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Financial de-dollarization in Argentina. When the wind always blows from the East

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Abstract

Dollarization hinders financial intermediation in domestic currency which is detrimental for economic growth and development. A broad branch of the financial dollarization literature is based on portfolio theory. Dollarization of savings portfolios is the result of optimal mean-variance portfolio selection. In this document, we use an optimal portfolio selection approach to analyse financial dollarization's hysteresis in Argentina. Based on the historical experience of our country, we model agents' expectations using second-order probability distributions, that allow us to incorporate positive bias in subjective distribution of dollar returns. This bias arises from the subjective perceptions of unsustainability of the current regime. Under the proposed analytical scheme, in contexts in which households and firms face difficulties in identifying informative signals about the sustainability of the current exchange-rate regime, policy measures aimed at promoting financial de-dollarization may produce unwanted behavior. For example, the usually stated mean-variance approach argument of rising real exchange rate volatility relative to domestic currency volatility (inflation) could be perceived as an increase in the subjective probability of regime change, leading to portfolio rebalancing towards the foreign currency, with opposite results to those expected.

Keywords: Dollarization; Asset substitution; Financial intermediation

JEL classification: E52; F36; F41; G11

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Resumen

La dolarización dificulta la intermediación financiera en moneda nacional, lo que es perjudicial para el crecimiento y el desarrollo económico. Una amplia rama de la literatura sobre dolarización financiera se basa en la teoría de cartera. La dolarización de las carteras de ahorro es el resultado de una selección óptima de carteras con un enfoque de media-varianza. En este documento, utilizamos un enfoque de selección de cartera óptima para analizar la histéresis de la dolarización financiera en Argentina. Con base en la experiencia histórica de nuestro país, modelamos las expectativas de los agentes utilizando distribuciones de probabilidad de segundo orden, que nos permiten incorporar un sesgo positivo en la distribución subjetiva de las rentabilidades en dólares. Este sesgo surge de las percepciones subjetivas de insostenibilidad del régimen monetario-cambiario actual. Bajo el esquema analítico propuesto, en contextos en los que las familias y empresas enfrentan dificultades para identificar señales informativas sobre la sostenibilidad del régimen cambiario vigente, las medidas de política dirigidas a promover la desdolarización financiera pueden generar comportamientos no deseados. Por ejemplo, el argumento del enfoque de media-varianza generalmente establecido de una mayor volatilidad del tipo de cambio real en relación con la volatilidad de la moneda nacional (inflación) podría percibirse como un aumento en la probabilidad subjetiva de cambio de régimen, lo que lleva a un rebalanceo de la cartera hacia la moneda extranjera, con resultados opuestos a los esperados.

1 Introduction

The way in which the private sector allocates its savings is crucial for the development of the financial system in domestic currency, as well as for a country's financial stability and economic development. Argentina's history shows an almost uninterrupted process of foreign asset formation, constituting a serious limitation for financial intermediation. Understanding the causes of this process is of first-order of importance for policy makers.

Traditional approaches that analyse financial dollarization from a portfolio theory perspective (Levy Yeyati (2021), Ize and Levy Yeyati (2003), among others) assume risk-averse agents who obtain their optimal portfolios by optimizing mean-variance criteria. Under such analytical schemes, the **hysteresis** of financial dollarization (that is, persistent dollarization after years of low inflation rates) may be the result of exchange rate-based stabilization efforts that stabilized inflation and, simultaneously, the real exchange rate. In other words, hysteresis arises as the result of reducing absolute volatilities without modifying relative volatilities.

Under this approach the usual recommendation to discourage financial dollarization is to adopt an inflation targeting policy with exchange rate flexibility (as Ize and Levy Yeyati (2003) states: *"For a given variance of inflation, an increase in the variance of the rate of depreciation reduces dollarization by limiting the hedging benefits of dollar assets"*). In addition, such approaches highlight the role of **expectations** and **credibility**. In contexts where the lack of credibility is persistent, monetary policy efforts that seek to favour the demand for local assets may not have the desired effects on financial dollarization.

In this paper we focus on the effects of the lack of credibility on financial dollarization hysteresis. We ask whether the observed recurrence of changes in the functioning of monetary and exchange rate regimes throughout Argentina's monetary history may affect the subjective probability that agents assign to an eventual regime change, giving persistence to financial dollarization.

First, we characterize the behaviour of real returns on peso and dollar denominated assets during seven episodes of exchange rate jumps over eighty years of monetary history in Argentina. Second, based on the previous analysis, we take two case study: i) the Convertibility crisis and; ii) the episodes of exchange rate instability in 2018[1] and solve the optimal portfolio selection assuming a negative exponential utility function using a second order probability distribution.[2]

[1] We choose those periods due to lack of data availability for earlier stages.

[2] Undoubtedly, financial dollarization is a phenomenon that responds to multiple determinants. Modelling them through a general equilibrium approach exceeds the objective of this work, constituting a relevant topic for future research.

Our results are compatible with the fact that crisis recurrence play a role in explaining financial dollarization positively affecting the subjective probability π of regime change. First, in absence of perfect credibility, the subjective probability of dollar denominated assets real returns may be positively skewed. This implies that when taking measures to promote financial de-dollarization, policy authorities should consider that, even in well-behaved contexts, agents might perceive a positive bias[3] in exchange rate variation which favours dollar assets returns.

Second, the (higher) subjective probability that agents assign to the abandonment of the current regime becomes a variable of first-order of importance to understand the process of (higher) savings dollarization. This element is consistent with those results that emphasize the role of credibility and institutions' quality to reverse the financial dollarization. Additionally, this result allows us to rethink, in economies with similar characteristics to the Argentinean case, the effectiveness of measures tending to increase the nominal exchange rate volatility with respect to inflation rate, as the mechanism to promote financial de-dollarization. Moreover, even in the case of reaching a stable macroeconomic regime for a long time, there may be factors linked to agents' memory that justify savings dollarization.

Our contribution consists of two main elements. First, from a conceptual perspective, we ask whether the high frequency and magnitude of exchange rates episodes over eighty years of monetary history may have had long lasting effects on households and firms' expectations formation, which are not fully representable by the mean-variance portfolio approach widely used in the literature on financial dollarization. For this reason, we move from the minimum variance portfolio methodological approach and we represent the agents' subjective expectations by means of a second-order probability distribution, which captures that, under a specific monetary-exchange rate regime, households and firms may perceive it unsustainable even when the authorities see no fundamental reasons to abandon it.[4] This representation based on portfolio theory under ambiguity literature,[5] enriches the analysis, by incorporating bias in the subjective distribution of dollar real returns. Second, analysing financial dollarization based on the Argentine experience for a long period allows us to capture specific elements that may are unnoticed in empirical

[3] In statistics the bias corresponds to the centred moment of order three and is used to describe the degree of symmetry (or asymmetry) of the density function of a random variable with respect to the mean. A positive bias implies that values on the right are farther from the mean (with respect to those values on the left). It is important to state that bias has no role in solving optimization problem. For a description of store of value's demand with higher order moments see Corso (2015).

[4] Strictly, we represent an expected utility maximization problem in terms of the purchasing power of the main stores of values. Such expected utility is computed through second-order probability distributions, that is, probability weighted distributions.

[5] See Guidolin and Rinaldi (2013), Klibanoff, Marinacci, and Mukerji (2005).

studies based on econometric analyses that involve a set of countries (that is, to distinguish heterogeneities that are generally hidden in average effects).

The work is organized as follows. Section 2 reviews the literature on financial dollarization. In Section 3, descriptive statistics are presented to characterize the historical evolution of ex-post real returns of time deposits in local currency and external assets in dollars. Section 4 develops the proposed analytical methodology and displays the results. Finally, the Section 5 presents some conclusions.

2 Literature review

2.1 Conceptual framework

The literature has developed a general framework that rationalizes the process of financial dollarization as an internal phenomenon, arising from equilibrium in the market of funds, in which creditors and debtors optimize currency composition of their contracts (see Armas, Ize, and Levy Yeyati (2006), various chapters). Underlying the process of selecting the optimal currency composition there are three basic motivations: i. The return maximization corrected by volatility (in presence of risk aversion); ii. The cost minimization of credit, which favours the currency that minimizes the probability of payment default (in the case of multiple creditors and imperfect information) and iii. The redemption option value or deposits guarantee maximization that promotes moral hazard-driven equilibria in which the preferred currency is the one that maximizes the insurer's expected costs.

