2.56	7.27	16.49	20
USD/BOB (Parallel)	10.54	2.53	7.50	16.90	20
Panel C: Monthly macroeconomic variables (trimmed, 23 obs.)[3]					
USD/BOB (Parallel)	8.88	1.74	7.03	12.96	23
FX Reserves (MM USD)	301	137	87	625	23
Public Debt (MM USD)	44 690	3 034	40 451	50 408	23

Table 5.1: Summary statistics (monthly data, 2023–2025)

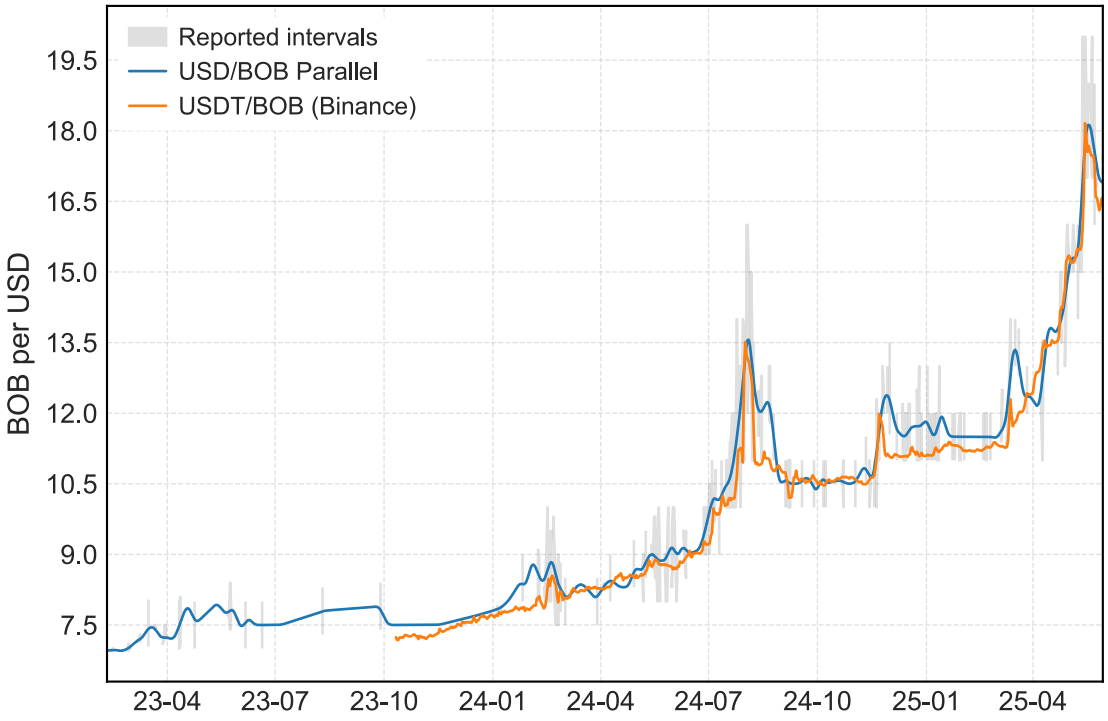


Figure 5.1: Daily exchange rates: USDT/BOB and USD/BOB (Parallel)

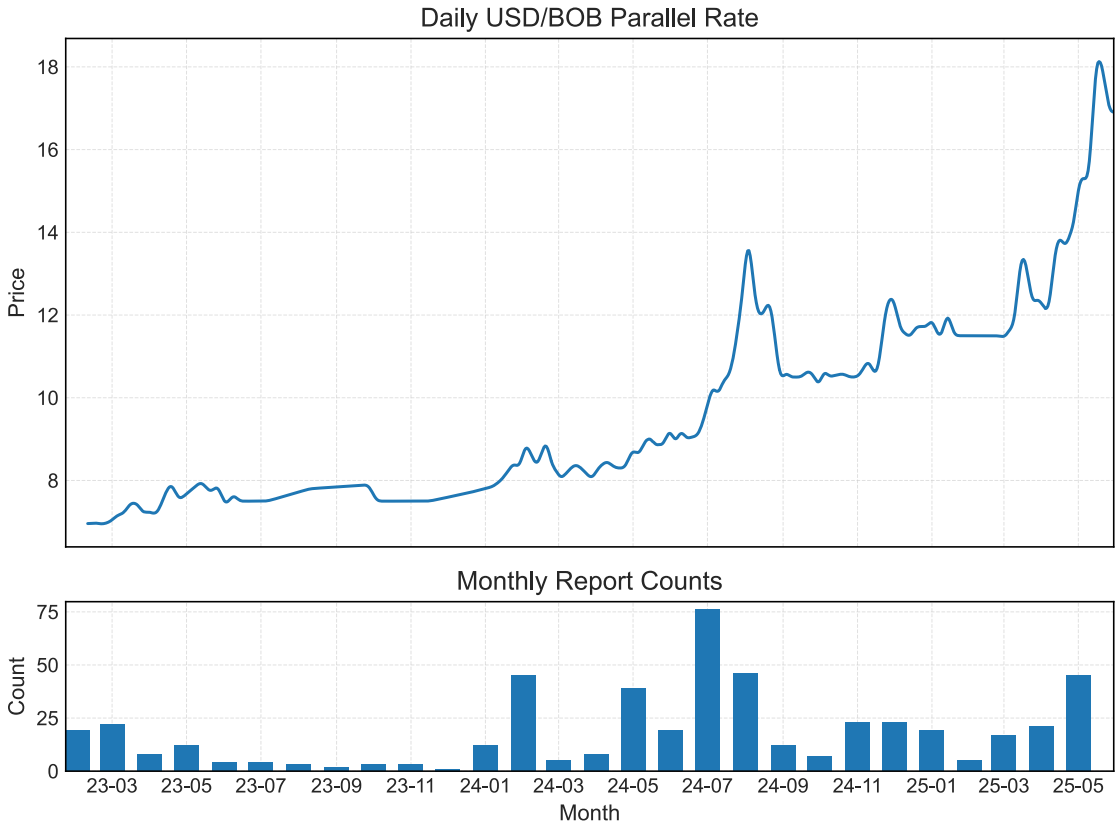


Figure 5.2: Daily USD/BOB Parallel Rate and Monthly Article Counts (Feb 2023–May 2025)

Top: USD/BOB rate inferred from newspaper reports
Bottom: Number of newspaper exchange rate quotes

In summary, once all series are harmonized to a common end-of-month frequency, the USDT/BOB and street USD/BOB rates behave almost as a single process, reinforcing the use of either as a reliable market-based gauge of boliviano pressure. These descriptive patterns provide the empirical backdrop for the empirical work that follows.

5.2 Shadow-Rate Convergence (H-1)

Figure 5.3 plots the end-of-month values of the crypto-denominated USDT/BOB rate alongside the street (parallel) USD/BOB rate for the period October 2023–May 2025. A visual inspection already suggests a near-one-for-one co-movement: both series track the same inflection points.

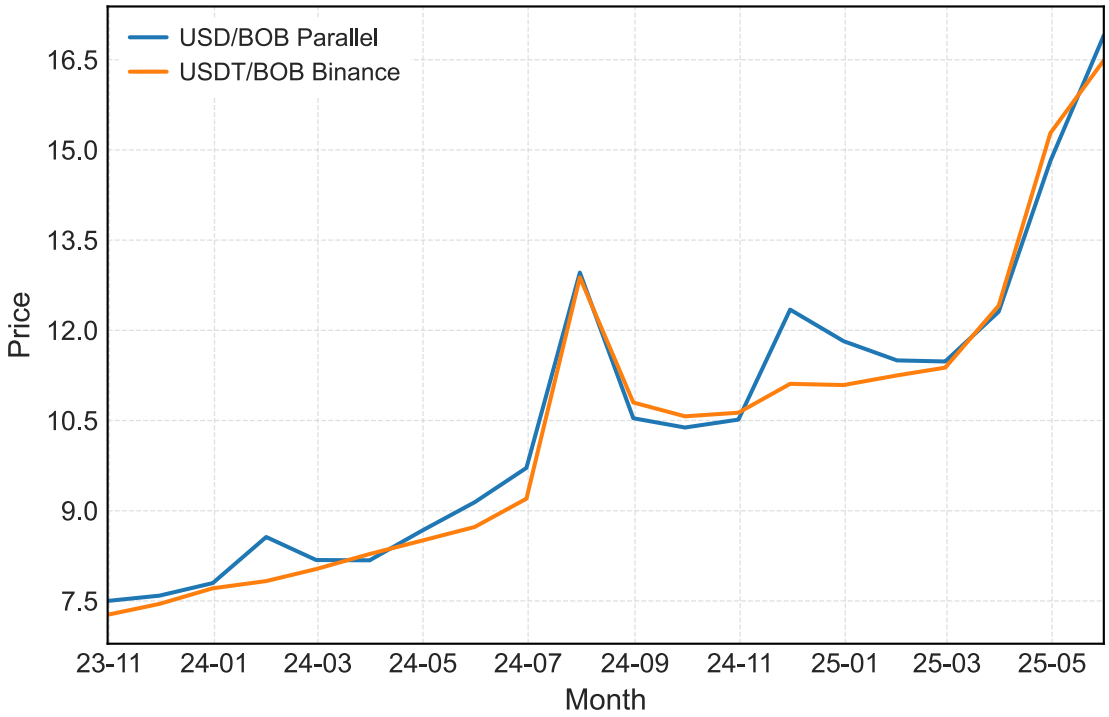


Figure 5.3: End-of-month exchange rates: USDT/BOB and USD/BOB (Parallel)

The remainder of this section formalizes that impression. We begin by confirming that both series are integrated of order one (Section 5.2.1). We then apply the Engle-Granger test to show they share a common stochastic trend (Section 5.2.2). Section 5.2.3 complements this with a Pearson-correlation check, Section 5.2.4 examines how the two rates reacted to key policy and political developments, and finally, Section 5.2.5 contrasts the findings with Argentina. Taken together, these tests demonstrate that the crypto-based USDT/BOB is a reliable real-time proxy for Bolivia's parallel exchange rate.

See Appendix C for the complete results of each of the statistical tests performed in the following sections.

5.2.1 Unit-root tests

Before any long-run relationship between USDT/BOB and the street USD/BOB rate can be assessed, we must establish the order of integration. Economic time-series often exhibit stochastic trends; running regressions in levels when at least one variable is non-stationary risks the well-known "spurious regression" problem. We therefore apply the Augmented Dickey-Fuller (ADF) test, as explained in Section 4.4, to the two monthly prices.

Results. Table 5.2 reports the ADF statistics and p-values.

	ADF stat.	**p-value**	**Decision (5%)**
USDT/BOB (Binance P2P)	0.21459	0.97307	non-stationary
USD/BOB (Parallel)	0.19124	0.97177	non-stationary

Table 5.2: ADF test, USDT/BOB and USD/BOB (levels)

Both test statistics lie far to the right on the 5% critical value and their associated p-values are close to one; hence we fail to reject the null hypothesis of a unit root for either series. In other words, USDT/BOB and the street USD/BOB follow integrated processes of order one, $I(1)$, exactly as visual inspection suggested.

Implications. Because both variables are I(1), any regression in levels is only statistically meaningful if the series are cointegrated. We therefore proceed in Section 5.2.2 with the Engle-Granger two-step procedure, testing whether the residuals from an OLS regression of USDT/BOB on USD/BOB are themselves stationary. Evidence of cointegration will legitimize subsequent analyses that rely on price-level data.

5.2.2 Cointegration test: Engle-Granger

Having verified in Section 5.2.1 that both rates are integrated of order one, the next step is to test whether they share a common stochastic trend. We apply the classic Engle-Granger two-step procedure:

1. **Step 1 − OLS in levels.** We run the OLS regression

$$\widehat{\text{USDT/BOB}}_t = \alpha + \beta\,\text{USD/BOB}_t + \varepsilon_t$$

   using the 20 monthly observations in the common sample (Oct 2023–May 2025). The slope is indistinguishable from unity ($\widehat{\beta} = 1.0002$, $t = 27.17$, $p < 0.001$) while the intercept is economically and statistically negligible ($\widehat{\alpha} = -0.202$, $t = -0.51$, $p = 0.62$). An R^2 of 0.976 indicates that almost 98% of the variation in the stablecoin price is explained by the street rate (Table 5.3).

