Exchange Rate Controls and Foreign Reserves[*]

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Abstract

We study the impact of multiple/parallel exchange rate markets. As controls on the exchange rate are often imposed to avoid a currency crisis we study their impact on foreign reserves using Argentina as a natural experiment. We design a Synthetic economy without exchange rate controls and compare it to Argentina. We show evidence that the 2011 controls were largely unexpected. We find that exchange rate controls reduce the accumulation of foreign reserves, contrary to their proclaimed objective. Quantitatively, Argentina's external reserve in 2014 were 40% smaller than those in the economy without the exchange rate controls.

Keywords: Dollar Clamp; Exchange Control; Multiple Exchange Rates; Synthetic Control Method; Distortions.

JEL Codes: C22; C54; F41; F31.

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1 Introduction

The nominal exchange rate is a key price as it determines how many units of foreign currency do agents need to purchase one unit of domestic currency. As such, the stabilization of the nominal exchange rate is often an important objective for central banks in open economies and specially those of emerging markets, which are particularly exposed to its variability. The reason of this exposure comes from the fact that some foreign currencies, i.e. the US dollar, are the unit of denomination of international trade and in many cases is also the currency at which the private and the public sector issues foreign debt (a phenomenon known as liability dollarization). To stabilize the exchange rate, historically, countries have relied on the use of exchange rate controls (over quantities and prices) and open market operations using foreign reserves. Additionally, for this last reason, accumulating large levels of foreign reserves has also been an objective in emerging economies, particularly because of the role the literature has identified in the dynamics of self-fulfilling currency crisis.

This paper uses Synthetic Control Methods to study whether exchange rate controls are efficient measures to accumulate or sustain the level of foreign reserves. We use the introduction of exchange rate controls in Argentina in the third quarter of 2011 as a natural experiment. We argue that, even though Argentina had introduced various capital controls before, the introduction of exchange rate controls was fairly unexpected, then we design a counterfactual economy without exchange rate controls and we study the evolution of foreign reserves in both economies.

We find that exchange rate controls of the type introduced in Argentina had a negative effect on the accumulation of foreign reserves that more than compensates for any potential benefit. As a consequence, after 2011 Argentina lost reserves at a fast pace since its introduction until 2014 while the counterfactual economy experiences a mild accumulation of reserves. Moreover, we also show that at the abandonment of the exchange rate controls, in 2015, the level of reserves in Argentina jumps almost to the same level of the reserves in the counterfactual economy.

The dynamics of foreign reserves and the level and volatility of the exchange rate are closely related. This is a fact that has been analyzed by an extensive literature in international macro. The first and second generation models of currency crisis demonstrate the importance of foreign reserves to defend and sustain the exchange rate. These models highlight different reasons for the occurrence of a currency crisis. First generation theories of currency crisis, for instance Krugman (1979) or Flood and Garber (1984), highlight the role of fiscal and monetary policy tensions. While the fiscal policy runs a primary deficit, the monetary policy intends to peg the exchange rates. The lack of coordination of the fiscal and monetary authority drives the economy to a currency crisis as the monetary authority uses the foreign reserves to sustain the exchange rate while the reserves last. Instead, second generation models as in Morris and Shin (1998), suggest that currency crisis may be originated by informational frictions. Under certain configurations, as discussed by Disyatat (2001) foreign reserves may help avoiding self-fulfilling currency crisis. Indeed, more recent theories indicate that it may be optimal to accumulate reserves in the context of multiple equilibrium. Nevertheless, the recent acceleration in the accumulation of reserves raised several questions. Rodrik (2006) suggests that accumulating reserves is socially costly and points to the following puzzle, why to accumulate reserves instead of reducing the level of external debt? Obstfeld et al. (2008) and Obstfeld et al. (2010) discuss the role of foreign reserves in a context of financial fragility and finds that a model of financial fragility can explain part of this accumulation. Barbosa-Alves et al. (2024) studies the optimal reserve accumulation when countries have external debt in a model with multiplicity as in Cole and Kehoe (2000) and find that reserve accumulation may be optimal to avoid the economy exposure to self-fulfilling equilibrium.