Based on these elements, dollarization will tend to consolidate in environments called in the literature as "weak monetary policy", understood as environments in which real returns of local currency assets present high volatility. Similarly, under specific configurations, dollarization will prevail in contexts in which the monetary policy is oriented to limit exchange rate fluctuations (reducing the risk of granting loans in foreign currency with respect to grant them in local currency); and in which depositors and debtors in foreign currency expect the government to bail them out in case of a large devaluation.

The aforementioned general schemes also allow us to conceptually analyse the way in which economic policy interacts with different sources of dollarization. This depends, for example, on its degree of credibility, the exchange rate volatility (fear of floating) and the asymmetry in exchange rate corrections in those cases in which the decision to smooth fluctuations does not allow the nominal exchange rate to appreciate in good times, even when it is expected to depreciate in contexts of negative shocks (exchange rate bidirectional vs. one way flexibility).

Relying on to those previously-mentioned elements, there is an extensive literature which focuses on studying the existence, stability and multiplicity of dollarization equilibria according to different paradigms and institutional and market environments. These analyses provide us with theoretical reasons that help us to understand why dollarization is expected to be a high persistence process.

2.2 Empirical studies

Levy Yeyati (2021) makes an extensive classification of dollarization concept that is useful to frame the area where the analysis of this study is focused. First, he distinguishes between **official** (or de jure) **dollarization**, which refers to the case in which the foreign currency receives a status of legal tender (usually exclusive), and **unofficial** (or de facto) dollarization, which is used to indicate the use of a foreign currency along with the domestic currency. In turn, within the latter, he distinguishes **real dollarization**: the use of foreign currency as a means of payment or unit of account; and **financial dollarization**: the use of foreign currency as store of value (savings).

Starting from the portfolio approach to explain financial dollarization, Ize and Levy Yeyati (2003) use a CAPM model where risk-averse agents choose the currency composition that optimizes their portfolio risk-return profile, measured in units of the domestic consumption basket. In equilibrium, dollarization is explained by the second moments (i.e., volatility) of inflation rate and depreciation of real exchange rate, instead of the first moment (that is, expected inflation and nominal depreciation). Therefore, for a given variance of inflation, an increase in the variability of the depreciation rate reduces dollarization by increasing the risk of dollars assets. In this way, they suggest that inflation targeting, combined with free floating exchange rate should contribute to reduce financial dollarization, by increasing the volatility of the exchange rate relative to inflation volatility.

However, as we pointed out previously, the phenomenon of financial dollarization responds to multiple determinants. De Nicoló, Honohan, and Ize (2005) constitute a reference on the effects of policy measures. With a sample of around 100 countries, they provide empirical evidence on the determinants of foreign currency deposits and its role in promoting financial development and financial stability. The results point out that the credibility of macroeconomic policy and the quality of institutions' are key determinants of financial dollarization. In turn, they find that dollarization only promotes financial deepening in environments of high inflation. Finally, they argue that financial instability is greater in dollarized economies.

The lack of credibility in the monetary regime is also used as an argument to explain

the dollarization of liabilities in emerging economies, even though it exposes debtors to large devaluations of the domestic currency. Jeanne (2003) presents a model where firms choose the currency composition of their debts between domestic and foreign currency to minimize the probability of default (that is, the composition of debt is the result of an optimal hedging strategy). The unpredictable monetary policy makes borrowers uncertain about the real future value of their debts in domestic currency and may induce them to dollarize their liabilities. This happens even though foreign currency debt itself exposes them to a greater risk, especially in the event of a large depreciation. Paradoxically, an increase in devaluation risk may lead domestic borrowers to contract less insurance against this risk. The author presents evidence suggesting such a link between monetary policy credibility and debt composition.

Christiano, Dalgic, and Nurbekyan (2021) use an insurance hypothesis to explain financial dollarization. Households who place their deposits in dollars buy insurance against the economic cycle from the companies that borrow in dollars. The "price" paid by depositors is the premium over domestic interest rate. The insurance gain is the increase in the return in dollars that occurs when the domestic currency depreciates during an economic recession.

In a regime with perfect credibility there is no foreign exchange rate risk, the firm borrows in domestic currency and since the project is profitable, it never goes bankrupt. But as the probability of devaluation increases, so does the peso's interest rate through uncovered interest rate parity. The solution is known as the *peso problem*. Dollar debt increases vulnerability to large devaluations but there is a peso's interest rate level at which the debtor cannot avoid default in all states. Therefore, with a low probability of regime change the firm chooses bankruptcy in the least likely state (a large devaluation) by issuing debt in foreign currency.[6]

To our knowledge, Rennhack and Nozaki (2006) is the only reference that incorporates bias into the analysis. Using data from various Latin American countries, they seek to test different explanations for financial dollarization. They find that it tends to remain high in countries with high and unstable inflation and with institutions that weaken the confidence in the inflation outlook. Likewise, an exchange rate policy biased towards depreciation tends to contribute to a high financial dollarization pressure.[7] On the other

[6] As the author points out, the document's assumption is that "original sin" (i.e., the inability of emerging countries to borrow in domestic currency, see Eichengreen and Hausmann (1999)) is the result of the lack of credibility in domestic monetary policy or the lack of credibility of the fiscal policy, to the extent that there is a fiscal dominance problem.

[7] They use 2 alternative measures: i) an asymmetry in exchange rate policies index assigning a value of -1 to months of currency appreciation and of 1 to months of depreciation and then calculate the annual average; ii) the degree of distribution asymmetry of currency depreciations for the years 1990-2001 and

hand, legal restrictions might have been effective in avoiding financial dollarization, mainly in countries with low inflation or with effective indexation mechanisms to preserve the purchasing power of the local currency. They conclude that countries with significant financial dollarization should try to encourage the use of local currency while maintaining macroeconomic stability with low and stable inflation, allowing greater exchange rate flexibility and lower bias towards depreciation.

3 Descriptive statistics

3.1 Dollarization in Argentina

Table 1 describes non-financial private sector's main financial assets stock as of December of years 2010, 2015 and 2020[8] by asset type and currency.

There is a clear preference for assets denominated in foreign currency with a financial dollarization coefficient (λ_D)[9] between 73% and 80%. Notice that the largest percentage of foreign assets is made up of bills and deposits. This concept integrates foreign currency holdings for hoarding outside the local financial system (localy referenced as "dollars in the mattress" or security box) which, therefore, do not accrue interest. The fact that households and firms are willing to hold a very significant portion of their store-of-value assets in instruments that do not pay a contractual rate, strongly suggests that the expected depreciation constitutes the most relevant component of expected return on asset, while the rate in dollars is a minor part of it (Christiano, Dalgic, and Nurbekyan (2021)). This item will be clearly evidenced in the following sub-section and shows the fact that exchange-rate jumps are an element of first order importance for households and firms when deciding their wealth portfolio decisions.

On the other hand, only between 14% and 20% of total financial assets were local currency deposits in financial entities, which constitutes a serious limitation for banking intermediation development. Finally, public debt hardly exceeds 5%[10] of the portfolio, which shows the limited size of local debt markets.

1980-1989. It should be noted that the latter is not statistically significant in none of the specifications.

[8] Years were selected based on data availability.

[9] In general, due to a limitation in data availability, the literature defines financial dollarization as the ratio between the sum of deposits in foreign currency (both in origin country and abroad) over total deposits (in domestic and foreign currency). In the present document the definition is more comprehensive since it considers a broader set of assets.

[10] Some of which are denominated in foreign currency, increasing financial dollarization coefficient. Due to lack of data availability, the opening is not shown.

Table 1: Financial assets of the non-financial private sector

	Millions of USD			Percentage		
	2010	2015	2020	2010	2015	2020
Deposits in financial entities	**64,791**	**80,978**	**77,501**	**27.2**	**24.3**	**17.2**
Peso	52,982	70,251	61,474	22.2	21.1	13.7
Dollar	11,809	10,728	16,028	5.0	3.2	3.6
Holding of public securities	**NA**	**19,338**	**30,482**	**NA**	**5.8**	**6.8**
Foreign financial assets	**173,526**	**232,323**	**341,314**	**72.8**	**69.8**	**76.0**
Currency and deposits	108,073	150,553	229,228	45.3	45.3	51.0
Direct investment	29,409	36,943	39,937	12.3	11.1	8.9
Portfolio investment and other assets	36,044	44,827	72,150	15.1	13.5	16.1
Financial dollarization (λ_D)		**243,051**	**357,342**		**73.1**	**79.5**

Note: year 2010 percentages were calculated assuming holding of public securities equal to zero, so figures are not directly comparables.