2. **Step 2 − ADF on the residuals.** We then test the fitted residuals $\widehat{\varepsilon}_t$ for unit root. With eight augmentation lags teh ADF statistic is -16.48, well bellow the 5% critical value (about -3.57). Hence we reject the null of non-stationarity and conclude that the residuals are I(0) (Table 5.3).

Interpretation. Together, these two steps establish that USDT/BOB and the street USD/BOB rate are cointegrated. Economically, the finding implies a stable long-run one-for-one relationship: whenever the two quotations drift apart, market forces quickly restore parity. This is precisely the shadow-rate convergence posited in Hypothesis H-1, providing its first piece of formal support.

	Coef.	t**-stat**	p**-value**
Step 1: OLS (USDT/BOB $\sim$ USD/BOB, $n = 20$**)**			
Constant	0.4483	1.173	0.256
USD/BOB	0.9760	27.170	< 0.001
$R^2 = 0.976$			Obs. (Step 1): 20
Step 2: ADF on residuals (lags=0, residual obs. = 19)			
ADF statistic	-3.293	—	0.015
Decision (5 %): reject H_0, residuals are $I(0)$			Lags used: 0

Table 5.3: Engle–Granger two-step: OLS regression and residual ADF test

5.2.3 Pearson correlation

For completeness we also quantify the contemporaneous co-movement in levels. Using the same 20-moth sample, the Pearson correlation coefficient is

$$\rho_{\text{USDT/BOB, USD/BOB}} = 0.9880.$$

Under the usual $H_0 : \rho = 0$, the associated t-statistic is $t = \rho\sqrt{(n-2)/(1-\rho^2)} = 27.1$ (df $= 18$), implying $p < 10^{-15}$—a virtually perfect linear association.

5.2.4 Event-study: key policy and political shocks

Figure 5.4 overlays the USD/BOB parallel rate and the Binance USDT/BOB rate with three vertical bars that mark pivotal domestic shocks.

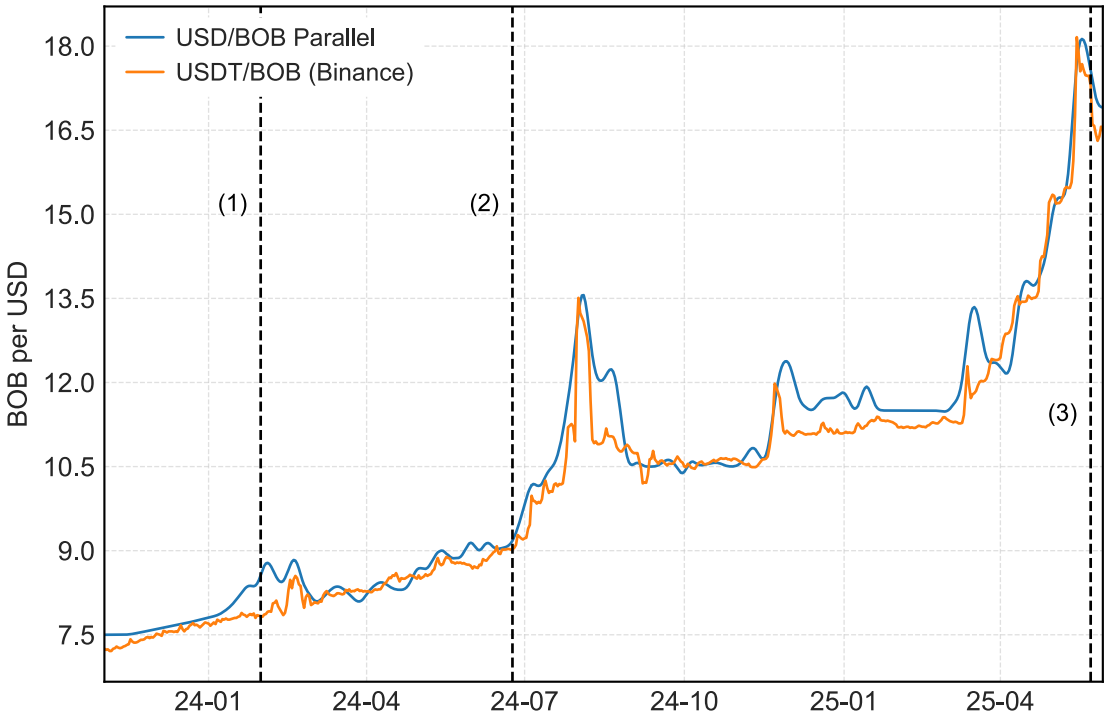


Figure 5.4: Key events their impact on the exchange rate

(1) (31/01/24) Start of the 16-day nationwide road blockages led by pro-Evo Morales groups. Blockages choked fuel and food logistics, froze inter-department trade and, according to government sources, had a speculative effect (eju, 2025). The stable-coin rose from 7.8 to 8.55 bolivianos per USDT on the third week of February.

(2) (24/06/24) Failed military coup attempt. The situation caused panic among population, generating a spike in the parallel exchange rate in the following weeks.

(3) (24/05/24) Supreme Decree 5399: YPFB barred from using crypto (USDT) for fuel imports. Rumors that the state oil firm would soon buy millions in USDT had propelled USDT speculation on Binance. By revoking that authorization—and clarifying that YPFB had never executed a crypto deal—President Arce removed a key narrative fueling the rally, prompting arbitrageurs to unwind positions. As a result, both curves drop almost 2 BOB within five days, right at the data cutoff.

Collectively, the three case studies demonstrate that discrete political or policy shocks are transmitted almost instantaneously to Bolivia's parallel FX market—an effect that materialises in lock-step both in the cash street-rate and in the Binance-quoted USDT price.

5.2.5 Comparison with Argentina

As a quick robustness check, Figure 5.5 plots Argentina's daily exchange-rate series over the May 2023–May 2025 period[2]. Two observations stand out.

1. **USDT and the parallel peso move almost one-for-one.** Throughout the sample the orange (USDT/ARS) and green (parallel USD/ARS) lines are virtually indistinguishable, including the sharp run-ups around the presidential primaries (Aug 2023), the December 2023 devaluation episode, and the bouts of volatility in early 2025. Even micro-deviations—largely weekend liquidity gaps on crypto venues—are quickly arbitraged away. This mirrors what we documented for Bolivia and reinforces the idea that a liquid USD-pegged stablecoin immediately prices the shadow FX rate.

2. **The official rate was also disconnected.** The blue line follows a crawling-peg punctuated by discrete "step" devaluations (most prominently the 118% overnight devaluation on 13 Dec 2023). Between these jumps, the series drifts upward at a pre-announced daily crawl while the parallel and USDT quotes re-price continuously.

The Argentine case therefore corroborates the Bolivian evidence: when capital controls are imposed on the official FX market, a USD-denominated stablecoin trades almost one-for-one with the black-market peso and bears no stable relationship to the regulated rate. No further statistical analysis is required for the purposes of this chapter as the visual comparison suffices to validate the parallel–USDT linkage.

[2]The USDT/ARS is the quotes provided by TradingView (Binance and Bitso). The parallel exchange rate is provided by the website DolarHoy. The official exchange rate is the one published by the Banco Central de la República Argentina and reported by TradingView.

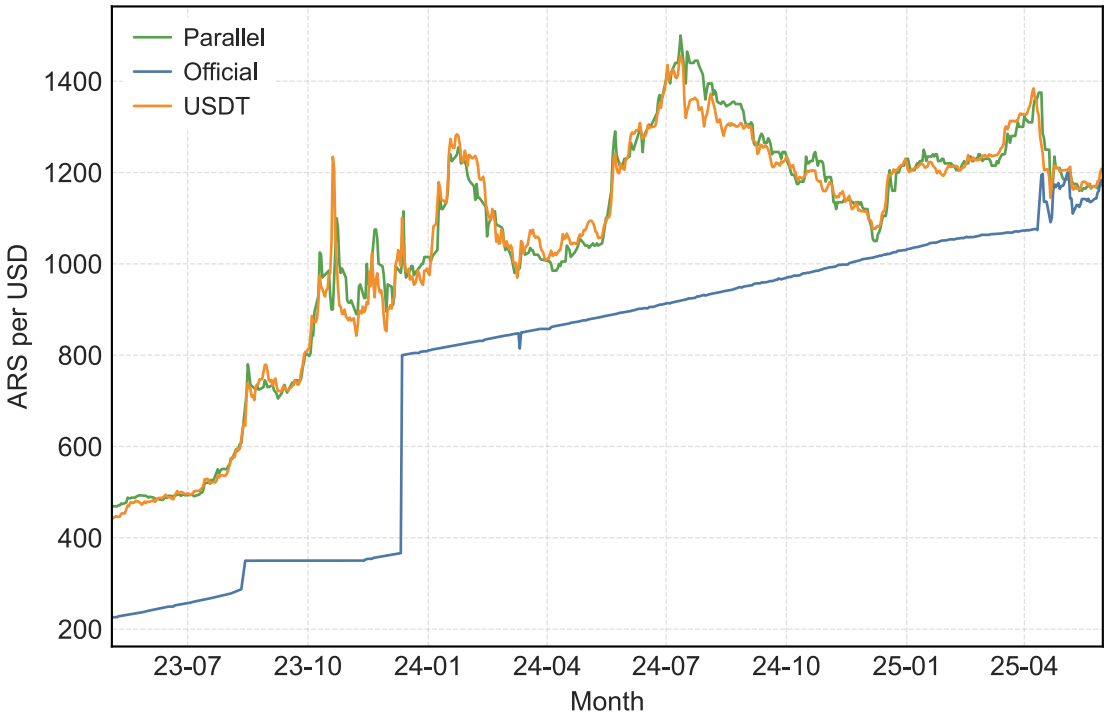


Figure 5.5: Daily ARS per USD exchange rates in Argentina, May 2023–May 2025.

5.2.6 Key takeaways

- **Both series are $I(1)$.** Augmented Dickey–Fuller tests fail to reject a unit root in levels for USDT/BOB and the street USD/BOB, confirming that each series is non-stationary.
- **They share a common stochastic trend.** The Engle–Granger two-step procedure shows the OLS residuals are stationary, implying a stable long-run one-for-one relationship between the crypto and cash quotations.
- **Near-perfect short-run co-movement.** A Pearson correlation of $\rho = 0.988$ ($t = 27.1$, $p < 10^{-15}$) indicates that the two rates move almost identically month-to-month.
- **Shocks transmit instantaneously.** Event-study evidence reveals that major political or policy shocks (road blockades, the June 2024 coup attempt, and Decree 5399) are immediately reflected in both the Binance USDT price and the street rate.
- **External validation from Argentina.** An analogous one-for-one pattern be-

tween USDT/ARS and the Argentine parallel peso reinforces the conclusion that a liquid USD-pegged stablecoin is an accurate real-time proxy for shadow FX markets under capital controls.

5.3 Credit-Driven Pressure (H-2)

5.3.1 Current-account pressure

Bolivia's external position has shifted from comfortable surpluses to persistent deficits, and the culprit is straightforward: imports kept trending up while the volume of exports peaked years ago and has since drifted lower. Figures 5.6 and 5.7 make this pattern unmistakable.