The level of foreign reserves matters both as a hedge in the presence of liability dollarization and also to control expectations of currency depreciation. A large level of foreign reserves suggests the government can defend the exchange rate from speculative attacks. Clearly, this is less the case for cases that fit the first generation theories of currency crisis, Krugman (1979), but more for cases were the currency crisis comes from equilibrium multiplicity. For instance, for these reasons, Emerging economies have introduced various forms of exchange rate controls over time with the objective of accumulating or defending the level of foreign reserves. As described in Schmitt-Grohé and Uribe (2023) and Ilzetzki et al. (2019), in recent years, about 20 percent of the countries have had multiple exchange rates. Moreover, parallel or multiple exchange rate markets are not new and have been implemented at least since the 1930s in many Latin American economies.

Why do practitioners consider exchange rate controls a tool for accumulation of reserves? In principle, we can think about two reasons: first, in the context of currency crisis as in Krugman (1979), using foreign reserves to sustain the exchange rate is futile. Eventually the monetary authority will run out of reserves and will be forced to let the exchange rate float. Hence, one way to avoid the outcome is to introduce a parallel exchange rate market. The second channel is that in the formal exchange rate market, the government can buy foreign reserves from exporters at the *official* exchange rate, a more convenient price than the one of informal or unregulated markets. Hence, the government is not forced to sell reserves to sustain a parity and can use it to purchase foreign reserves at a low price.

On the other hand, exchange rate controls may have a negative effect on the accumulation of foreign reserves. These controls distort the economy in several ways. As usually implies that the government will buy foreign currency at below market prices, they are in fact a tax on exports and a subsidy on imports. Perceived to be sustained over time, they may induce a misallocation of resources from the exporting sectors to non-tradables. Moreover, as they are implemented in the context of rationing, they may be rationed in an ad-hoc basis, distorting differently different types of exports and imports. Importantly, as these controls matter more when the governments implement them in a context of a crisis, they tend to be associated with higher depreciation expectations as the implementation of these controls contribute to the accumulation of distortions. Hence, exchange rate controls may increase imports and reduce exports, and induce a delay in exporting. In that way, can have a negative effect on reserve accumulation.

We relate to an extensive literature that has studied exchange rates and exchange rate regimes. Recently, Ilzetzki et al. (2019) provides a comprehensive cross-country analysis of exchange rate regimes and exchange rate anchors since the abandonment of the Bretton-Woods. They show that about 20% of the economies have dual, multiple or parallel exchange rate regimes, similar to the episode we analyze in this paper. Exchange rate management seems to be the norm rather than the exception.

More theoretically, Schmitt-Grohé and Uribe (2023) studies the fiscal and macroeconomic impact of exchange rate controls using a general equilibrium structural model. They also provide a normative analysis regarding the optimality of these arrangements to finance an exogenous stream of government spending. They find that exchange rate controls as a fiscal instrument implies welfare losses. Our motivation and objective are in line with those of this paper as the authors focus on the fiscal implications of exchange rate controls and have in mind the same country episode.

Our analysis is complementary to theirs as our approach is rather agnostic and purely empirical and focus on the impact of exchange rate controls on foreign reserves.

Also related to the episode we study here, Mosquera and Sturzenegger (2021) build an equilibrium model to study the impact of exchange rate controls that works as a tax to exports and subsidy to imports. Espino et al. (2023) introduce capital controls and exchange rate controls in the Krugman (1979) environment to study the crisis dynamics. Instead, our paper sheds light on the quantitative effects of the policy from a purely empirical approach.

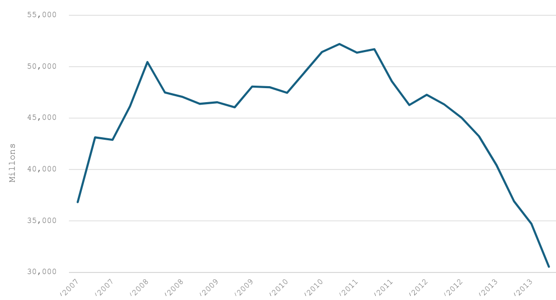
The remainder of the paper goes as follows. In Section 2 we describe the context in which the government implemented the first exchange rate control of our sample in 2011 and its main features. Section 3 describes the empirical strategy, the data and model specification. Section 5 presents the main findings of the paper. Section 6 provides a few exercises to study the robustness of the main findings. Finally, section 7 concludes.