3.2 Awareness of the exchange rate correction

In this section we analyse the evolution of real returns in local currency and in dollars over a period of almost eighty years. Our goal is to identify the presence of regularities in the ex-post real returns distributions that may have been incorporated in the expectation formation process of households and firms in Argentina, in order to understand key aspects of financial dollarization process evidenced in Table 1.

As a first approximation, Figure 1 shows the monthly evolution of 1-month real return of fixed term deposit in pesos and dollar denominated assets holding[11] for the last 80 years (between January 1939 and December 2020). Appendix I presents a detailed computation of the two series represented.

The first element that stands out from Figure 1 is the high volatility of the series. Secondly, volatility presents clusters, associated with frequent exchange rate correction episodes evidenced during the period. We refer to "exchange rate corrections" because some episodes correspond to exchange rates jumps that implied modifications in the monetary-exchange rate regime, but that do not necessarily represent a critical event that put end to a particular regime.

Regarding the cluster structure, it is important to mention that during the period of analysis, there were at least 15 episodes of exchange rate corrections of non-neglegible

[11] Because the variation of the exchange rate constitutes the main component of the return of the asset external, we will refer indistinctly of external assets or dollars.

magnitude.[12] This implies an average of one event every approximately **five and a half years**. As we said, these exchange rate correction events implied sudden jumps in the price of US currency, which may be either the consequence of abandonment of a specific regime, such as the Convertibility crisis, or be part of a stabilization program, such as the 1959 devaluation or the one associated with the Plan Austral of 1985, as well as the result of an environment of high economic and/or political uncertainty, such as the exchange rate episodes of 1962. In terms of our analysis, regardless of the underlying reasons behind the jump, it implies for agents an attractor towards the dollar as store of value.

Among the aforementioned episodes, we will concentrate on seven specific cases, which share two fundamental characteristics. The first, and the reason why they were selected, is that evolution of the real returns prior to the occurrence of the exchange rate disruption justified, from an optimal portfolio selection criteria, the demand for assets denominated in local currency as part of private sector's store of value. The second characteristic is that such regimes were followed by exchange rate corrections. It is important to point out that the description of the particular context of different episodes is beyond this papers' scope. Our goal here limits to explore such experiences to identify common patterns in the empirical distributions of ex-post real returns during the period prior to the exchange rate jump, with respect to the distribution that characterizes the evolution of the returns after it.[13]

The first experience considered is the crisis of the year 1949. The second, the devaluation carried out by the administration of President Frondizi in December 1958. The third is the exchange rate jump associated with high uncertainty during Frondizi's dismissal. The fourth is the exchange rate crisis popular known as "Tablita" in April 1981. The fifth, the exchange rate uncertainty once the effects of Austral Plan, implemented in June 1985, had weakened. The sixth is the Convertibility crisis in December of 2001 and the seventh, the episodes of exchange rate jumps that followed the month of April of 2018.

In order to identify common patterns, Table 2 presents the first four central moments of the distribution of monthly real returns of fixed term deposit in pesos and dollar denominated assets holding (same series of Figure 1), splitting the stages before and after the correction episode.

As can be seen, the average real return in dollars was always positive in the stages corresponding to the exchange rate correction episode with significant differences in levels

[12] In terms of our series, we refer to the variations in the free exchange rate in 1949, 1959, 1962, 1972, 1975, 1981, 1986, 1989, 1990, 2001, 2015, 2018 and 2019. In the period 2002-2020, corrections of lesser magnitude have been observed in 2008 and 2014.

[13] For the interested reader, Appendix II presents a brief description of the institutional context of each selected episode.

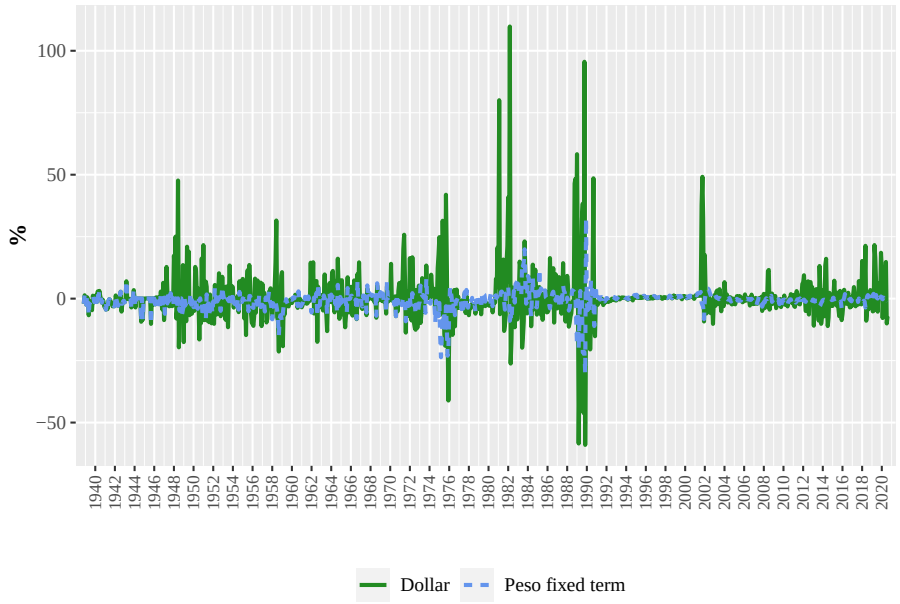


Figure 1: Evolution of 1-month real return of fixed term deposit in pesos and dollar denominated assets holding

in relation to the period before the exchange rate correction, as well as regarding the return of the fixed term deposit in pesos. In turn, the performance of the foreign currency was additionally more volatile during exchange rate episodes compared to previous periods and to the return of fixed term deposits. The distributions in the environment of the exchange rate correction present a positive bias, which implies that devaluation movements are more intense than appreciations. Finally, the kurtosis alternates between values greater and lower than 3, the reference value of the Normal distribution, so not clear pattern is discernible in the tails' weight (that is, the frequency of observations at the extremes).

Figure 2 displays the boxplots of the real returns. The horizontal line inside of the box represents the median, the lower and upper hinges correspond to the first and third quartile, the upper whisker extends from the upper hinge to one and a half times the interquartile range ($Q3 + 1.5 \times IQR$) and the lower whisker does the same but downward ($Q1 - 1.5 \times IQR$). Data beyond the end of whiskers are considered outliers and are plotted individually.

Panel 2a shows that, in general, the median of real returns of fixed term deposits in pesos moves in negative values during critical periods except in Austral Plan and Convertibility. The different "boxes" are larger and in some cases are below the pre-crisis level. The maximum real return barely reaches 12% with a higher frequency of outliers in negative values. Months corresponding to Convertibility crisis show a great dispersion of values

Table 2: Central moments of the distribution of real returns at 1 month of the fixed term in pesos and the dollar

Period	Mean		Std. Deviation		Bias		Kurtosis	
	Dollar	Fixed term	Dollar	Fixed term	Dollar	Fixed term	Dollar	Fixed term
Pre Crisis of 1949	-0.80	-0.83	2.97	2.40	0.28	-0.99	7.72	6.87
Crisis of 1949	2.01	-2.25	12.51	2.38	1.16	-0.68	5.31	2.95
Pre Frondizi's devaluation	-0.34	-1.00	6.41	2.27	-0.08	-0.38	2.41	3.99
Frondizi's devaluation (1958)	0.02	-6.42	14.95	3.58	0.51	-0.96	2.79	3.79
Pre Frondizi's departure	-1.36	-0.83	1.62	1.45	-0.57	0.21	5.04	2.93
Frondizi's departure (1962)	2.28	-2.19	10.16	2.97	-0.55	-0.25	2.68	2.30
Pre-Crisis of "Tablita"	-1.95	-0.66	2.64	1.89	1.26	-0.17	6.15	2.92
Crisis of "Tablita" (1981)	15.34	-0.24	34.31	3.61	1.57	-1.03	4.91	3.48
Plan Austral (1985)	-1.05	1.81	6.03	3.55	1.60	1.29	5.72	5.77
Post Plan Austral	2.26	0.48	7.08	2.21	0.15	0.23	1.87	2.93
Pre-Convertibility Crisis	0.20	0.53	0.78	0.68	-1.44	-0.55	5.39	5.02
Convertibility Crisis (2002)	8.64	0.50	19.22	3.58	1.06	-1.18	2.65	3.66
Pre Crisis of 2018	-0.88	-0.47	3.54	1.09	-0.05	-1.01	3.07	5.57
Crisis of 2018	3.64	-0.22	8.94	1.41	0.79	-0.45	2.58	2.74