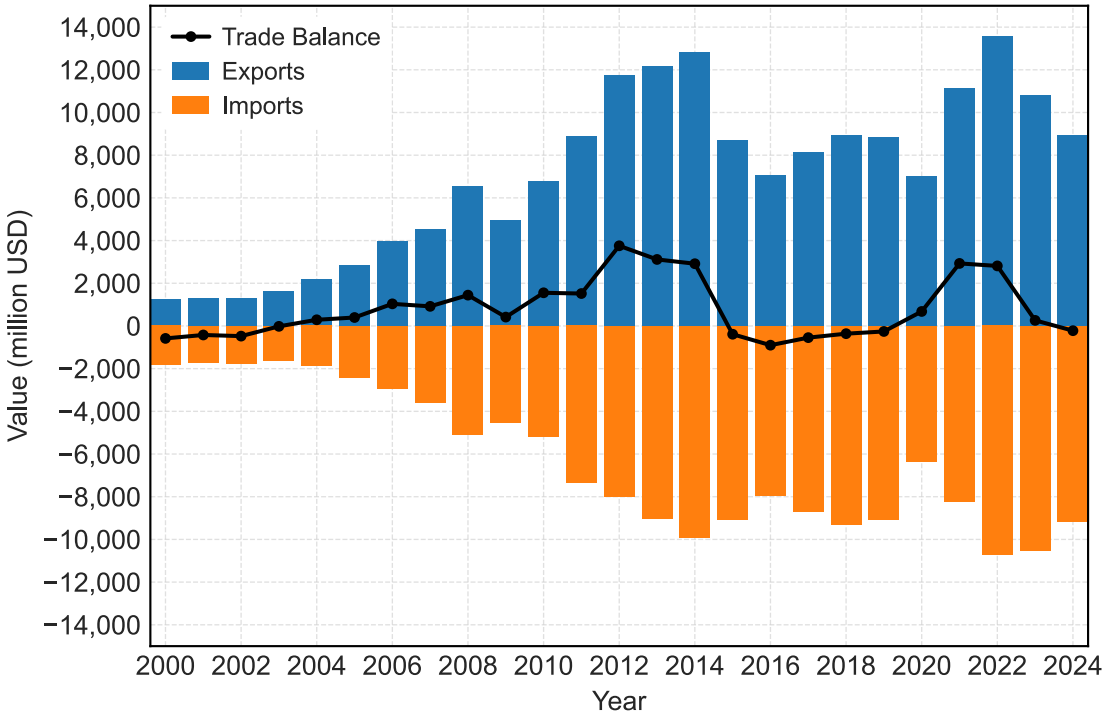


Figure 5.6: Trade Balance (in million USD)

Imports versus exports. Until 2014, export receipts (blue bars) rode fast enough to cover a parallel climb in imports (orange bars), leaving a small but positive trade balance (black line). The pivot year is 2015:

- **Export value** falls sharply as natural-gas prices collapse and metal prices soften.

- **Imports** barely adjust, held up by buoyant domestic demand.

The result is a string of trade deficits from 2015 onward—interrupted only briefly in 2020-2022 when commodity prices spiked post-pandemic. By 2023 the deficit is back in the red, exerting continuous downward pressure on reserves.

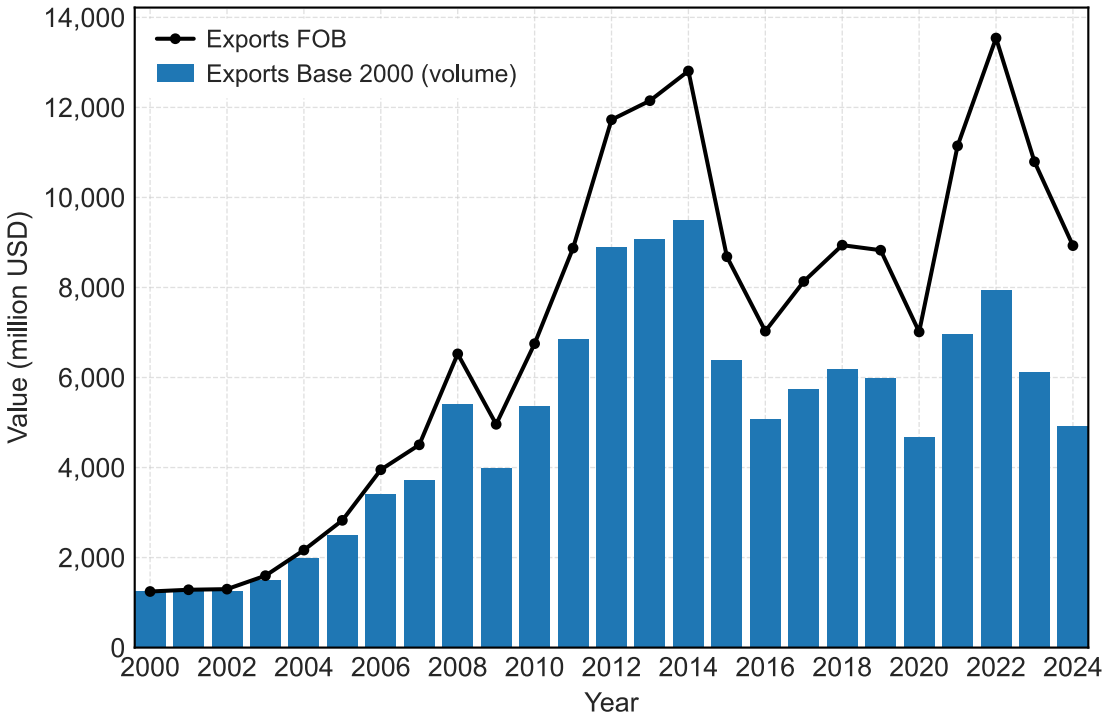


Figure 5.7: Export value and volume (base 2000)

Volume tells the real story. Figure 5.7 separates price effects from physical shipments by re-pricing exports at constant-2000 prices. Two messages stand out:

- **Volume plateau and decline.** Export volume stops growing after 2012 and then trends downward—mirroring the depletion of natural-gas fields and the absence of new export projects.
- **Value is propped up by prices.** The value fluctuates with global commodity cycles, reaching local peaks in 2013, 2018 and 2022 even as actual volume stagnates. The 2021–2022 uptick is therefore a price mirage, not a structural recovery.

Why this is important. Import demand has proven sticky—partly consumption goods, partly capital equipment for public-sector projects. Without a corresponding recovery in export volume, any fall in world prices immediately widens the external gap.

The merchandise deficit must be covered by services, transfers, new borrowing, or reserve drawdowns. As Sections 5.3.2 and 5.3.3 will show, reserves are already thin, so the current-account shortfall puts more pressure on the exchange rate.

Markets observe that export volume is not rebounding, which means future price dips will again hit revenues hard. That forward-looking assessment reinforces the view that the central bank lacks the resources to defend the peg for long, setting the stage for the speculative attack analyzed in Section 5.3.5.

5.3.2 Reserve stocks

A first-generation balance-of-payments (BoP) crisis is, at its core, a story about a central bank's net foreign reserves being eroded by the domestic-credit expansion that finances persistent fiscal deficits. In Krugman (1979)'s model the relevant stock is net reserves: once they approach zero, a speculative attack is both inevitable and perfectly rational. In Bolivia, two very similar—but not identical—series track that stock:

- **Net International Reserves (NIR).** This is the headline item reported to the IMF. It nets gross foreign assets minus reserve-related short-term liabilities (SDR allocations, outstanding repos and gold swaps) and is the concept normally used in crisis-monitoring dashboards.
- **External Net Assets (NEA, "Activos Externos Netos").** This is the balance-sheet line that the Central Bank of Bolivia publishes for constructing certain reports. It is broader on the asset side—it includes gold, SDRs and FX deposits at correspondents—but does not subtract every liability that the IMF definition would. Because Bolivia rarely draws on the Fund and keeps little short-term FX debt, the two aggregates differ only by a narrow, mostly constant wedge.

Figure 5.8 plots both series in levels. As expected, they move virtually one-for-one. For the econometrics that follow we therefore treat ENA as a perfectly acceptable proxy whenever the central bank uses is instead of the NIR.

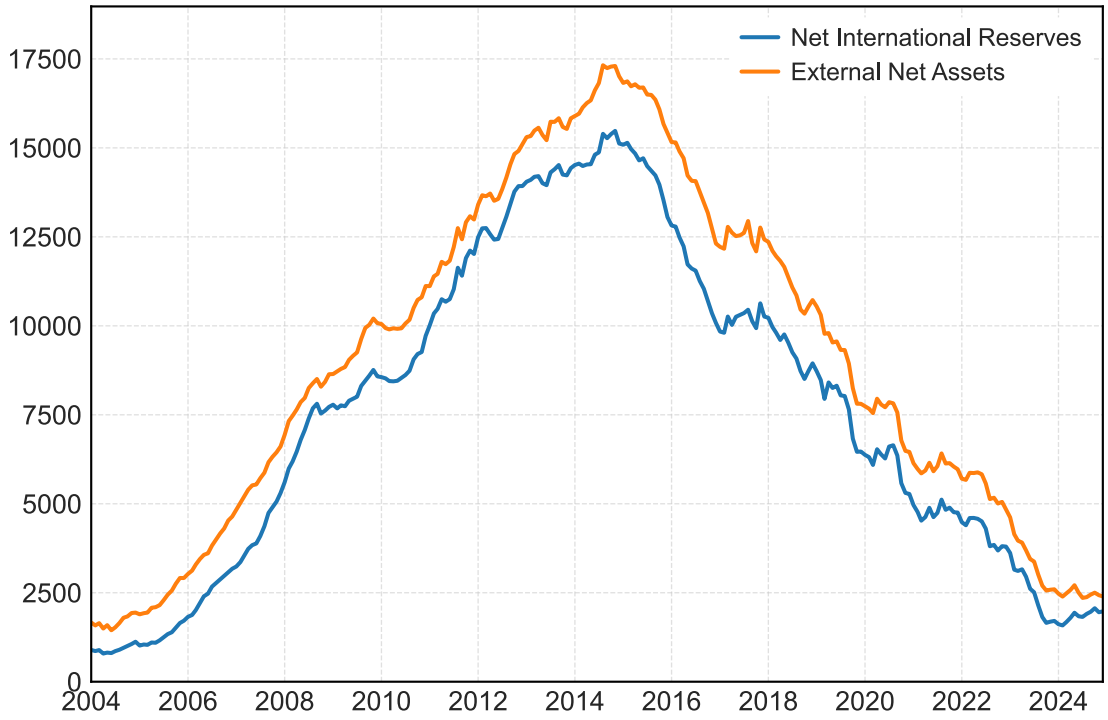


Figure 5.8: Net International Reserves vs. External Net Assets

5.3.3 The last line of defense: Bolivia's gold war-chest

Figure 5.9 parses the Central Bank of Bolivia's gold position into three simultaneously plotted series:

- Gold reserves, value in million USD (left-hand axis, solid area).
- International gold price per tonne, in million USD (right-hand axis, blue line).
- Physical gold holdings, tonnes (right-hand axis, black line).
- A horizontal dashed line marks the statutory floor of 22 tonnes introduced by the Gold Law.

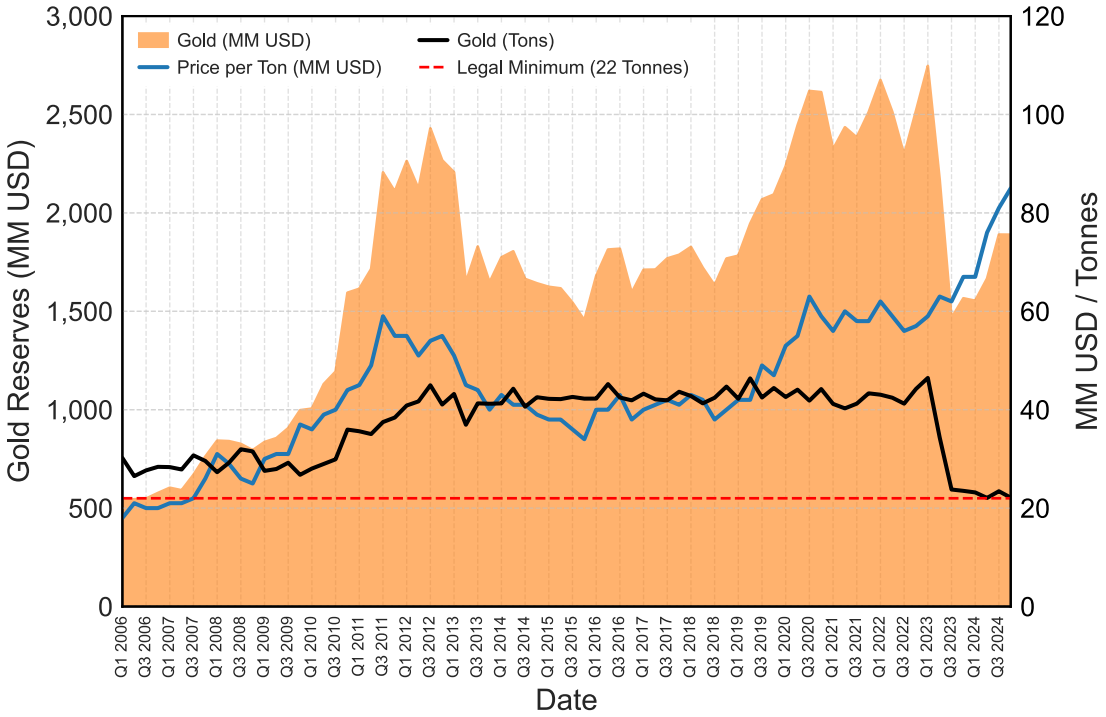


Figure 5.9: Decomposition of value of gold reserves

Between Q1 2006 and Q3 2012, Bolivia's gold reserves increased significantly—from approximately USD 500 million to nearly USD 2.5 billion. This substantial growth was mainly due to record revenues from natural gas exports and consistent fiscal surpluses. Another contributing factor was the notable rise in the gold price, from around USD 20 million per tonne to USD 50 million per tonne, effectively more than doubling the value of the acquired gold.