2 The macroeconomic context

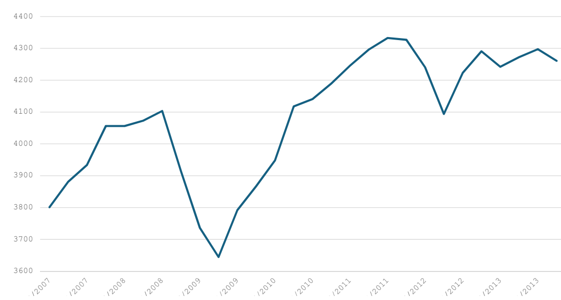
The end of 2001 and beginning of 2002 were turbulent times in Argentina. The Convertibility program, the stabilization plan implemented in 1991, was abandoned in the context of massive violation and renegotiation of many economic contracts, a 300% devaluation of the currency and one of the largest sovereign default episodes at that time. The crisis required a major re-organization of the economy and its institutions and a strong cleaning of the balance sheets of all the economic actors. The process was somewhat finished around 2003 where the economy started to grow again as a rebound from the crisis and in a context of very favorable terms of trade that helped the economy attain sovereign and external surpluses that lasted until 2010.

Argentina started the 2011 with strong signs of stagnation, 25% annual inflation rate, increasing loss in foreign reserves and twin deficits, public sector and external deficits. There was also an acceleration of capital control measures as the economy was deteriorating and the exchange rate was appreciating in real terms, see Fernández et al. (2015). In this context the government introduced restrictions to who could purchase foreign currency from the government at the official exchange rate and the maximum quantity per month. This is the so-called "cepo cambiario", introduced after an increase in capital outflows, Mosquera and Sturzenegger (2021). The macro performance around the introduction of the exchange rate controls is in Figure 1.

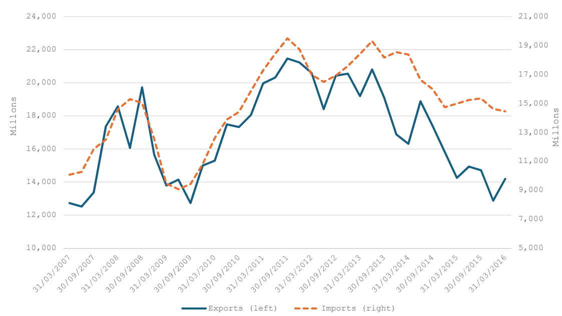
After a rebound from the crisis, the per capital GDP stagnated in the mid 2011 while the economy started to loose foreign reserves. In this context, there was a sharp deterioration of the exports and a milder fall of imports related to the lack of macroeconomic growth. These negative trends were prevalent until the end of the Peronist administration in 2015.



(a) Foreign Reserves



(b) GDP Per-Capita



(c) Exports and Imports

Figure 1: Argentina's Macroeconomic Context

Note: The figure presents the data for foreign reserves in millon of USD, GDP per-capita in constant LCU, and Imports and Exports in millon of USD. Data is from Macrobonds and IMF-IFS datasets.

The restrictions affected the market value of foreign currency and the expectations about its future price. The figure 2 presents the exchange rate gap. The difference between the market exchange rate (computed using the implicit exchange rate using ADRs of equity that are traded both domestically and in the US stock market) and the official exchange rate from 2003 to 2024.

The imposition of exchange rate controls and its market implication can be seen as a widening of the gap, that occurred since the beginning of 2012 until the end of 2015, when the Macri's administration started and lifted the controls, and the end of 2019 until the current days.

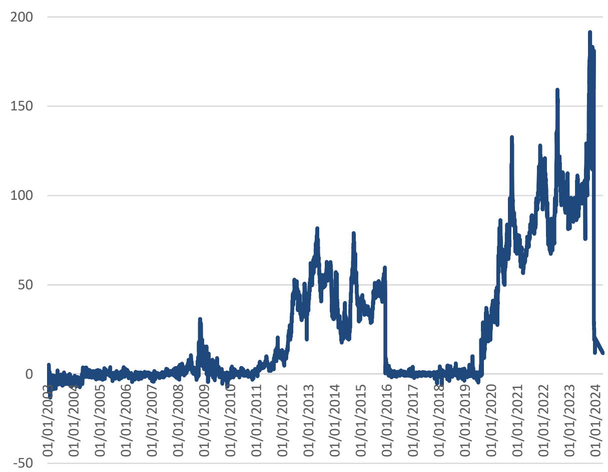


Figure 2: Exchange rate gap (Argentina 2003-2024)

Note: percentage difference between the implicit exchange rate computed using the Argentinean ADRs and the official exchange rate (in %). Source: Ministerio de Hacienda, Argentina.