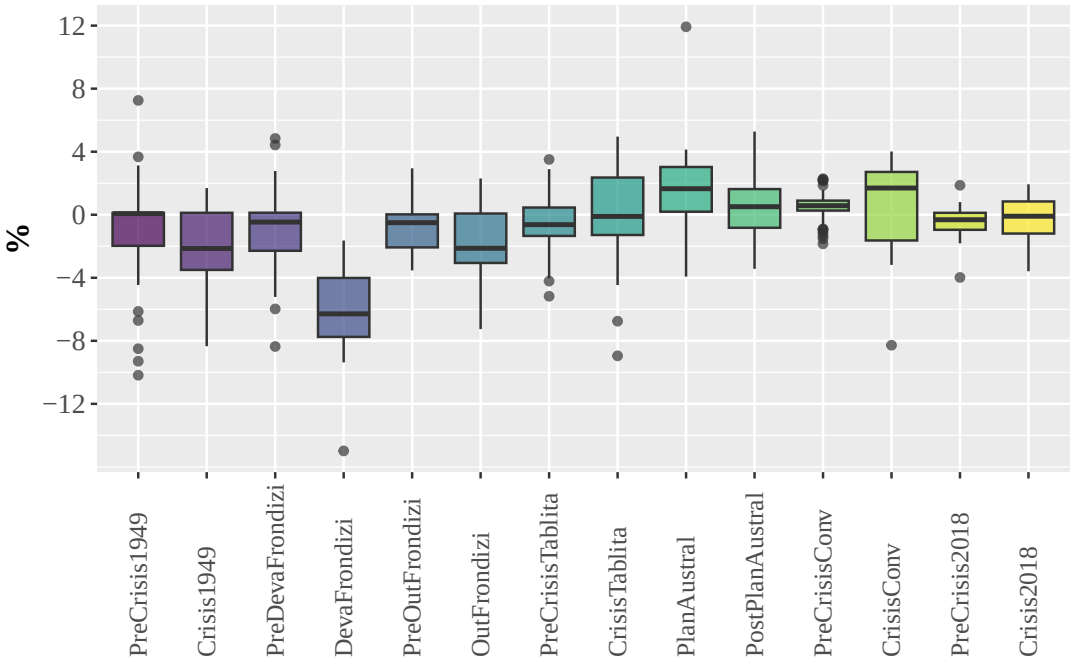
with a maximum fall of 15% in the real return of the fixed term deposit during the devaluation of Frondizi.

In contrast, panel 2b allows us to observe the difference in the distributions of the real yield of dollar in all stages of the crisis. As in the previous case, in general, the different "boxes" are broader compared to the pre-crisis, although with a bias towards the right (strictly upwards because it is vertical). In turn, the magnitude of devaluations is reflected in return values that, as mentioned above, reach extreme levels of 100%. Finally, the crisis of "Tablita" and Convertibility are the episodes with the greatest dispersion of returns.

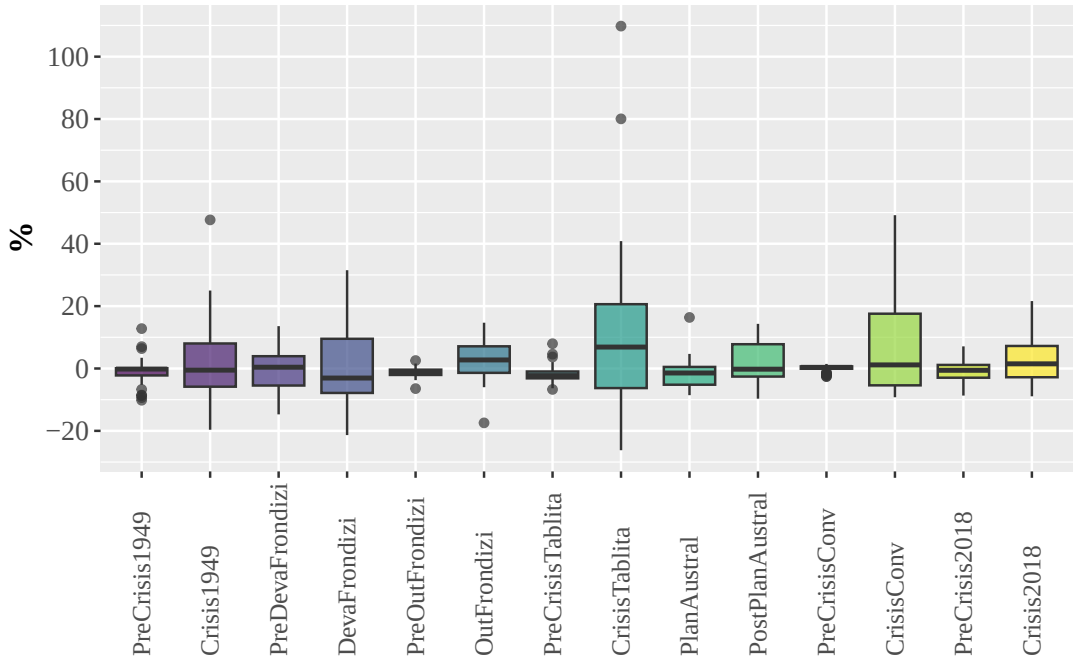
From this evidence, we can identify the following patterns that characterize the empirical distributions of ex-post real returns:

First, regardless of the characteristics of the regimes before the exchange-rate correction, the distributions of the real returns of dollar denominated assets during periods of exchange rate correction present a higher mean and standard deviation with respect to the previous stage. Secondly, the mean and volatility of dollar denominated assets return is greater than that of fixed terms deposits in pesos in crisis times. Although at first sight this result might seem trivial, it turns out essential when thinking about the implications on agents' subjective distributions characteristics.

In the rest of the paper, we will argue that the recurrence of the stability pattern of the monetary-exchange rate regimen, followed by its modification and eventual abandonment, has been incorporated into the process of households and firms' expectations formation. The next section presents the methodology with which we will characterize this process.



(a) Peso fixed term



(b) Dollar

Figure 2: Boxplot of real return at 1 month

4 Methodology

4.1 Theoretical approach

Our objective is to model the agent's (households and firms) portfolio decision problem under a determined monetary-exchange rate regime, who has to decide in which asset to preserve her/his wealth purchasing power during a holding period h. At the time of making her/his asset allocation decision, we assume that the agent does not know if the current regime will remain in force or if it will be abandoned at some point during that period. We call θ_1 the subjective distribution on real returns if the agent considers that the institutional scheme associated with the current monetary-exchange rate regime remain. On the other hand, we call θ_2 the subjective distribution on real returns in the case agents perceive the abandonment of current institutional scheme. That is, it is the associated distribution to the environment of the exchange upward movement. Finally, the agent assigns a subjective probability $(1-\pi)$ to abandonment of monetary-exchange rate regime throughout the holding period h. Notice that a value $\pi = 1$ means that the current regime is perceived as perfectly credible.

To solve her asset allocation problem, the agent must first form the subjective distributions θ_1 and θ_2 and the subjective probability π. The mechanism by which she infers θ_1, θ_2 and π from her stock of information in t, $I(t)$, constitutes her expectations formation process, which is endogenous to the evolution of her environment.

Based on these assumptions, and conditional on the stock of information $I(t)$, the portfolio problem that the agent solves at a time t can be considered as a second-order distribution expected utility maximization, with a subjective distribution function for the returns under the current monetary-exchange rate regime (θ_1) with probability of occurrence π and another associated subjective distribution function with exchange correction (θ_2) with probability $(1-\pi)$. Equation (1) represents this argument formally where w is the vector of asset holdings and r the vector of real returns (further details about utility function in Appendix I).