However, following a sharp decline in natural gas exports and prices, gold holdings stabilized at around 45 tonnes until March 2023. Between March and September 2023, Bolivia experienced a dramatic reduction in its gold reserves, losing roughly 23 tonnes—from approximately 46.5 tonnes to just 23.8 tonnes—in only five months. This steep decline followed shortly after a speculative attack, as detailed later in this thesis.

In Q2 2023, the approval of the Gold Law explicitly permitted a reduction in mandatory gold holdings from 44 tonnes to a lower statutory floor of 22 tonnes, thus facilitating this significant decrease in reserves.

Although the prevailing narrative towards the end of 2024 suggested that the BCB had successfully "strengthened" international reserves, figure 5.9 clearly illustrates that this apparent recovery was merely due to rising gold prices rather than genuine reserve accumulation, a price illusion. As of April 2025, the BCB's gold stock sits close to the

statutory minimum at 22.5 tonnes, basically leaving, in theory, no room for further monetization under existing law.

Effective 25 March 2025, through Directory Resolution No. 028/2025, the Central Bank authorized pledging its gold reserves as collateral in exchange for foreign currency. By doing to, the BCB effectively sidestepped the 22-tonne legal floor to obtain liquidity [cite bcb, newspaper]. While this maneuver provides short-term FX relief, it further undermines Bolivia's economic stability and erodes market confidence in the central bank, complicating any future recovery.

The dynamic closely parallels Krugman (1979)'s first-generation model of a balance-of-payments crisis, which predicts that pegged currencies collapse once reserves are fully exhausted. In practice, however, crisis often materialize before reserves really hit zero. Remember the sharp drop in reserves between Q1 2023 and Q3 2023; it will play a pivotal role when we dissect the speculative attack in Section 5.3.5.

5.3.4 A balance-sheet view of liquidity creation

Figures 5.10 and 5.11 decompose Bolivia's balance-sheet into the four elements that finance—and therefore ultimately limit—the growth of broad liquidity ($M'4$). In Krugman's notation, the External Net Assets correspond to R while the three domestic-credit aggregates: Credit to the Public Sector (CPS), Credit to the Private Sector (CPrS), and Other Net Accounts (ONA) map into D. Balance-sheet identity then gives:

$$M'4 = R + D \quad \text{with} \quad D = \text{CPS} + \text{CPrS} + \text{ONA}. \tag{5.1}$$

- **External net assets (ENA).** As explained before, similar to Net International Reserves, this figure is a slightly more broad metric that essentially tracks the reserves of the Central Bank.
- **Credit to the public sector.** Claims on general government
- **Credit to the private sector.** Claims on domestic non-bank sectors.
- **Other Net Accounts.** Equity, revaluation, and sterilization instruments.

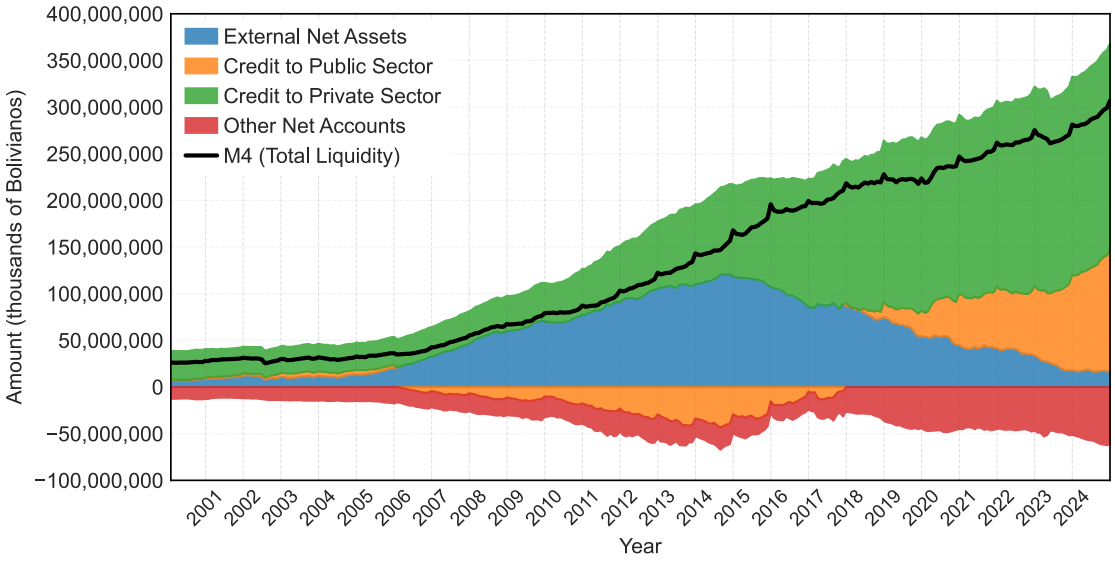


Figure 5.10: Composition of Total Liquidity (M'4)

Phase 1 (2006–2014): Hard-currency backing. During the commodity boom, ENA dominate the asset side of the balance sheet (Figure 5.10); CPS, CPrS and ONA are negligible or even negative. Every new boliviano is matched by an extra dollar (or an ounce of gold) so $\dot{D} \approx 0, \dot{R} > 0$. Under Krugman's framework, no speculative pressure emerges.

Phase 2 (2015–2018): Turning point. Falling gas royalties widen the fiscal deficit. CPS swings into positive territory, while CPrS begins a steady rise. Reserves can still cover the monetary base, but a deterministic depletion path is now visible: $\Delta M'4 \approx -\Delta R + \Delta CPS + \Delta CPrS$.

Phase 3 (2019–present): Credit-driven expansion. Twin-credit growth (CPS + CPrS) outstrips the loss of reserves. ENA contract sharply. Importantly, ONA stays negative and becomes more negative reflecting the rapid build-up of sterilization liabilities and valuation losses on gold swaps. Those negative balances drag down liquidity growth, yet the combined rise in CPS + CPrS still drives $M'4$ upward.

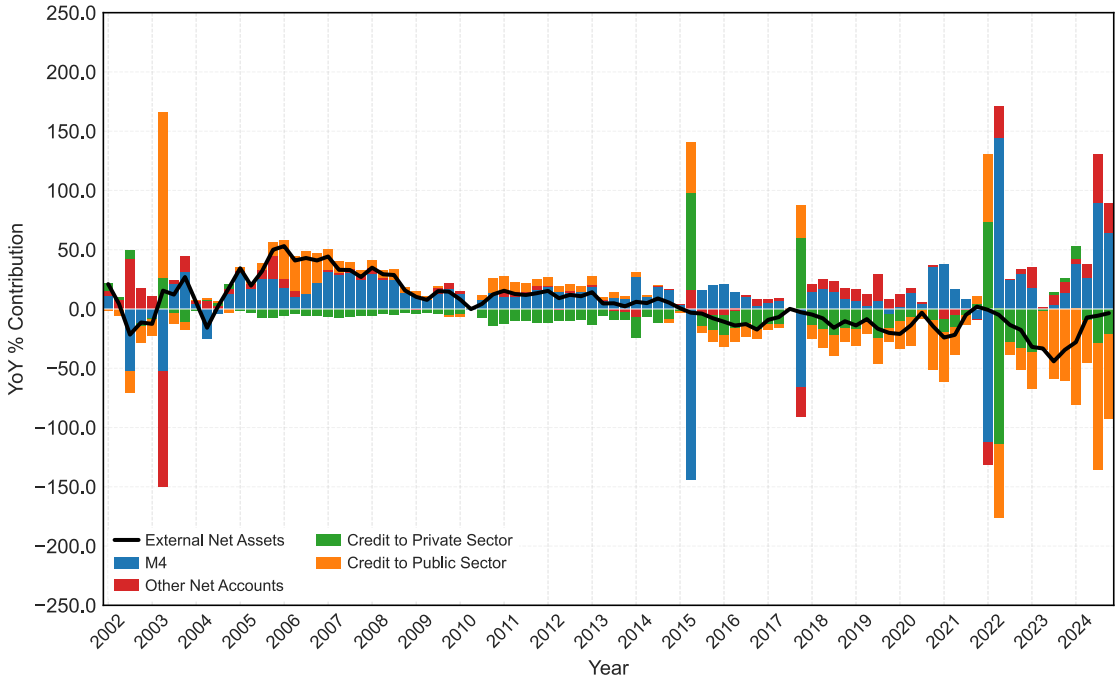


Figure 5.11: Contribution to External Net Assets (YoY%)

Figure 5.11 dissects what drives the YoY change in ENA (black line):

- **M'4.** When money supply expands faster than domestic credit, it drains ENA; large negative blue bars after 2015 capture exactly that effect.
- **CPS and CPrS.** Positive throughout most of the post-2015 period, showing how public- and private-sector credit creation substitutes for lost reserves.
- **ONA.** Consistently negative—especially after 2019—because sterilization bills and revaluation losses widen the Bank's net-liability position.

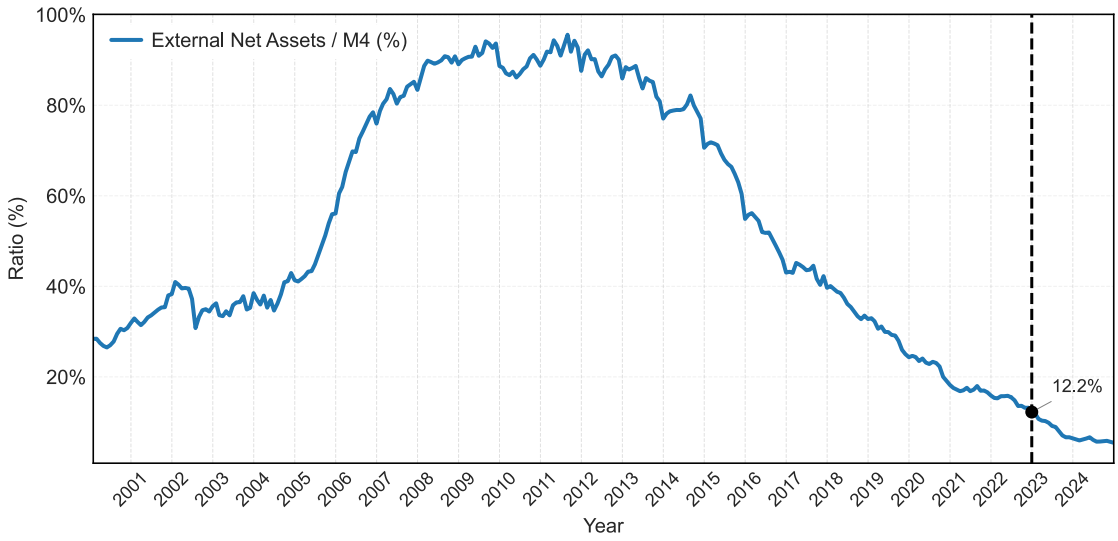


Figure 5.12: External Net Assets / M'4 over time

Figure 5.12 plots the reserve-coverage ratio $R/M'4$. It peaks near 95% in 2011, then falls continuously; by early-2023 it reaches 12%. At that point, market participants recognize that the central bank's remaining reserves are far too small to credibly defend the fixed exchange rate.