The restrictions to access the foreign currency market were largely unexpected in both the 2011 and the 2019 cases. To show this we present in the Figure 2 evidence from Google Trends that collects all google searches associated to the term "Cepo Cambiario" during the last twenty years.

The figure presents the searches of the term "cepo cambiario" in every period relative to the period with the maximum number of searches that correspond to the abandonment of the first period of exchange rate controls, in December 2015. The figure also indicates the starting of the 2011 and 2019 exchange rate controls and the period of abandonment in 2015. As seen, these periods correspond to the periods of widening of the exchange rate gap in figure 2. The most important piece of information is the figure, is that before the end of 2011 there are no searches of the term "cepo cambiario" which suggest there was no anticipation by the private sector of such an event. Similarly, there is not much action before the start of the exchange rate control in 2019 as

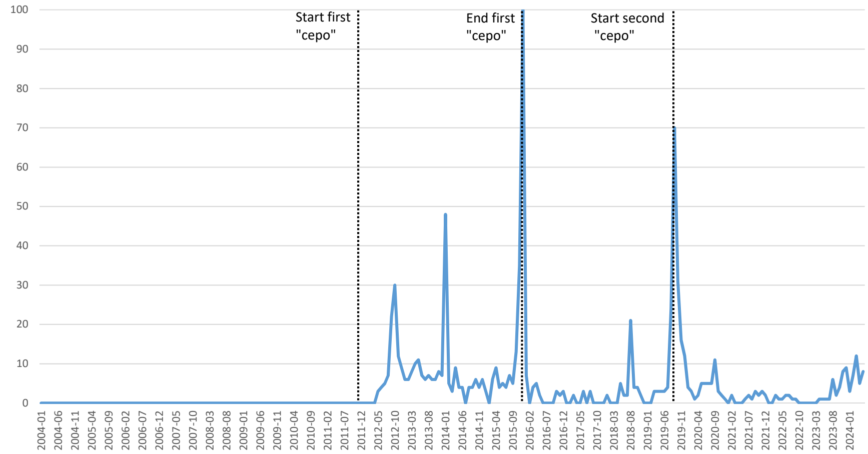


Figure 3: Search for ”cepo cambiario”

Note: Data is from Google trends. On the vertical axis we have the searches in google of the term “cepo cambiario”. The axis indicates the numbers of searches relative to the maximum number of searches. That is, in 2015 with the “End first cepo” there is the maximum number of search for the term in our sample. Hence, the index is 100%. All other periods the series present the number of search relative to this maximum.

the peak of the searches occurred at the start, not before. We find similar evidence searching for other terms such as “control del cambios” (exchange rate control), “tipos de cambio” (exchange rates) and others.

3 Empirical Methodology

The key objective of the paper is to assess the impact of the exchange rate control in the accumulation of external reserves. To this purpose, we use the Synthetic Control Method (SCM), a methodology developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010). We present here a short review of the methodology that follows Galiani and Quistorff (2017).[1]

Intuitively, we have a country (unit 1) that implemented a policy in a given period, i.e. the intervention. Additionally, we have a set of other countries (units 2 to J) that did not. The objective of the methodology is to construct a counterfactual economy using the information of the countries

[1]For a detailed presentation of the methodology we refer the reader to these sources.

that did not suffer the intervention that mimics the behavior of the treated unit before the policy intervention. To do so, we weigh the different countries optimally. With those weights fixed, we simulate the counterfactual economy after the policy intervention and compare it to the treated economy. The differences, if any, come from the intervention. In that way, we can assess the causal impact of the intervention on the variable(s) of interest.

Formally, the SCM assumes that the data of interest follows the following data generating process:

$$Y_{jt} = \alpha_{jt} D_{jt} + Y_{jt}^{N},$$

with

$$Y_{jt}^{N} = \delta_t + \theta_t Z_t + \lambda_t \mu_j + \epsilon_{jt}.$$

Here D_{jt} is an indicator of the intervention, which depends on the unit j and period t. Y_{jt} is the actual observed data of interest and Y_{jt}^{N} is the variable of interest in the counterfactual case for the untreated synthetic unit. The variable Z_j is a vector of covariates (observed), δ_t is a time factor. λ_t and μ_j are unknown factors and loadings and ϵ_{jt} are errors, independent over time and units.