Equation (2) shows that the problem can be equivalently stated as the expected utility maximization over a probability distribution θ_3, which results from weighting distributions θ_1 and θ_2 by the subjective probability of occurrence π and $(1-\pi)$, respectively.

$$max_w U = \pi E_{\theta_1} u(w'r) + (1-\pi) E_{\theta_2} u(w'r) \tag{1}$$

$$max_w U = E_{\theta_3} u(w'r) \tag{2}$$

As an illustrative example, Figure 3 displays the differences between three simulated subjective distributions under consideration, for the case of dollar denominated asset returns. Based on the relationships between the first two moments described in Table 2, we will assume the case of two normal distributions where the pre-crisis period (purple) has lower mean and lower variance than the one corresponding to the environment of the exchange rate correction (green).

It is important to understand that the assumption of normality of the subjective distributions θ_1 and θ_2, implies the skewness to the right of the distribution θ_3, since the probability mass $(1-\pi)\theta_2$ is distributed around a mode larger than $\pi\theta_1$. In short, agents end up solving an expected utility maximization problem on a skewed distribution.

Alternatively, and *ceteris paribus* the distribution of local currency denominated asset returns, from the perspective of a risk-averse agent who optimizes her expected utility[14] if the higher mean of the foreign asset return under θ_2 more than compensates its higher variance, there will be an incentive to dollarize the portfolio.[15]

It is the skewness of distribution θ_3, to which the title of this document refers. In Argentina, episodes of exchange rate uncertainty are associated with movements in the foreign currency's value with a bias towards the same side, that is, devaluation. Therefore, the proposed approach assumes that agents incorporate in their expectations' formation process the fact that exchange rate corrections regularly modify the institutional scheme of current regime. This implies that in periods of relative stability, agents could assign a certain probability $(1-\pi)$ that the realizations of real returns on stores of value are being generated by a distribution consistent with an environment of exchange rate correction and possible regime change.[16]

To model formal mechanisms through which agents could infer the distributions θ_1 and θ_2 and the probability value π constitutes a possible extension of this work. Our emphasis is on highlighting that the expectation formation process could be endogenous to the pattern described in the previous section and that the bias of distribution θ_3 is the result of assuming that agents form their expectations by weighting two subjective probability distributions. First, the one that the agent perceives would govern in her investment horizon if current monetary regime is sustained. Second, the one that results from the

[14] Or equivalently an approximation of mean and variance.

[15] Note that in this case it is not necessary to assume a utility function that explicitly accounts for bias.

[16] The recurrence of regime change observed in Argentina motivates this argument.

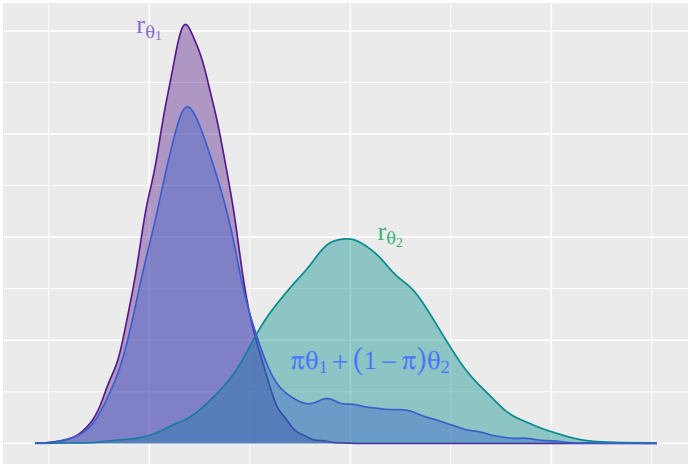


Figure 3: Subjective distributions on real returns

abandonment of the current regime. In other words, the approach seeks to model portfolio decisions in ambiguous contexts without explicitly assuming ambiguity aversion.

It is important to note that portfolio allocation of agents will depend, among other elements, on the subjective probability assigned to the abandonment of the current regime. Additionally, as the eventual change of regime entails an exchange rate correction, the distribution under regime's abandonment will be associated with a devaluation shock, and consequently with above-average real returns on dollar denominated assets under previous regime. The greater the perceived probability of regime change, the greater the bias of subjective distribution with which agents will make their decision of assets' allocation during the regime being in force.

Under the proposed representation, changes in the subjective probability of regime change could lead to the rebalancing of optimal asset holdings even when, from the perspective of policy makers, the fundamental variables do not imply changes in the sustainability conditions of the exchange rate regime.

4.2 Results

The main objective of this section is to study the empirical characteristics of distribution θ_3 in the two experiences in Table 2 closest[17] in time (the period of Convertibility regime and the monetary-exchange rate regime implemented during the period from January 2016 to November 2019), **taking as given** the evolution of dollarization coefficient (portfolio

[17]We do not extend the analysis to previous experiences due to the lack of information on external assets prior to the 1990s.

shares w) observed in each stage[18] and assuming for each experience the distributions θ_1 and θ_2.

In other words, although according to our approach θ_1 and θ_2 are endogenous to our macro-financial history, in the exercises that follow we will focus on computing the evolution of π in equation (1), taking as given the distributions θ_1 and θ_2, which will be computed based on real returns actually observed in the period. Specifically, pre-crisis of Convertibility refers to the period from May 1991 to November of 2001 and its crisis throughout the year 2002. On the other hand, the pre-crisis of 2018 ranges from January 2016 to March 2018 and the crisis begins in April 2018 and extends until November 2019.

As we have previously mentioned, the agent's expectations formation process can be thought as a signal extraction problem, where realizations of real returns are noisy signals to the agent, from which she must infer the distributions θ_1 and θ_2 and crisis probability $(1-\pi)$, and hence select her optimal portfolio. In our exercises we assume that θ_1 and θ_2 correspond to unconditional bivariate distributions (returns in pesos (1) and in dollars (2)) of two periods that we consider of "regime normality" and "exchange rate correction environment", respectively. In other terms, our exercise is equivalent to assume that changes in the dollarization ratio only reflect changes in the subjective crisis probability $(1-\pi)$ (and equivalently, changes in the subjective distribution θ_3), and they are not the reflection of modifications in the subjective distributions θ_1 and θ_2. These assumptions are sufficient to characterize the distribution θ_3, our principal objective. Figures 4 to 7 exhibit these results.

Figure 4 shows the evolution of crisis probability $(1-\pi)$ (left) and the mean of distribution θ_3 (right) corresponding to the dollar denominated assets that results from the exercise corresponding to Convertibility period. As can be seen, given the assumptions of our approach, the evolution of the dollarization coefficient of the period is consistent with a subjective probability of crisis that on average was 12%, and that showed a strong increase from 1998 and fundamentally during 2001. It should be noted that the level of this subjective probability for a given dollarization coefficient could be affected by

[18]For the Convertibility regime, the shares are computed based on a portfolio composed only of time deposits in pesos and dollars in the local financial system. For the 2016-2018 period, the shares are computed based on the estimation of a stock of assets denominated in dollars "substitutable" by peso-denominated assets. This stock is computed as the accumulated flow in pesos of external asset formation, deflated by the CPI. By computing the "substitutable" stock of dollar assets in this way, we avoid the effects on shares of capital gains generated by exchange rate fluctuations. In this way, the shares correspond to those of a portfolio composed of this "substitutable" stock of assets denominated in dollars and time deposits in the local financial system, denominated in local currency. The reader should bear in mind that the share measures of both exercises are not comparable. This is not a problem, since the objective of the exercise is to show that, for each experience, the evolution of shares is consistent with a portfolio selection problem with second-order probability distributions.

other factors. To illustrate this point in sub-section 4.2.1 we introduce the existence of rebalancing cost in our model.

An element that deserves to be highlighted is the fact that dollarization coefficient of the period is consistent with a crisis probability of around 10% even during the years in which the sustainability of Convertibility regime was not under discussion by the monetary authorities. This result suggests that in their expectation formation process, agents have incorporated the high frequency of changes in monetary-exchange rate regimes observed throughout Argentina's monetary history. This implies that even in periods in which the monetary-exchange rate system functions normally, the agents ***still*** assign a non-negligible probability to the fact that returns' distributions would move to a "crisis" context.