In Krugman's terms, the economy has effectively reached the point where $R/M'4$ is approaching zero, triggering the speculative pressures that ultimately force a devaluation. The sharp drop in reserves between Q1 and Q3 2023—discussed in Section 5.3.5—marks the moment when that theoretical "knife-edge" became a reality.

5.3.5 The speculative attack materializes

The final ingredient in a first-generation balance-of-payments crisis is the moment when private agents realize—collectively and almost overnight—that the central bank can no longer meet all dollar demand at the official price. Figures 5.13 and 5.14 plot that realization in real time.

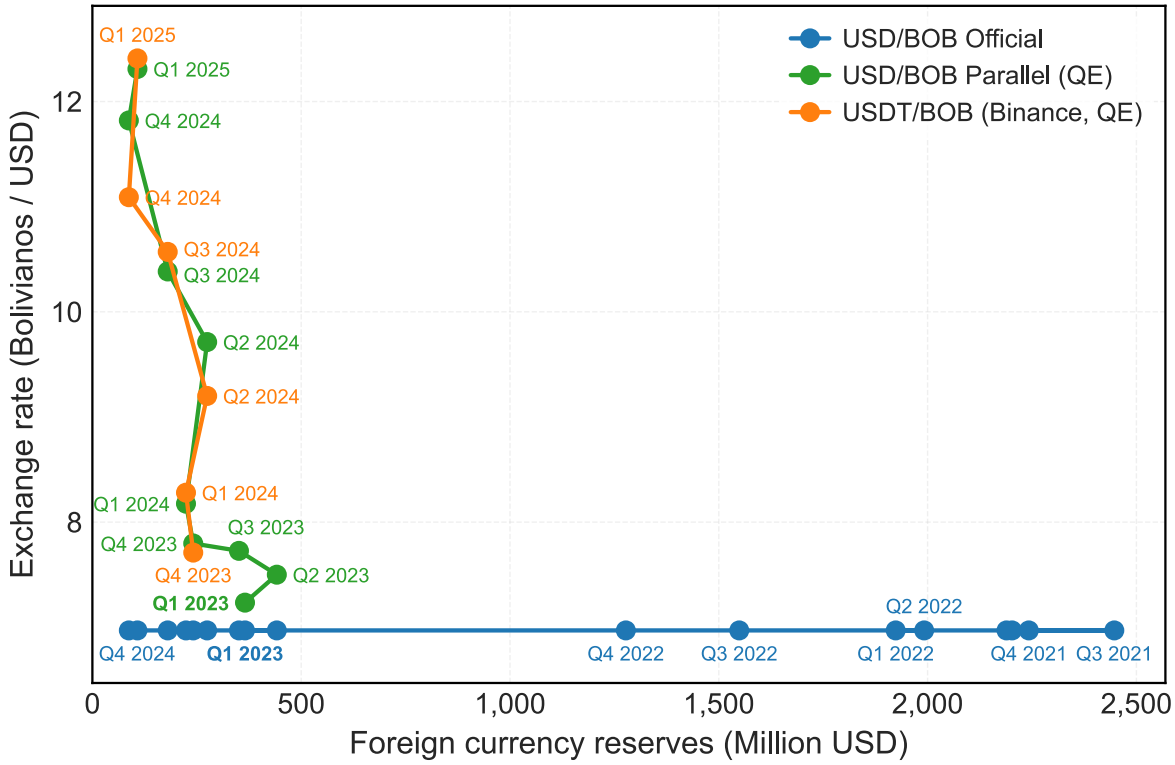


Figure 5.13: FX Reserves and Exchange Rate Developments

Three quotes for the same dollar. Figure 5.13 plots three series, but economically we are looking at just two prices (official rate versus parallel rate) at quarter-end quotes.

The scatter plot thus boils down to a single downward-sloping relationship: as usable FX reserves (horizontal axis) shrink toward zero, the parallel price of dollars (green/orange) emerges in Q1 2023 and rises nearly proportionally, while the official price (blue) stays flat, non-reactive.

By the time usable FX balances approach zero (upper-left corner), the Boliviano trades at more than 12 per dollar—nearly double the peg.

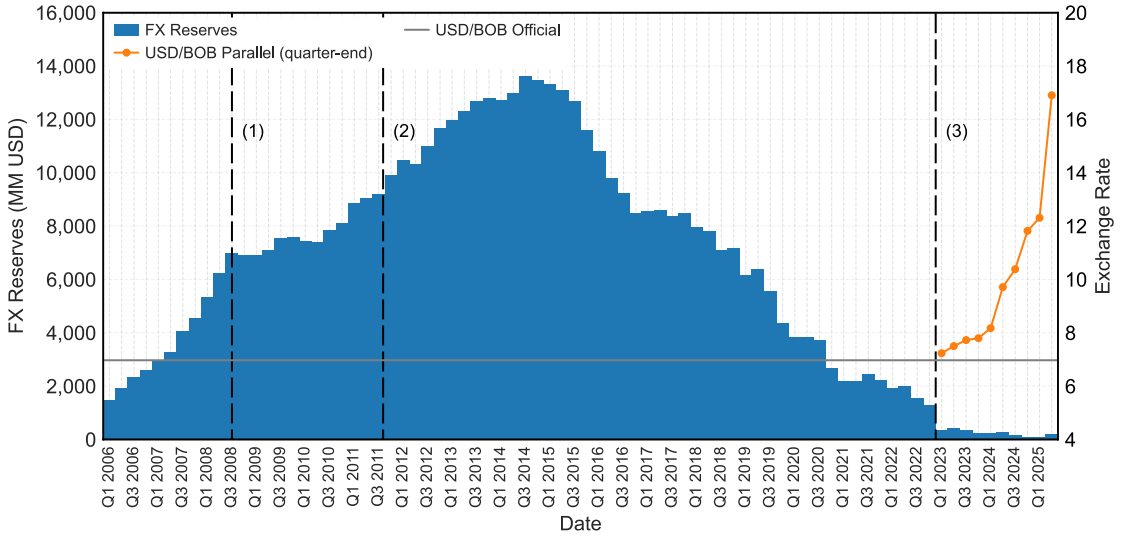


Figure 5.14: FX Reserves and Parallel-Rate Surge

From slow bleed to sudden stop. Figure 5.14 present the same story. The bars show quarterly FX-reserve stocks; the orange line is the end-quarter parallel rate (USD/BOB). Three dashed markets highlight key episodes:

(1) Fixed exchange rate is introduced. In September 2008, the BCB fixes the boliviano for the first time after a long crawl, in a context of growing reserves and a $R/M'4$ ratio above 80%.

(2) Fixed exchange rate confirmed. In November 2011, the fixed exchange rate undergoes that last mini-revaluation, with the peg finally set at 6.96. Reserves had not reached their peak, but the $R/M'4$ ratio sits at its peak of around 90%.

(3) Speculative attack. FX Reserves plunge from USD 1.27 billion at the end of Q4 2022 to USD 0.37 billion at the end of Q1 2023—a 71% draw-down in one quarter.

Between (1) and (2) the peg is credible because booming gas revenues keep the stock of hard currency very well above hard money. From 2015 onward, however, the decline in exports (see Section 5.3.1) and the explosion of domestic credit (see Section 5.3.4) erode that cushion year after year. By late-2022 the reserve-coverage ratio reaches 12.2% (Figure 5.12), triggering the speculative attack.

Why Q1 2023 signals the speculative attack. The reserve collapse at marker (3) satisfies every prediction of Krugman (1979)'s first-generation model:

- **Predictability.** As shown in Section 5.3.4, the $R/M'4$ ratio had shrunk to 12%; informed agents could extrapolate that only a few more quarters of current-account deficits would exhaust the buffer.
- **Pre-emptive exit.** Rather than waiting for the last dollar to disappear, households and firms rushed to acquire dollars and, increasingly, stablecoins—assets beyond the central bank's direct control.
- **Self-fullfilling dynamic.** The BCB "converted" 17 tonnes of gold for nearly USD 1.1 billion between May and August 2023 to satisfy that rush, confirming the market's worst fears, defending with no success the exchange rate.

After-shocks and policy response. Faced with razor-thin reserves and a widening dual market, authorities resorted to gold monetization. As documented in Section 5.3.3, 23 tonnes were sold between March and September 2023. When even that proved inadequate, Directory Resolution 028/2025 authorized pledging the statutory 22-tonne floor, underscoring that the hard-currency backing of the boliviano was now largely fictional.

Why the peg held past the attack. Krugman's model assumes perfect capital mobility and zero controls, so the peg breaks instantly. Bolivia, however, operates with:

- Strict FX surrender requirements for exports from public companies (ICLG, 2025). Anyways the exports from private businesses to come back to the country must go through the financial system, which operates with the official exchange rate.
- Criminal penalties for quoting prices in foreign currency (opi, 2023).
- Dollar rationing from both the Central Bank and from commercial banks.

These frictions do not invalidate Krugman's proposition, as right after the speculative attack, a parallel—floating—exchange rate emerged, and is the only exchange rate accessible to most agents in the country, while the fixed exchange rate is merely an illusion, only accessible to public companies and few other agents. So, validating Krugman, the currency has de-facto changed from a fixed exchange rate to a floating exchange rate.

In sum, the Q1 2023 reserve crash marks the exact point where Bolivia moved from a slow, deterministic drain of foreign assets to a textbook speculative attack: the parallel

exchange rate detached from the peg, stablecoins emerged as a way to circumvent capital controls, and every additional drop in reserves fed directly into further depreciation beyond the fixed exchange rate.

The remainder of this chapter employ the same statistical tools as in Section 5.2 to further back the claims.

See Appendix C for the complete results of each of the statistical tests performed in the following sections.

5.3.6 Unit-root tests on fundamentals

Before estimating any long-run relationships we check whether the main fundamentals are stationary in levels. Table 5.4 reports Augmented Dickey–Fuller (ADF) statistics using monthly data (February 2023 to May 2025).

	ADF stat.	**p-value**	**Decision (5%)**
FX Reserves (MM USD)	−1.00395	0.75182	non-stationary
USD/BOB (Parallel)	0.73510	0.99051	non-stationary
Public Debt (MM USD)	1.35344	0.99689	non-stationary

Table 5.4: ADF test, key fundamentals (levels)

Interpreting the numbers is straightforward:

- **FX Reserves.** With an ADF statistic of −1.00 (critical value at the 5 % level is −3.10) we cannot reject the unit-root null; the reserve stock is non-stationary.
- **Parallel USD/BOB rate.** The positive ADF statistic repeats what tested in Section 5.2; the parallel USD/BOB rate is non-stationary.
- **Public Debt.** The largest p-value in the table (0.997) again points to non-stationarity; debt grows in a level sense rather than cycling around a mean.

Because each series is non-stationary in levels, the next step is to examine whether a stable linear combination exists among them. Section 5.3.7 therefore turns to the Engle–Granger cointegration test in pairs to evaluate the variables.

5.3.7 Bivariate cointegration diagnostics

As a first pass we run the classical Engle–Granger two–step procedure between the parallel exchange rate and each single "Krugman-style" fundamental. Figure 5.15 offers a visual preview: the left panel shows the expected negative relation to foreign reserves, the right panel the positive relation to public debt. The numerical diagnostics are summarised in Table 5.5.