In our case, we have a single unit with a intervention, Argentina in 2011Q3. Suppose we have a matrix of donors $\mathbf{Y_0}$ of dimensions T times J. This object contains all observables for all units except the one that suffered the intervention, for the whole sample (pre- and post- intervention). We want to construct a weighted sum of donors $\mathbf{WY}$ that represents the pre-intervention features of the intervened unit. Let $\mathbf{X}$ represent a matrix of predictors that include the $\mathbf{Z}$ and pre-intervention $\mathbf{Y}$. The SCM aims to identify a matrix of optimal weights for the observations and the relative significance of the predictors such that the treated unit and the synthetic (counterfactual) look similar in the pre-intervention period.

Hence, this method minimizes the root mean squared prediction error (RMSPE) of the pre-treatment characteristics ($\mathbf{X}$): $\|\boldsymbol{X}_1 - \boldsymbol{X}_0 \boldsymbol{W}\|_V$, where the treated unit is the first unit. With $\mathbf{V}$, a matrix of the relative importance of the predictor variables, chosen as it approximates to zero the difference between the pre-treatment RMSPE of the variable of interest from the unit under treatment and the control variable created by the synthetic. Analogously,

$$\|\overleftarrow{Y}_1 - \overleftarrow{Y}_0 \mathbf{W}\| = 0 = \|\mathbf{Z}_1 - \mathbf{Z}_0 \mathbf{W}\|$$

.

Thus, the estimated effect of the intervention, $\hat{\alpha}_{1t}$, is the difference between the observed outcome for the treated unit ($\mathbf{Y}_{1t}$) and the predicted outcome constructed using the Synthetic Control ($\sum_{j\geq 2} w_j Y_{jt}$).

$$\hat{\alpha}_{1t} = \mathbf{Y}_{1t} - \sum_{j\geq 2} w_j Y_{jt}$$

In our analysis, $\hat{\alpha}_{1t}$ represents the difference between the observed evolution of foreign reserves in Argentina -the treated unit- and the counterfactual economy constructed using SCM. That effect is attributed to the intervention, the introduction of the "cepo cambiario".

4 The model

This section provides a discussion of the structural models that support the reduced-form equation that we use in the SCM design. We start from the following Balance of Payments accounting identity:

$$E_t \Delta R_t = (GNP_t - C_t - I_t - G_t) - E_t(\Delta F_{p,t} + \Delta F_{g,t})$$

Here, E_t denotes the nominal exchange rate, ΔR_t is the change in foreign reserves position of the government, $CA_t = GNP_t - C_t - I_t - G_t$, denotes current account, the gross national product net of private consumption and investment, and net government spending, in our formulation expressed in domestic currency. The second term, $KFA_t = \Delta F_{p,t} + \Delta F_{g,t}$, the net position of the capital and financial account that is ultimately determined by the accumulation of foreign assets (net) for the government and the private sectors.

The balance-of-payments (BoP) equation highlights that foreign reserve accumulation and the exchange rate are related to public and private choice variables. The government deficit summarizes the way government decisions impact on their net asset formation that directly contributes to the acquisition of foreign reserves. The relationship between external reserves and primary deficits is central to the argument of the First Generation Models of currency crisis, see Krugman (1979). In this literature, a fixed exchange rate regime is not sustainable due to an inconsistent fiscal policy that runs perpetual deficits and a monetary policy that intends to defend the value of the exchange rate. This literature and the BoP equation motivates the inclusion of the primary deficit to the reduced form model of reserve accumulation.

For the case of Argentina, the primary deficit, reserves accumulation and the nominal exchange rate have been following inconsistent dynamics for a long time before the introduction of the exchange rate controls. This is, indeed, one of the motivations the government had to introduce exchange rate controls suggesting that the fiscal deficit may be a relevant variable to consider in the reduced form model.