With respect to the second graph in Figure 4 (right), the purple dashed line shows the mean of distribution θ_1 while the green line corresponds to the mean of the distribution θ_2. Both are fixed for the entire period, as we mentioned earlier. The mean of distribution θ_3 is the weighted average by the subjective probability π of the corresponding dashed lines and mimics its behaviour.

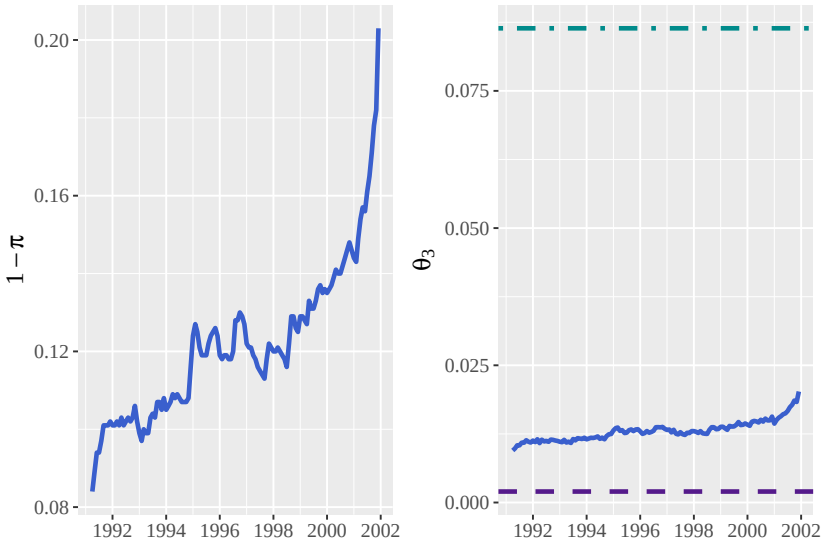


Figure 4: Evolution of $(1-\pi)$ and the mean of θ_3 (dollar) – Convertibility

Figure 5 shows the evolution of the second (left) and third moment (right) of the subjective distribution θ_3. As in the case of the mean, the purple and green lines show the corresponding moments of the distributions θ_1 and θ_2, which are fixed since it is assumed that both distributions do not change to throughout the period. As can be seen, and as we have argued previously (see Figure 3), the subjective distribution θ_3 presents a marked

bias to the right throughout the period. This fact reflects that the observed dollarization coefficient is consistent with a non-zero crisis probability $(1-\pi)$, and that the mean's value of θ_2 is greater than the mean of θ_1.

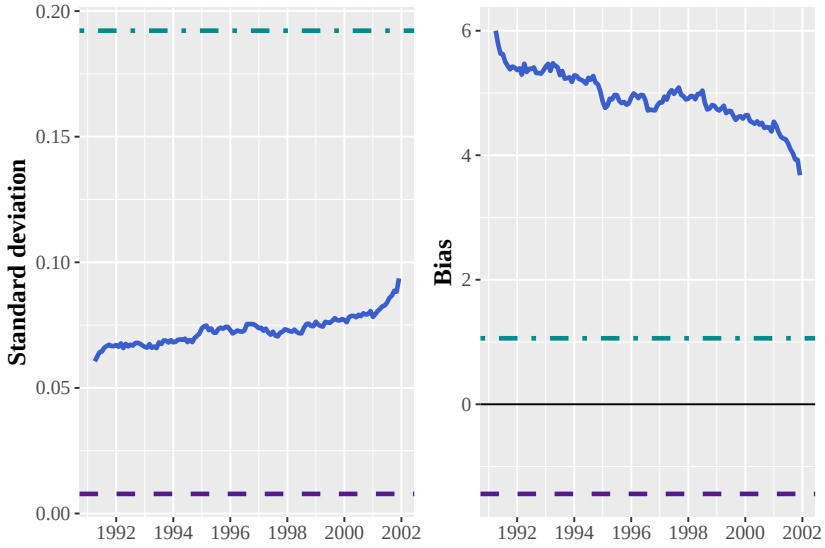


Figure 5: Evolution of the standard deviation and the bias of θ_3 (dollar) – Convertibility

On the other hand, Figures 6 and 7 show the evolution of subjective probability of crisis and the first three moments of θ_3 corresponding to the period between January 2016 and November 2019. As can be seen again, the probability of crisis $(1-\pi)$ shows an increasing trend throughout the analysed period. During the first few months, the increase in this probability may be the reflection of a growth in the dollarization ratio due to an initial increase in the demand for dollars motivated by the restrictions' opening in the foreign exchange market in December 2015. However, after stabilizing during the first half of 2017, it begins to show again an increasing trend during the second half of that year.

Again, as can be seen in Figure 7, and consistent with our analysis, the distribution θ_3 presents a marked positive bias throughout the period.

Despite the differences in the monetary-exchange rates regimes in force in the two analysed stages, both cases show a high coefficient of financial dollarization.[19] This result is in line with our argument that the high frequency with which changes in the institutional scheme of the monetary and exchange regimes (whatever these may be) are verified, would has been incorporated in the processes of agents' expectation formation. In terms of our approach this implies that, irrespective of the regime, agents have developed defensive mechanisms by which they assign a non-negligible probability that real returns

[19] Beyond the aforementioned differences in the calculation of the dollarization coefficient in both cases.

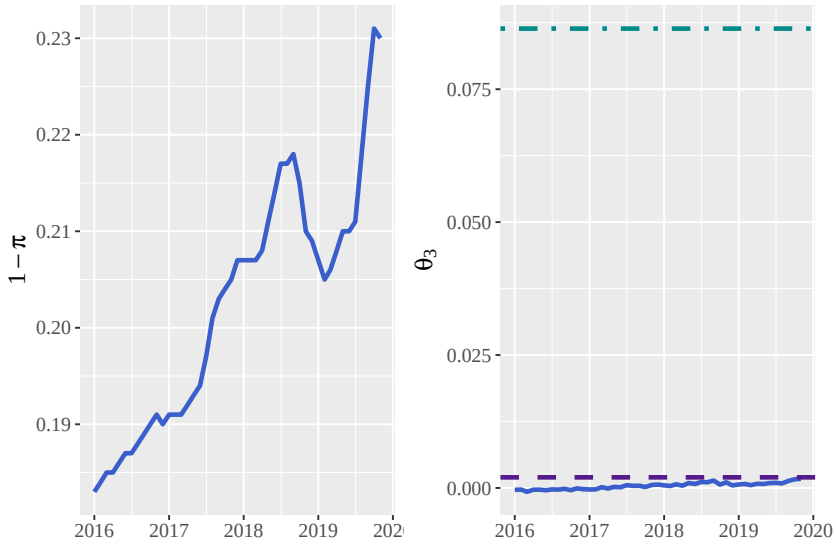


Figure 6: Evolution of $(1 - \pi)$ and the mean of θ_3 (dollar) – Period 2016 - 2019

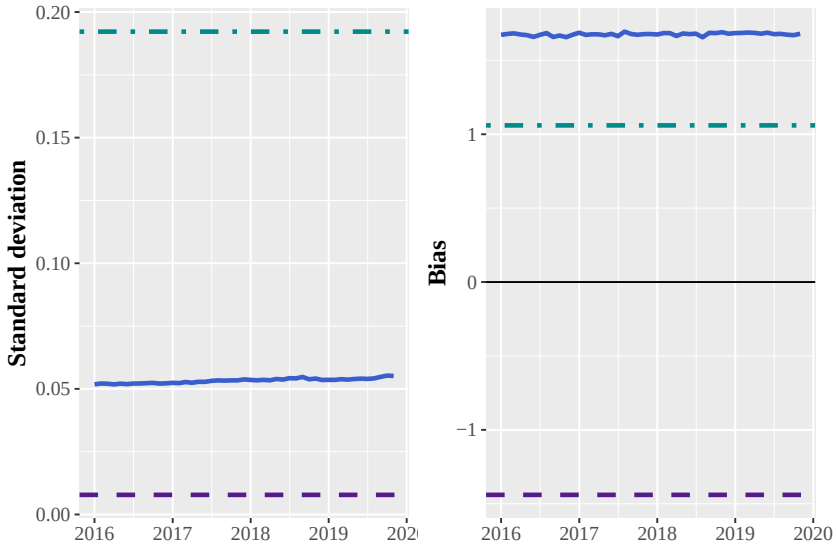


Figure 7: Evolution of the standard deviation and the bias of θ_3 (dollar) – Period 2016 - 2019

realizations may be generated by distributions consistent with a crisis environment. As a result, the expectations formation about the evolution of dollar denominated assets' real returns could be consistent with a subjective distribution with a marked positive bias having significant implications. On the one hand, it is an argument that is added to the mechanisms described in the literature by which financial dollarization is a process that shows high persistence. On the other hand, as we will analyse in Section 5, it is an additional element to be taken into account when evaluating the effectiveness of policy measures that seek to promote de-dollarization processes, based on the characteristics of the established monetary regime.