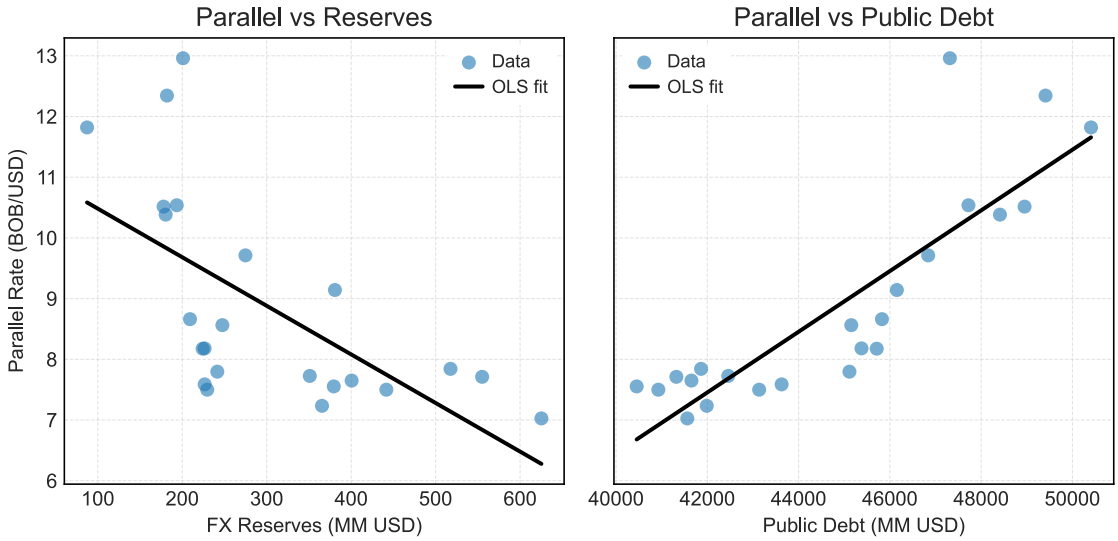


Figure 5.15: Scatterplots and OLS fits used in the Engle–Granger step 1

	Coef.	t-stat	p-value
(A) Step 1: OLS, Parallel ∼ FX Reserves ($n = 23$)			
Constant	11.2827	15.938	< 0.001
FX Reserves	-0.0080	-3.724	0.001
$R^2 = 0.398$			Obs. (step 1): 23
(A) Step 2: ADF on residuals (lags = 9, $n = 13$**)**			
ADF statistic	1.073	—	0.995
Decision (5%): *fail to reject* H_0, residuals are $I(1)$			
(B) Step 1: OLS, Parallel ∼ Public Debt ($n = 23$)			
Constant	-13.5340	-4.712	< 0.001
Public Debt	0.00050	7.818	< 0.001
$R^2 = 0.744$			Obs. (step 1): 23
(B) Step 2: ADF on residuals (lags = 9, $n = 13$**)**			
ADF statistic	-2.008	—	0.283
Decision (5%): *fail to reject* H_0, residuals are $I(1)$			

Table 5.5: Engle–Granger two–step: USD/BOB (parallel) versus fundamentals

Interpretation.

- **OLS fit.** Reserves carry the expected negative sign (-0.008) and public debt the expected positive sign ($+0.0005$). Debt explains a respectable 74% of the cross–sectional variation; reserves only 40%. Both slopes are highly significant.
- **Residual stationarity.** In neither case does the ADF statistic on step-2 residuals reach the 5% critical value. Hence the null of a unit root cannot be rejected and bivariate cointegration is not supported by the data.

In practical terms, the scatterplots do confirm that the parallel rate moves inversely with reserves and directly with debt, but the lack of cointegration implies that the relationship is not mean-reverting in levels. Section 5.3.8 therefore shifts to Engle-Granger tests on the full $\{R, D, \text{Parallel Rate}\}$ trio, where common stochastic trends are more likely to show up.

5.3.8 Joint cointegration

The Engle–Granger procedure was repeated with both fundamentals entered simultaneously. The visual intuition is given in Figure 5.16: the left panel holds debt at its sample mean while varying reserves, the right panel does the opposite.

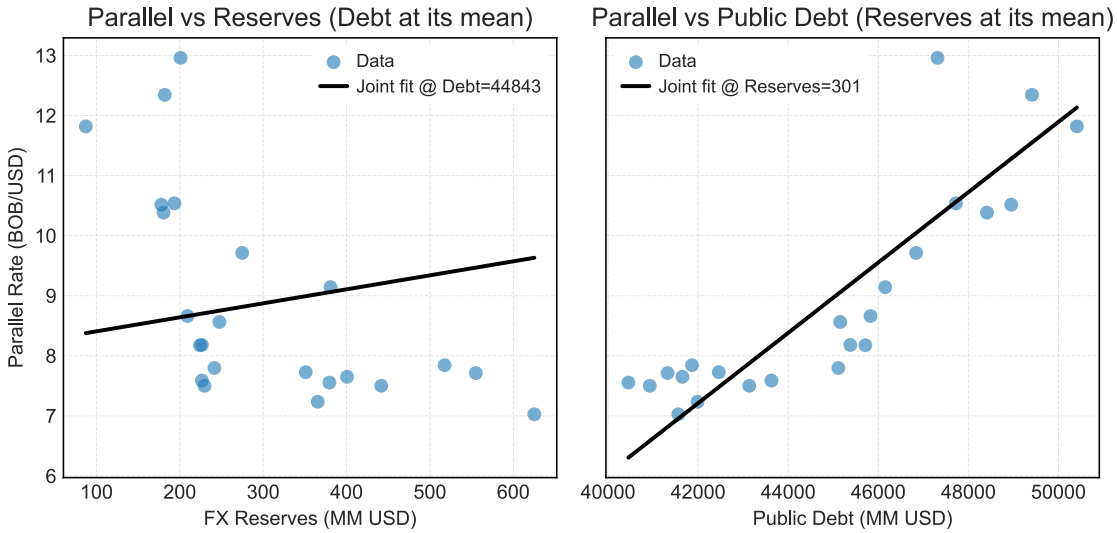


Figure 5.16: Partial dependence plots from the multivariate OLS regression

	Coef.	***t*-stat**	***p*-value**
Step 1: OLS ($n = 23$)			
Constant	-18.0797	-3.326	0.003
FX Reserves	0.0023	0.985	0.336
Public Debt	0.0006	5.421	< 0.001
$R^2 = 0.756$			Obs. (step 1): 23
Step 2: ADF on residuals (lags = 6, residual $n = 16$**)**			
ADF statistic	-3.741	—	0.004
Decision (5 %): **reject** H_0; residuals are $I(0)$			

Table 5.6: Engle–Granger two–step: USD/BOB (parallel) on FX reserves and public debt

Interpretation.

- **Long-run fit.** Introducing both fundamentals lifts the explanatory power to 76%. The debt coefficient remains highly significant and positive, while the reserve coefficient becomes small and insignificant once debt is controlled for—suggesting that reserves affect the shadow rate mainly *via* their correlation with fiscal-debt dynamics.

- **Cointegration test.** The ADF statistic on the step-2 residuals (-3.74) exceeds the 5 % critical value (-3.07), allowing us to reject the unit-root null. Unlike the

bivariate cases, the three-variable combination forms a stationary equilibrium in levels.

In short, while reserves alone do not cointegrate with the shadow rate, jointly with public debt they do: the parallel boliviano tracks a stable linear combination of external liquidity and the fiscal-credit expansion that drains it—an empirical confirmation of Krugman's core mechanism.

5.3.9 Key takeaways

- **Persistent external deficits have become structural.** A post-2015 slide in export volume—masked at times by transient price booms—paired with sticky import demand has kept the trade and current accounts in the red, setting a deterministic drain on foreign-currency liquidity.
- **The reserve cushion has effectively vanished.** Net hard-currency cover for broad liquidity ($R/M'4$) tumbled from almost 95% in 2011 to 12% by early-2023. Heavy gold monetization and the 2025 regulatory changes to the rigidness of the statutory floor underscore that the central bank's "war-chest" is now largely exhausted.
- **Domestic credit replaced reserves as the engine of money growth.** Since 2015 the expansion of credit to the public and private sectors has financed broad-money growth, while sterilization costs (ONA) further eroded the balance-sheet, mirroring Krugman's $D\uparrow$, $R\downarrow$ mechanism.
- **Q1 2023 marks a textbook speculative attack.** A 71 % quarterly reserve draw-down triggered a sudden jump from a fixed to a de-facto dual exchange-rate regime: the cash parallel rate and the USDT price detached from the peg, while the official rate survived only as an illusion, behind capital controls.
- **Econometric evidence confirms the Krugman narrative.** Reserves, public debt and the parallel rate are each $I(1)$. Neither fundamental cointegrates with the exchange rate in isolation, yet together they form a stationary linear combination—debt exerting the dominant influence—validating the model's joint-fundamental equilibrium.
- **Policy implication.** Without a rebound in export volume or a fiscal/credit retrenchment, any temporary FX relief obtained by pledging gold merely postpones

the next attack; the peg's credibility now hinges on deeper macro-adjustment rather than on remaining reserves.

6 Discussion

This chapter synthesizes the empirical findings, situates them within the theoretical and policy debates, and reflects on the thesis's contributions, limitations, and avenues for future research.

6.1 What did we learn?

6.1.1 Stablecoins Accurately Mirror the Street Exchange Rate

All three empirical lenses point to the same conclusion:

- **Near-perfect contemporaneous co-movement.** Monthly USDT/BOB quotes and the manually reconstructed USD/BOB parallel rate exhibit a Pearson correlation of 0.988 ($t = 27.1$, $p < 10^{-15}$) over the period from October 2023 to May 2025. Both series are non-stationary (I(1)) yet cointegrated, with an Engle–Granger slope statistically indistinguishable from one ($\beta \approx 0.976$).
- **Rapid, albeit not instantaneous, shock transmission.** Political and policy disruptions—such as the February 2024 road blockades, the failed June 2024 coup attempt, and the May 2025 crypto-ban decree on fuel imports—were typically reflected in both series within hours to a few weeks, depending on the magnitude of the event. The fastest adjustment occurred in May 2025, when prices declined within less than 24 hours.
- **External validity.** Argentina provides a stringent out-of-sample test: during periods of capital controls, USDT prices and the "blue-dollar" peso moved in lockstep.

Conclusion for H-1. The data deliver emphatic support for shadow-rate convergence: a liquid, USD-pegged stablecoin mirrors Bolivia's true peso price in near real-time and

provides continuous price discovery when press reporting is sporadic.

6.1.2 Determinants of the Premium

Using a Krugman-style framework, we examine whether fundamentals that drain reserves also widen the parallel premium.

- **A first-generation crisis unfolding gradually.** Bolivia's current-account deficits, financed by monetized fiscal imbalances and fuel subsidies, have depleted foreign-exchange reserves: net international reserves fell by 71% in Q1 2023 alone and now hover near the statutory gold floor.
- **Fundamentals cointegrate jointly.** Bivariate tests with either reserves or public debt alone do not yield cointegration; however, the trivariate system—including the parallel rate, reserves, and public debt—does (residual ADF = –3.74). Public debt remains highly significant. Once fiscal expansion (proxied by public-sector debt) enters the regression, the reserve coefficient approaches zero, suggesting that reserves act as a passive buffer, drained by monetized deficits pressuring the fixed exchange rate.
- **Timing the speculative attack.** The attack materialized when reserves fell below 12% of broad money (M'4) in early 2023, at which point the shadow rate permanently diverged from the official peg. The Central Bank of Bolivia's subsequent attempt to defend the peg failed, culminating in the liquidation of 23 tonnes of gold.

Conclusion for H-2. A stable linear combination of falling reserves and rising domestic credit explains the persistent overshooting of the boliviano, echoing Krugman's first-generation mechanism: fiscal monetization → reserve drain → speculative attack → collapse of the peg (de facto).

6.2 Placing the Results in the Theoretical Frame

Krugman (1979) predicts that a peg collapses as soon as the market's shadow rate equals the official rate, even if some reserves remain. Bolivia fits this prediction with a twist. Thanks to strict capital controls, the official exchange rate still appears on the Central Bank's screens, but in practice the economy operates with a floating rate—as reflected by

street and USDT quotes. The model holds: the official rate has become a non-convertible price tag for a privileged few, while the parallel rate governs transactions for everyone else.

6.3 Contribution to the Literature

Gap (Table 2.2)	**This thesis's contribution**
Geography	Provides the first evidence from Bolivia that stablecoin prices mirror the parallel peso rate, extending the cryptocurrency-premium findings of Graf von Luckner et al. (2024) to a previously unexamined economy.
Methodology	Combines minute-level cryptocurrency quotes with over 200 street-rate articles processed through a two-stage LLM pipeline, overcoming sparse reporting.
Microstructure	Examines USDT in 24/7 peer-to-peer markets—a venue overlooked by prior Bitcoin-centric research.
Policy feedback	Demonstrates cointegration among the parallel rate, reserves, and fiscal credit—empirically embedding Krugman's model within a cryptocurrency context.