We use two additional variables to further characterize the fiscal side of the economy: the stock of money and the inflation rate. This is not, at first sight, on the BoP equation but, in fact, these objects represent an important source of government resources in the case of Argentina for the period that followed the 2001 crisis. Since 2001, Argentina has relied substantially on seigniorage as a source of financing. Hence, money demand, captured by M_2 is included in the reduced-form model. Similarly, the inflation rate as a determinant of the inflationary tax and a signal to capture misalignment between money demand and supply, is also included. The relationship between these variables and the sovereign deficit, that is, public savings, has been largely studied; see Cagan (1956). In this classical article, Cagan studies the dynamics of seigniorage and hyperinflation when the government has limited access to bond financing and highlights how determinate the primary deficit can be in nominal dynamics.

We consider two additional variables to capture the behavior of the private sector towards foreign reserve accumulation. The first one is the Current-Account, that appears directly in the BoP equation. Improvements in the Current-Account happens through higher exports, lower imports or higher returns on the external asset position: any of these drivers increase the foreign currency received by domestic agents. The second one is the price of exportables, particularly, commodity prices of exportables that played a key role in Argentina in the 2003-2010 expansion. In Argentina, exporters have to sell their USD position to the government at the official exchange rate and the government can buy it with primary surplus or using seignoriage. The lower is the official exchange rate compared to what the market would expect in the context of exchange rate controls, the harder will be for the government to acquire foreign currency. For this reason, the market exchange rate is also a relevent regressor for the reduced form model.

Our model uses as predictors four lags of the log of reserves, the current and three lags of the current account to output ratio, and the deficit to output ratio. For all the remainder of the variables we include the current and one lagged value. We also use the dependent variable in the third and fourth quarter of 2008, and those for 2010Q1 to 2011Q2.

Data and sample

We use a cross-country sample of data at a quarterly frequency. Our sample goes back to 1995 but as Argentina had a major macroeconomic crisis in 2001/2002 that implied a significant change in the data generating process, we start the pre-intervention sample in 2002, that is 9 years before the intervention. Moreover, as there is a second control over the exchange rate in 2019, we will use post-intervention data until 2017.

The data is mostly from Macrobonds and the IMF. A detailed source and description of each data is in the appendix. After cleaning the data, we have 36 countries. The outcome variable is the natural log of foreign reserves, measured as the total international reserves (including gold) in US dollars. Our variables are the natural logarithm of reserves, GDP, the Current account to output ratio, M2, primary deficit to output ratio, inflation rate, the nominal exchange rate and the terms of trade.

Attending to the data sources, we collect information about the covariates as follows. The inflation rate is the year-over-year (YoY) percent change of Consumer Prices, from Macrobond, IMF-IFS, for all countries except Argentina. We used the alternative price indices provided by InflacionVerdadera.com for the period 1995 to 2017 due to the manipulation of official statistics by Argentina's government from 2007 to 2015. From Macrobond, we also collected M2 in USD from National sources; the primary deficit to output ratio as the primary balance provided by the Cross Country Database of Fiscal Space of the World Bank; and the GDP in current prices (USD) was sourced from the Global Economic Monitor (World Bank) but for some countries, where no data was available from the World Bank, we got the GDP from National sources. Other data from IMF-IFS are included, the nominal exchange rate as the quarterly national currency per U.S. Dollar (period average) and the current account in millions of USD from IMF. Additionally, from the World Bank, we obtained the terms of trade, defined as the net barter terms of trade index (2015 = 100) (TT.PRI.MRCH.XD.WD).

Since we use quarterly data to analyze short and medium-term effects, we interpolated the primary balance and terms of trade from annual to quarterly frequency. For interpolation, we apply the Chow-Lin method (Chow and Lin (1971)), which transforms low-frequency time series data into high-frequency data by estimating a regression model. Thus, the regression is constructed by making the low-frequency (annual) series dependent on the high-frequency (quarterly) series, and then using the coefficients of the regression to project and distribute the low-frequency data over the high-frequency periods. This method ensures that the interpolation is consistent with the temporal structure of the original data.

The donor pool includes: Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom and Uruguay.

5 Results

As discussed in the previous section, the methodology weights the information contained in the donor pool to produce a pre-intervention trend for the set of donors that mimics as much as possible the one of the unit that suffered the intervention, in this case Argentina. Table 1 shows the set of donors with positive weights that help replicate the trend of the variable of interest, in our case the log of external reserves.