Finally, it is important to highlight again that our approach is theoretical[20] and not econometric, which prevents us from isolating specific dollarization determinants. The proposed exercise harness the portfolio theory with second-order probability to recover crisis probability $(1-\pi)$ and illustrate the fact that the persistence of financial dollarization may be influenced, among other factors, by the frequency of crises throughout Argentine history.

4.2.1 Computing transaction cost

In this section we extend the optimization problem in equation (1) by incorporating a vector of costs k for rebalancing asset holdings. Transaction costs[21] will be modelled by the absolute value of the difference between the vector of optimal holdings w and an initial vector of asset holdings w_0.[22]

Thus, the cost function results:

$$c = k' \times |w - w_0| \tag{3}$$

Where $k = [k^{\$}, k^{US\$}]$ is the vector of costs (in terms of returns) for changing the shares between assets denominated in local and foreign currency.

The optimization problem in the presence of rebalancing costs can be expressed as:

$$max_w U = \pi \frac{1}{n_1} \sum_{i=1}^{n_1} -e^{-\lambda[1+w'r-k'\times|w-w_0|]} + (1-\pi)\frac{1}{n_2} \sum_{i=1}^{n_2} -e^{-\lambda[1+w'r-k'\times|w-w_0|]} \tag{4}$$

[20] Inspired by the literature on portfolio selection under ambiguity.

[21] See Markowitz (1987), Perold (1984) and Yoshimoto (1996).

[22] In the exercise presented below, we assume an initial portfolio denominated entirely in local currency, such that $w_0 = [1, 0]$.

We redo the exercise for the period 2016-2019 but the subjective probability π is computed assuming a real monthly rebalancing cost of 1% for changing the share between peso and dollar denominated assets.

Figure 8 exhibits the evolution of crisis probability $(1-\pi)$ (left) and the mean of distribution θ_3 (right) and Figure 9 shows the standard deviation and bias of θ_3 for the mentioned exercise.

As expected, the evolution of crisis probability has the same shape as in the previous exercise but its range level is substantially higher.

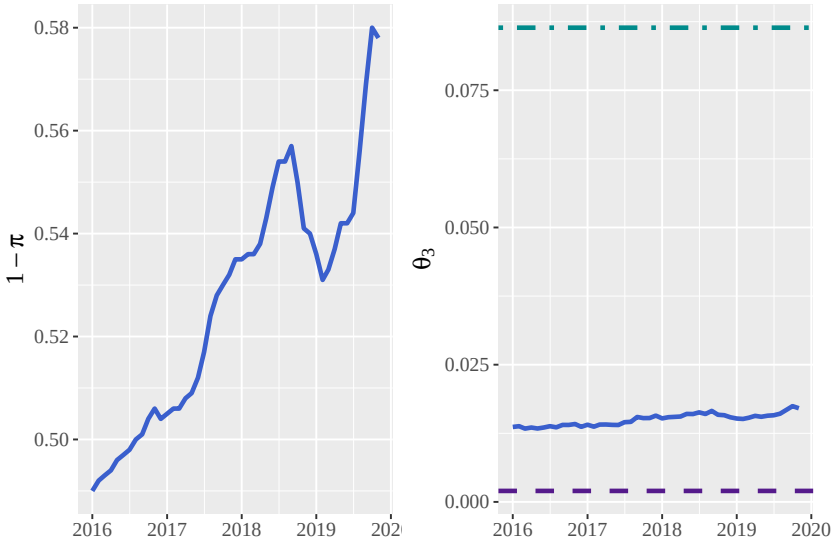


Figure 8: Evolution of $(1-\pi)$ and the mean of θ_3 (dollar) – Period 2016 - 2019 with transaction cost

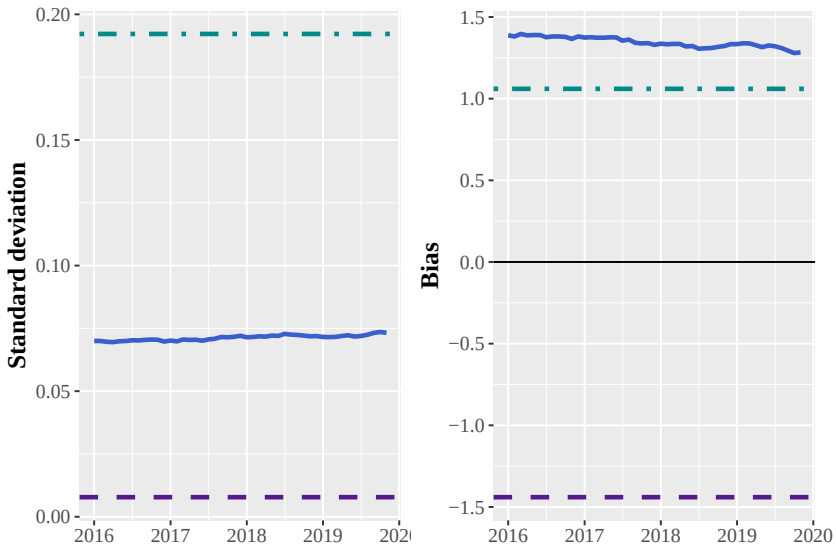


Figure 9: Evolution of the standard deviation and the bias of θ_3 (dollar) – Period 2016 - 2019 with transaction cost

5 Conclusions

In this paper we have examined the impact of our macro-financial volatility history over the expectations formation process that is behind household's and firms' store of value decision. Specifically, we have shown that the observed demands are compatible with real returns expectations computed through second-order probabilities. The scheme consists of three central elements: two subjective probability distributions, corresponding to the evolution of real returns under the normal functioning of the current regime and the environment of its modification, respectively, and a subjective probability π that weights both distributions.

To take their portfolio decision, households and firms must infer these three elements, based on context evolution. That is, expectations formation is endogenous to perceived changes. To do this, they must evaluate the potential relevance of the variables they consider informative for the process.

However, in economies that frequently experience changes in the functioning schemes of monetary and exchange regimes, agents face greater difficulties in identifying which signals are the correct ones to obtain information with respect to their environment when making asset allocation decisions. In such circumstances, under a specific monetary regime, agents may interpret certain changes in the environment as indicative of a greater probability of regimen change, even when the authorities consider that no relevant condition for regimen stability has changed.

Note that the problem is not limited to how "noisy" a signal is, but also refers to the identification of which signals are "relevant" to assess the environment. In economies in which agents recurrently face volatile macroeconomic and financial contexts, this identification problem is expected to be more important. In such contexts, expectations will be even less associated with economic fundamental conditions, and more linked to conjectures (founded in experience) by agents.

Let us see some mechanisms through which the subjective distributions θ_1 and θ_2 are endogenous to our history of macro-financial volatility. Among the most relevant ones, we can mention the memory of the agents regarding the response of the monetary authority under different contexts of abandonment of regime or correction of imbalances. Devaluations which impact the parametric structure of θ_2.

We can think of other adaptive mechanisms such as real dollarization, or the shortening of the contractual structure in contexts of uncertainty. For example, in economies with a high degree of real dollarization it is expected that the average real return of pesos denominated assets in the crisis environment of the regime were lower than in the case of economies with a lower degree of real dollarization. Additionally, in the case that agents perceive a signal as indicator of a higher probability of regime abandonment, it is expected that the elasticity of $(1 - \pi)$ with respect to the signal will be greater, the greater the degree of real dollarization. Finally, the degree of real dollarization will also affect the domain of signals that can be considered as indicative of changes under the conditions of sustainability of the current regime.