Table 6.1: Thesis' contribution to literature

6.4 Policy Implications

1. **Real-time surveillance tool.** Regulators (e.g., the BCB and IMF Article IV teams) can scrape Binance quotes to obtain near-instantaneous indicators of devaluation pressure—weeks before official Central Bank reports become available.

2. **Communication and credibility.** Publishing an official series that incorporates P2P USDT data and continuous street-rate surveys would reduce information asymmetries and mitigate panic-induced spikes.

3. **Exit-strategy options.** Implementing a crawling peg starting from Bs. 6.96 appears optimal—provided fundamentals are restored, as Argentina's recent experience illustrates.

4. **Stablecoin regulation.** Rather than outright bans (as in 2014), regulation is necessary for monitoring purposes and anti-money-laundering compliance.

6.5 Limitations

- **Sample length.** Cryptocurrency data are unavailable for the initial period of parallel exchange-rate emergence, and the overall sample size is limited: only 20 monthly observations overlap between cleaned street data and USDT quotes. A longer time series would increase statistical power.
- **Transaction-level opacity.** Binance P2P displays advertisements rather than executed trades; the PVWAP proxy may not capture the true USDT market price. Without transaction data, we cannot accurately analyze other dimensions such as trading volumes over time.
- **Incomplete or delayed Central Bank data.** The recency of the crisis, combined with reporting lags at the Central Bank, further reduces the available dataset for analysis.
- **Press data sparsity.** Although the LLM pipeline extracted the few available quotations and interpolation produced a time series, newspaper quotes remain irregular and imprecise, limiting intraday validation.
- **Market size.** Some findings may be constrained by Bolivia's small economy and the relatively low volumes observed in P2P exchanges compared to larger countries.

6.6 Future Research Paths

1. **Transaction-level data.** Obtaining granular transaction data from Binance P2P could enhance the analysis or reveal new insights.
2. **Broader set of fundamentals.** Incorporating additional central bank data could clarify the money-creation channel.
3. **Cross-country panel.** Pooling data from Bolivia, Argentina, Nigeria, and Egypt for a comparative analysis could distinguish universal from idiosyncratic drivers of the cryptocurrency premium.

6.7 Answer to the Research Question

Lead Research Question

Can stablecoin-denominated boliviano-to-dollar prices observed in P2P crypto markets serve as an accurate and timely proxy for Bolivia's shadow exchange rate and/or as an indicator of exchange rate pressures?

Yes. USDT/BOB rates track the street rate almost perfectly in near real-time, react within hours to shocks, and reflect the same long-run fundamentals predicted by first-generation crisis models. In short, USDT/BOB is not merely a proxy for Bolivia's shadow exchange rate—it is the shadow exchange rate.

7 Conclusion

This thesis set out to determine if stablecoin-denominated boliviano-to-dollar prices, specifically USDT/BOB rates observed in peer-to-peer (P2P) crypto markets, can serve as an accurate and timely proxy for Bolivia's shadow exchange rate and as an indicator of exchange rate pressures. The comprehensive analysis undertaken, combining high-frequency P2P market data, newspaper-extracted parallel market rates via an LLM pipeline, and macroeconomic fundamentals, overwhelmingly supports an affirmative answer.

The empirical investigation yielded several key findings. Firstly, a strong convergence between the USDT/BOB P2P rates and the street parallel exchange rate was established (Hypothesis H-1). These two rates exhibit near-perfect contemporaneous co-movement, are cointegrated with a near one-for-one long-run relationship, and react in lock-step to significant political and policy shocks. This finding was further corroborated by a comparative analysis with Argentina, where a similar dynamic between USDT/ARS and the "blue dollar" was observed during periods of capital controls. This robustly demonstrates that USDT/BOB P2P prices are not merely an echo but an accurate real-time reflection of the otherwise opaque parallel market in Bolivia.

Secondly, the thesis confirmed that the widening premium of the parallel exchange rate is driven by deteriorating macroeconomic fundamentals, consistent with a Krugman-style first-generation balance-of-payments crisis model (Hypothesis H-2). The analysis revealed that Bolivia's persistent current account deficits, fueled by monetized fiscal imbalances and substantial fuel subsidies, led to a severe depletion of foreign exchange reserves. A speculative attack was identified as materializing in Q1 2023, when reserves fell below a critical threshold relative to broad money, causing the shadow exchange rate to permanently diverge from the official peg. While neither reserves nor public debt alone cointegrated with the parallel rate, a trivariate system incorporating the parallel rate, FX reserves, and public debt demonstrated a stable long-run equilibrium, with public debt (fiscal expansion) being the dominant driver. This underscores that the de facto

collapse of the fixed exchange rate regime was a predictable outcome of underlying policy inconsistencies.

The contributions of this research are multifaceted. It provides the first empirical evidence from Bolivia on the role of stablecoins in reflecting shadow exchange rates, extending existing literature to a new geographical and microstructural context (USDT in P2P markets). Methodologically, it introduced a novel approach by merging minute-level crypto data with LLM-processed street quotes and integrated these into a classical BoP crisis framework.

The policy implications stemming from these findings are significant. Stablecoin P2P market data offers a valuable real-time surveillance tool for policymakers and international organizations to monitor devaluation pressures. Increased transparency through the publication of a composite shadow rate incorporating such data could mitigate information asymmetries. Furthermore, the analysis highlights the unsustainability of the current fixed exchange rate regime without fundamental macroeconomic adjustments.

While this study provides compelling evidence, it is subject to limitations, including the relatively short sample period for overlapping data, the opacity of P2P transaction-level data, and lags in official Central Bank reporting. Future research could extend this work by obtaining more granular transaction data, incorporating a broader set of fundamentals, and conducting cross-country panel analyses to generalize the findings.

In direct response to the central research question: Yes, stablecoin-denominated boliviano-to-dollar prices observed in P2P crypto markets serve as an accurate and timely proxy for Bolivia's shadow exchange rate and as a clear indicator of exchange rate pressures. The USDT/BOB rate, in essence, is the shadow exchange rate in the current Bolivian context, offering continuous price discovery in an environment where official channels are constrained and traditional parallel market information is sparse. This research underscores the growing importance of crypto-asset markets as indicators of underlying economic realities, particularly in economies facing exchange rate stress and capital controls.

To facilitate further research and ensure reproducibility, all code and data used in this thesis are available at `github.com/leofarfan7/uncovering-currency-price-thesis`.

A Flowcharts

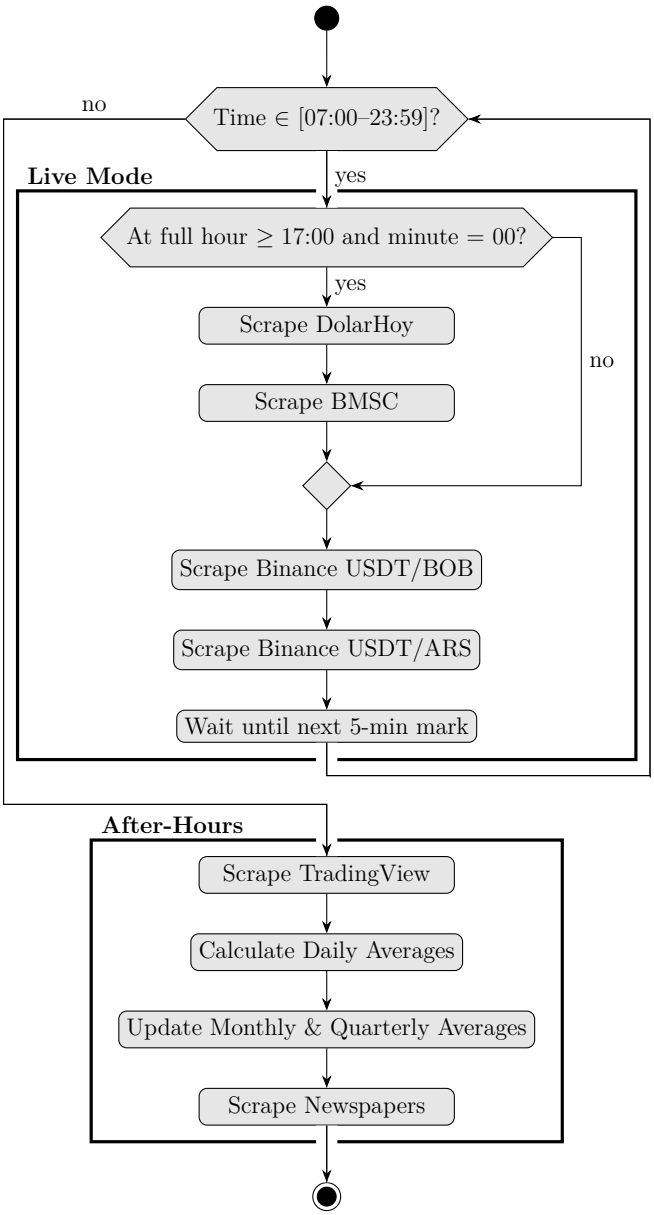


Figure A.1: End-to-end pipeline overview.

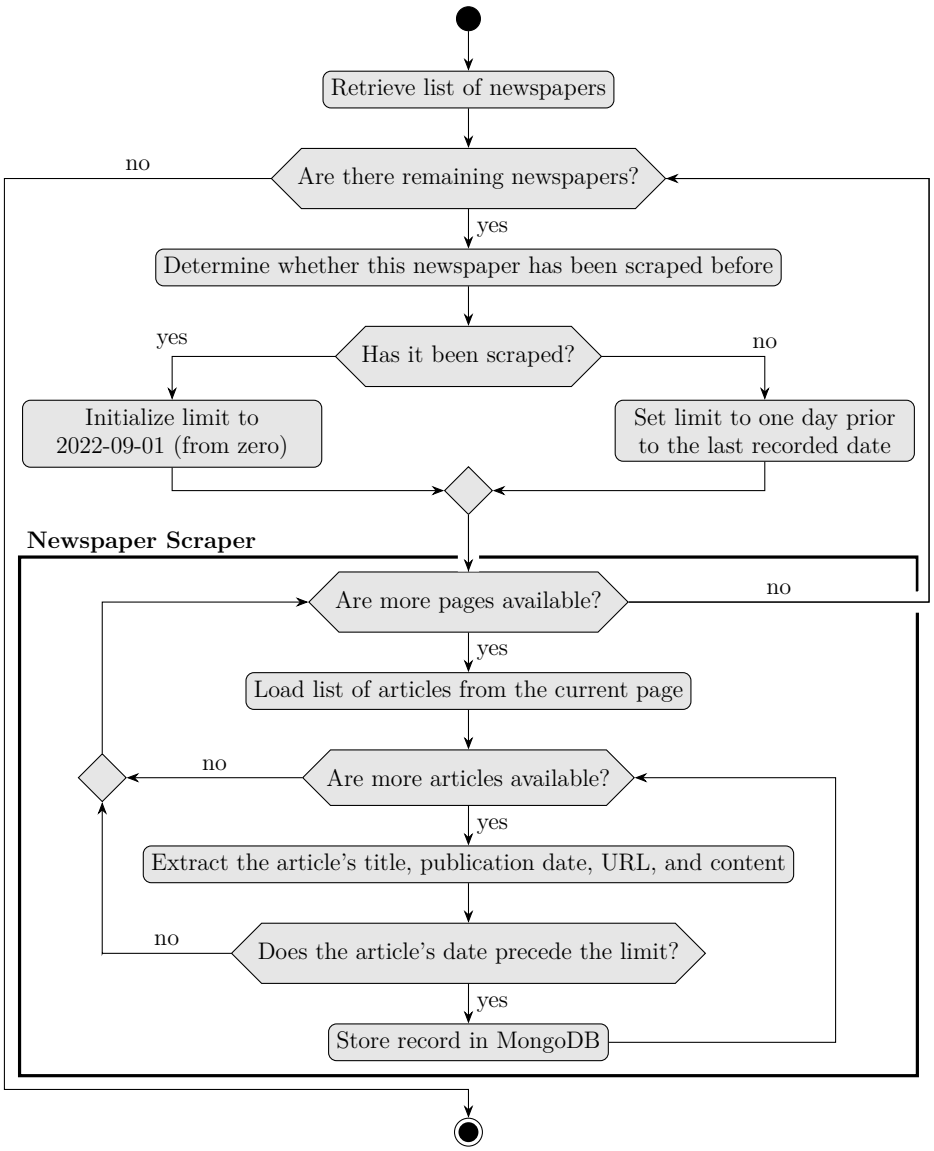


Figure A.2: `newspaper_scraper()` flowchart.