As the table shows, the algorithm assigns positive weights to a set of countries that includes both developed and emerging economies. The period 2003-2007 was one of large accumulation of foreign reserves combined with the commodity boom. It is not surprising that the algorithm weights countries that to some extent were also beneficiaries of this cycle. Peru, Ecuador and Russia are the two more important countries to mimic the pre-intervention trend and share the exposure of the economy to commodity exports whose prices increased during the commodity cycle and are also emerging economies.

Figure 4 plots the log of the foreign reserves for Argentina with a blue line (treated unit) together with the counterfactual Argentina (Synthetic Control) in red. The vertical line indicates the

Unit	Weight
Ecuador	0.144
Hong Kong	0.077
Norway	0.084
Peru	0.456
Russia	0.137
United Kingdom	0.103

Table 1: Optimal weights for the synthetic pre-trend

Note: optimal weights implied by the Synthetic Control Method. We only include in the table the countries with non-negligible weights.

intervention period, i.e. the moment when the government introduced the exchange rate controls, the third quarter of 2011.

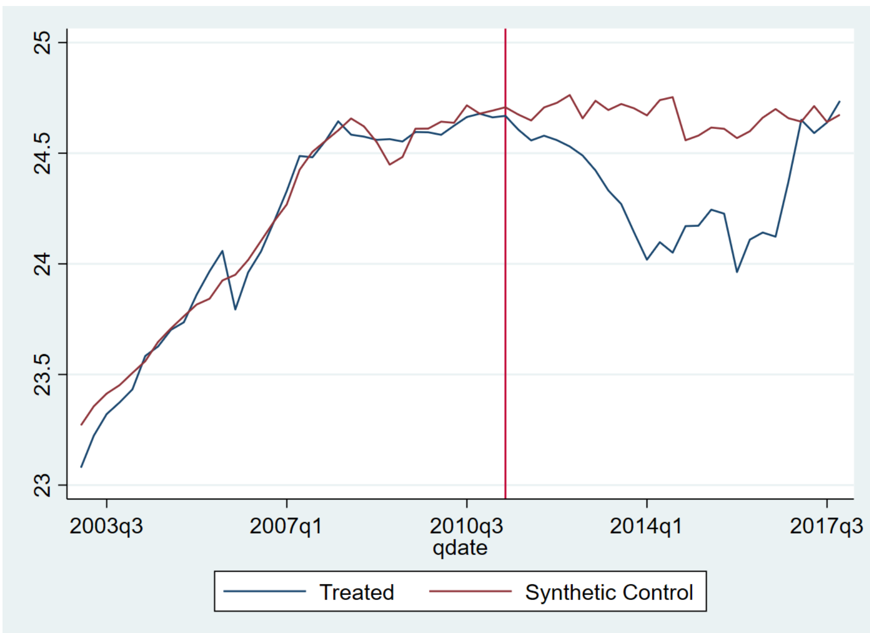


Figure 4: Synthetic control analysis

Note: The vertical axis measures the foreign reserves of Argentina (blue) and Synthetic Argentina (red) in natural logarithms. The red vertical line indicates the introduction of exchange rate controls in 2011Q3.

The figure shows that the model produces an accurate pre-intervention trend as it coincides with the one observed for Argentina before the third quarter of 2011. When the first measures of exchange rate control are introduced in that period, the foreign reserves in Argentina starts falling compared to the counterfactual Argentina.

Economically, this result sheds light of the impact of exchange rate controls on foreign reserves accumulation. It is often suggested that this type of controls are introduced to defend the level of foreign reserves, let the central bank accumulate them or avoid their loss. However, as it is clear from the figure, the set of exchange rate controls introduced in Argentina produced the opposite effect. The counterfactual economy indicates that the introduction of the exchange rate control reduced the log reserves in 20%. In levels, Argentina reserves are 40% lower than those of the Synthetic Unit.

An important finding of the figure is the convergence between the reserves of Argentina and the counterfactual case in the late 2016. As seen in Figure 3, Argentina lifted the restrictions of the first "Cepo" at the end of 2015 and beginning of 2016 with the change in the administration of the government. This policy change induced a strong accumulation of reserves. As seen in the figure, Argentina downward trend in the log reserves reverts suddenly and catches up with the synthetic control unit in about a year from the elimination of the exchange rate controls.