As we said before, an implication of our paper is that, under the previously mentioned conditions (recurrent crises with one-way exchange rate flexibility), agents face difficulties in identifying the informative value of the signals they receive from the environment. In this context, some of the recommendations to undertake processes of de-dollarization postulated in the literature on the basis of approaches that employ plain mean-variance representations, could be rethought based on the presence of bias. One of them is to reduce the volatility of inflation and raise the volatility of the depreciation rate. Although under certain environments of high credibility, this recommendation could have the desired effects, in the presence of subjective distributions that show bias (low credibility) and signal extraction, the answers of the agents could go in the **opposite direction**. In that case, an increase in exchange rate variability by monetary policy authority could be perceived by agents as a *change* in the environment, and therefore, an increase in their subjective probability of regime change. This may imply opposite results to those desired, promoting rebalancing in the agent's portfolio in favour of dollar assets holdings.

To illustrate the relationship between both variables, let us take as example the case of the

second analysed experience. As can be seen in Figure 6, the crisis probability was increasing throughout the entire period. If we compute the nominal exchange rate volatility as a 12-month centred moving window, we find a 0.8 correlation coefficient between exchange rate volatility and crisis probability. In other words, the greater volatility observed in the exchange rate would evidenced a high correlation with the subjective crisis probability.

Our results are in line with literature that points that, to promote de-dollarization processes, it is essential to establish institutional schemes that are perceived as sustainable by agents (De Nicoló, Honohan, and Ize (2005)). From this point on, and in terms of our analytical approach, the discussion about de-dollarization should pay particular attention to the determinants of π, which summarizes the subjective probability assigned by agents to the credibility of established regime by economic authorities.

In the Argentine case, the stock of information that agents considers to set the subjective probability $(1 - \pi)$ exceeds the exchange rate regime that is circumstantially adopted. Their response to changes in the environment has been delineated over many decades of instability in the institutional schemes. Stabilizing perceptions of regime change entails dismantling adaptive responses that have been institutionalized throughout our history. In an economy where the wind has *always* blown from the East, the reduction of financial dollarization is a long-term challenge, which goes beyond the mere adoption of the monetary-exchange rate regime, to encompass the entire economic development strategy.

Appendix I

Financial assets of Argentine non-financial private sector

The first database collects information from the Central Bank of Argentina, the National Secretariat of Finance and the National Directorate of International Accounts of INDEC[23] presented in Table 1 to analyse the composition of the main assets of the Argentine non-financial private sector and, in turn, the temporal evolution of the financial dollarization coefficient.

Calculation of real returns

The second database consist of the monthly evolution of real returns for the period 1939-2020 of the fixed term deposit denominated in pesos (equation (5)) and the holding of foreign assets (equation (6)) with the aim of analysing the way in which economic agents generate their expectations when deciding the portfolio composition in Argentina.

The (ex-post) real return of domestic asset with monthly compounding and time portfolio maintenance h is calculated as:

$$r_{t,h}^{ad} = \left(\frac{\prod_{j=t-(12\times h)-1}^{t-j}(1+i_j^{ad})}{\prod_{j=t-(12\times h)}^{t}(1+\pi_j)} \right)^{\frac{1}{h}} - 1 \tag{5}$$

where i_j^{ad} is the monthly nominal interest rate of a fixed term deposit in pesos at 30-59 days published by the BCRA and π_j is the monthly inflation.

On the other hand, the (ex-post) real return of foreign assets with monthly capitalization and portfolio holding time h is:

$$r_{t,h}^{aext} = \left(\frac{\prod_{j=t-(12\times h)-1}^{t-j}(1+i_j^{aext}) \prod_{j=t-(12\times h)}^{t}(1+e_j)}{\prod_{j=t-(12\times h)}^{t}(1+\pi_j)} \right)^{\frac{1}{h}} - 1 \tag{6}$$

where i_j^{aext} is the monthly interest rate of a United States Treasury bond to a one-year term and e_j the monthly depreciation rate.[24]

[23] Specifically, the International Investment Position.

[24] In periods in which there was a split in exchange rate market, the prices are taken from the parallel market.

Utility function

To solve the optimal portfolio share w in equation (1), we assume a negative exponential utility function in returns of the type:[25]

$$u(w'r) = -e^{-\lambda[1+w'r]} \tag{7}$$

Where λ is absolute risk aversion coefficient. We solve the problem numerically using the empirical distribution of $\hat{\theta_1}$ and $\hat{\theta_2}$ which results from sampling $1,000$ observations of the normal distributions θ_1 and θ_2 which parametres mean and variance corresponds to the actual observed data. Thus, the optimization problem in equation (1) can be written as:

$$max_w U = \pi \frac{1}{n_1} \sum_{i=1}^{n_1} -e^{-\lambda[1+w'r]} + (1-\pi) \frac{1}{n_2} \sum_{i=1}^{n_2} -e^{-\lambda[1+w'r]} \tag{8}$$

where n_1 and n_2 are the observations of real returns composing the empirical distributions $\hat{\theta_1}$ and $\hat{\theta_2}$, respectively (with $n_1 = n_2 = 1,000$).

[25] This is a utility function usually used in the literature. The results obtained are not substantially modified when using alternative utility functions (i.e. constant relative risk aversion).

Appendix II. Brief description of selected episodes

The seven episodes of exchange rate correction selected correspond to significant changes in monetary-exchange rate regimes in force. Naturally, they do not exhaust the universe of exchange correction experiences in Argentina, but they constitute a representative sample of the heterogeneity of regimes experienced in our country and the high frequency with which changes in operating schemes occur. The experiences also illustrate the bias observed in the exchange rate variability throughout our history. The reader should keep in mind that the change between periods that define the validity of the regime and posterior correction, not necessarily correspond to the date on which the upward movement is observed in the official parity. This is due to two reasons. In the first place, the composition of real returns we are working with is free dollar price. Sometimes the correction on the official dollar was anticipated by this price, observing an increase during the months prior to the exchange rate episode. Second, the goal of the second distribution is to capture the regime change environment and not strictly the period that follow the correction.

1. The first episode is the exchange correction that occurred in September of 1949, within the framework of the change in bias policy carried out between 1949 and 1952 to reduce inflation rate. In this episode we define the distribution corresponding to the regime in force prior to the correction as that defined between February 1939 and April 1948. On the other hand, the sample corresponding to the new scheme (abandonment of the previous scheme) it is defined by the period between May 1948 and February 1952.

2. The second episode corresponds to the "Stabilization and Development Plan" launched on December 29, 1958 during the administration of President Frondizi. The program included the release of the foreign exchange market. At the time of the plan launch, the gap between the official market and the free market amounted to 292%. In terms of the evolution of real returns, the period covered by the Frondizi administration prior to the exchange rate shock does not differ significantly of the period between mid-1952 and May 1958. Consequently, we define the regimen distribution as that observed between March of 1952 and June of 1958, while the distribution corresponding to its abandonment (new regime) is defined between July 1958 and June 1959.

3. The third episode corresponds to the exchange rate crisis that took place in March 1962, in the framework of the impeachment of President Frondizi. The representative distribution of regime in force until this critical episode is defined by the period

covered between July 1959 and March 1962. On the other hand, the regime crisis period is defined between April and December, 1962.

4. The fourth experience corresponds to the crisis of financial liberalization process carried out in the second half of the 1970s. In this case, the distribution associated with the operation of the regime extends from January 1977 to March 1981. This period is longer than the stage in which the crawling peg scheme (known as "Tablita") was established between January 1979 and April 1981. Mainly the stage that characterizes the regime captures the exchange rate appreciation associated with capital and financial account liberalization. On the other hand, the regime crisis distribution covers the period between April 1981 and August 1982, characterized by the high frequency and magnitude of devaluation events.

5. The fifth experience corresponds to the exhaustion of the "Economic Reform Plan" announced in June 1985, informally called the "Plan Austral" in reference to the monetary unit created as part of it. We will consider real returns distribution in the successful phase of the stabilization plan the months between June 1985 and August 1986. On the other hand, the distribution corresponding to the plan exhaustion period covers the period between September 1986 and December 1987.

6. The sixth experience corresponds to the Convertibility regime. The pre-crisis distribution includes the period that extends between May 1991 and November 2001. The crisis distribution if defined by the period December 2001-December 2012.

7. The last experience considered corresponds to the devaluation episodes that occurred since April 2018. In this case, the period of regime stability covers the months between January 2016 and March 2018. The distribution of regime change extends from April 2018 to November 2019.

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