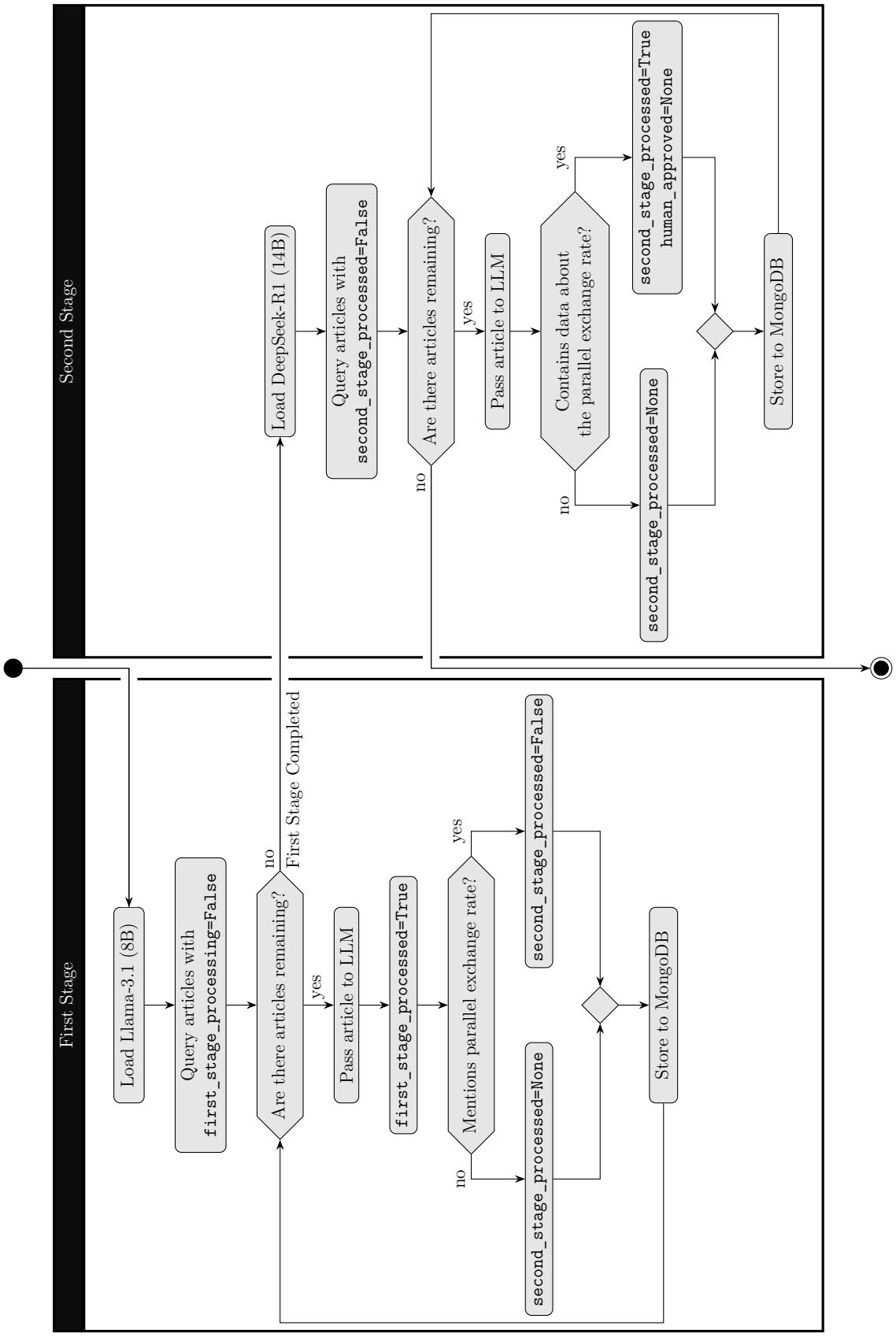


Figure A.3: `newspaper_llm_processing()` flowchart.

B Comisión Máxima Variable

The CMV is defined by the supervisor ASFI as

$$\mathrm{CMV}_t = \left(\frac{\sum_{i=0}^{29} \mathrm{TC}_{t-7-i}\, \mathrm{M}_{t-7-i}}{\sum_{i=0}^{29} \mathrm{M}_{t-7-i}} \Big/ 6.86 \right) - 1 \tag{B.1}$$

CMV_t	maximum variable fee applied on day t,
TC_t	volume-weighted average USD buying rate of banks on day t,
M_t	total USD amount those banks bought on day t,
6.86	official USD buying rate set by the central bank (Bs/USD),
$i = 0, \ldots, 29$	index of the 30 observation days,
$t - 7 - i$	observation day, 7 to 36 days before t.

C Statistical Results

C.1 Corresponding to H-1

ADF Test for USDT/BOB Monthly Series	
ADF Statistic	0.21459
p-value	0.97307
Lags used	0
Observations	19
Critical Values	
1%	−3.83260
5%	−3.03123
10%	−2.65552

Table C.1: ADF test results for the USDT/BOB monthly series.

ADF Test for USD/BOB Parallel Monthly Series	
ADF Statistic	0.19124
p-value	0.97177
Lags used	0
Observations	19
Critical Values	
1%	−3.83260
5%	−3.03123
10%	−2.65552

Table C.2: ADF test results for the USD/BOB parallel monthly series.

Table C.3: Engle–Granger Step 1: OLS Regression (Dep. Variable: USDT/BOB, Indep. Variable: USD/BOB), ADF Test on Residuals, and ANOVA

OLS Regression Results (Dep. Variable: USDT/BOB)					
	coef	**std err**	**t**	**P>|t|**	**[0.025, 0.975]**
const	0.4483	0.382	1.173	0.256	[−0.355, 1.251]
USD/BOB	0.9760	0.036	27.170	0.000	[0.901, 1.051]
Model statistics: R-squared = 0.976, Adj. R-squared = 0.975, F-statistic = 738.2 (Prob(F) = 4.60×10^{-16}), Log-Likelihood = –9.0187, AIC = 22.04, BIC = 24.03, No. Observations = 20, Df Residuals = 18, Df Model = 1, Covariance Type = nonrobust					
ADF Test on OLS Residuals					
Statistic (residuals)	−3.29268	**p-value**	0.01521	**Lags used**	0
Observations (residuals)	19				
Critical Values (residuals): 1% = –3.83260, 5% = –3.03123, 10% = –2.65552					
ANOVA					
Source	**sum_sq**	**df**	**F**	**PR(>F)**	
USDBOB	118.339401	1.0	738.188558	4.600023×10^{-16}	
Residual	2.885590	18.0			

C.2 Corresponding to H-2

ADF Test for FX Reserves (MM USD)	
ADF Statistic	−1.00395
p-value	0.75182
Lags used	8
Observations	14
Critical Values	
1%	−4.01203
5%	−3.10418
10%	−2.69099

Table C.4: ADF test results for FX Reserves (in millions of USD).

ADF Test for Public Debt (MM USD)	
ADF Statistic	1.35344
p-value	0.99689
Lags used	8
Observations	15
Critical Values	
1%	−3.96444
5%	−3.08491
10%	−2.68181

Table C.5: ADF test results for Public Debt (in millions of USD).

ADF Test for USD/BOB Parallel	
ADF Statistic	0.73510
p-value	0.99051
Lags used	6
Observations	16
Critical Values	
1%	−3.92402
5%	−3.06850
10%	−2.67389

Table C.6: ADF test results for USD/BOB Parallel series.

Table C.7: Engle–Granger Step 1: OLS Regression (Dep. Variable: USD/BOB Parallel, Indep. Variable: FX Reserves), ADF Test on Residuals, and ANOVA

OLS Regression Results (Dep. Variable: USD/BOB Parallel)					
	coef	**std err**	**t**	**P>|t|**	**[0.025, 0.975]**
const	11.2827	0.708	15.938	0.000	[9.811, 12.755]
FX Reserves	-0.0080	0.002	-3.724	0.001	[−0.012, −0.004]
Model statistics: R-squared = 0.398, Adj. R-squared = 0.369, F-statistic = 13.87 (Prob(F) = 0.00125), Log-Likelihood = –39.051, AIC = 82.10, BIC = 84.37, No. Observations = 23, Df Residuals = 21, Df Model = 1, Covariance Type = nonrobust					
ADF Test on OLS Residuals					
Statistic (residuals)	1.07268	**p-value**	0.99498	**Lags used**	9
Observations (residuals)	13				
Critical Values (residuals): 1% = –4.06885, 5% = –3.12715, 10% = –2.70173					
ANOVA					
Source	**sum_sq**	**df**	**F**	**PR(>F)**	
FXReserves	26.535073	1.0	13.868773	0.001254	
Residual	40.179224	21.0			

Table C.8: Engle–Granger Step 1: OLS Regression (Dep. Variable: USD/BOB Parallel, Indep. Variable: Public Debt), ADF Test on Residuals, and ANOVA

OLS Regression Results (Dep. Variable: USD/BOB Parallel)

	coef	**std err**	**t**	**P>|t|**	**[0.025, 0.975]**
const	-13.5340	2.872	-4.712	0.000	[−19.508, −7.560]
Public Debt	0.0005	6.39e-05	7.818	0.000	[0.000, 0.001]

Model statistics: R-squared = 0.744, Adj. R-squared = 0.732, F-statistic = 61.12 (Prob(F) = 1.19×10^{-7}), Log-Likelihood = –29.200, AIC = 62.40, BIC = 64.67, No. Observations = 23, Df Residuals = 21, Df Model = 1, Covariance Type = nonrobust

ADF Test on OLS Residuals

Statistic (residuals)	−2.00783	**p-value**	0.28315	**Lags used**	9
Observations (residuals)	13				

Critical Values (residuals): 1% = –4.06885, 5% = –3.12715, 10% = –2.70173

ANOVA

Source	**sum_sq**	**df**	**F**	**PR(>F)**
PublicDebt	49.654641	1.0	61.123592	1.188229×10^{-7}
Residual	17.059656	21.0		

Table C.9: Engle–Granger Step 1: OLS Regression (Dep. Variable: USD/BOB Parallel, Indep. Variables: FX Reserves, Public Debt), ADF Test on Residuals, and ANOVA

OLS Regression Results (Dep. Variable: USD/BOB Parallel)

	coef	**std err**	**t**	**P>|t|**	**[0.025, 0.975]**
const	-18.0797	5.436	-3.326	0.003	[−29.418, −6.741]
FX Reserves	0.0023	0.002	0.985	0.336	[−0.003, 0.007]
Public Debt	0.0006	0.000	5.421	0.000	[0.000, 0.001]

Model statistics: R-squared = 0.756, Adj. R-squared = 0.732, F-statistic = 31.00 (Prob(F) = 7.44×10^{-7}), Log-Likelihood = –28.655, AIC = 63.31, BIC = 66.72, No. Observations = 23, Df Residuals = 20, Df Model = 2, Covariance Type = nonrobust

ADF Test on OLS Residuals

Statistic (residuals)	−3.74090	**p-value**	0.00357	**Lags used**	6
Observations (residuals)	16				

Critical Values (residuals): 1% = –3.92402, 5% = –3.06850, 10% = –2.67389

ANOVA

Source	**sum_sq**	**df**	**F**	**PR(>F)**
FXReserves	0.789747	1.0	0.970807	0.336249
PublicDebt	23.909315	1.0	29.390841	0.000026
Residual	16.269909	20.0		

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