As discussed in the introduction, there are various arguments on the efficiency of exchange rate controls as an instrument to accumulate foreign reserves. Our findings suggest that the exchange rate controls have a negative impact on the foreign reserves. We hypothesize on two channels: (1) there are limits to the government's ability to purchase foreign reserves because the private sector expects a currency depreciation and, as such, hoards foreign currency; and (2) there are increasing pressure over the demand of foreign currency by the private sector: as the private sector expects a depreciation of the currency will try to anticipate imports and anticipate the payments of dollarized debt. This pressures up the demand by the private sector crowding out the government demand that happens at the official rate.

Our interpretation of the results can be framed into the literature of temporariness of macroeconomic policies, see Calvo (1986), and anticipation of currency devaluations, as in Feenstra (1985). This literature highlights the importance of anticipation by the private sector. Particularly, the fact that the policy is known (or expected) to be temporary affects the behavior of the private sector. Specifically, the widening of the gap between the observed dynamics and the counterfactual happens because exported, expecting an abandonment of the exchange rate control, delays exports and the selling of foreign currency to the government, there is lower supply of foreign currency, reflected in the increasing exchange rate gap for the same period, shown in Figure 2. Additionally, also expecting an abandonment of the controls, the importers accelerate imports implying an increase in foreign currency demand, contributing to the increase in the exchange rate gap. Eventually, when the exchange rate controls are abandoned, the foreign reserves for Argentina jumps to the level of its counterfactual. At this point, the exchange rate gap vanishes.

Figure 5 presents the standardized p-values of the exercise. This figure shows the probability that the differences between the observed and counterfactual economies arise by chance. As observed in the figure, even though the probability is relatively large during the first couple of periods after the introduction of the exchange rate controls it quickly falls reaching zero in about two years after the intervention. The reason for this is that even though there is a clear separation between the series at the intervention, the magnitudes are relatively small. The same happens by the end of the sample as the differences between the treated unit and the control disappear.

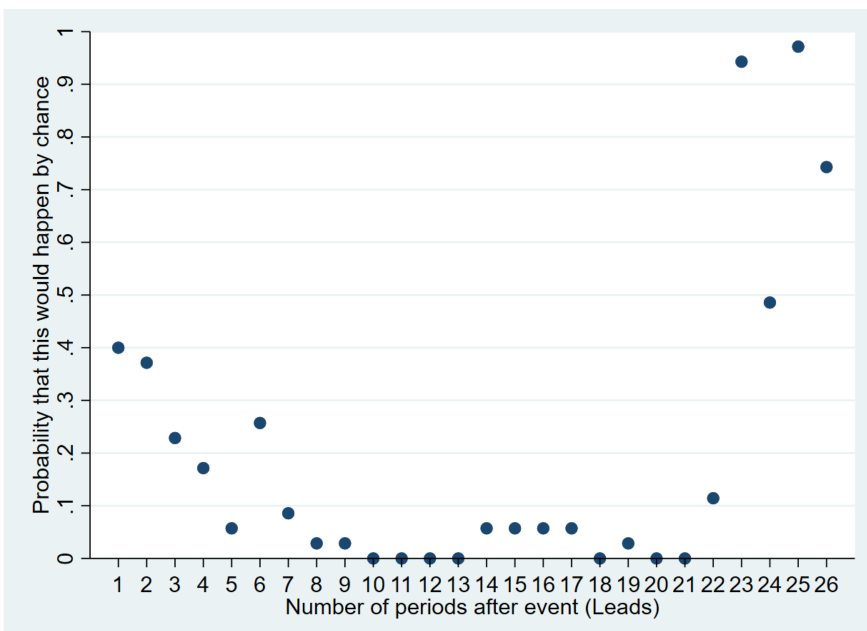


Figure 5: Probabilities that the differences happen by chance

Note: Standardized p-values. The points indicate for each period (x-axis) the probability that the differences between Argentina and the Synthetic unit arise by chance.

6 Robustness checks

The economic intuition behind the results presented in the previous section is appealing and the dynamics obtained by the counterfactual are plausible. Nevertheless, this section presents several exercises to show that our statistical results are robust. We present three robustness checks in this section: in time place analysis, and study the implication of removing some countries from our specification. Finally, we consider a sub-sample where we include only those countries that are Emerging Economies or share some clear features with the treated unit.

In Time Placebo

As a robustness check we do an in time placebo. Figure 6 presents the observed dynamics and the counterfactual ones when the intervention happens every quarter from 2010 to 2011Q2. We do this analysis to check whether the results remain when we go back in the sample.

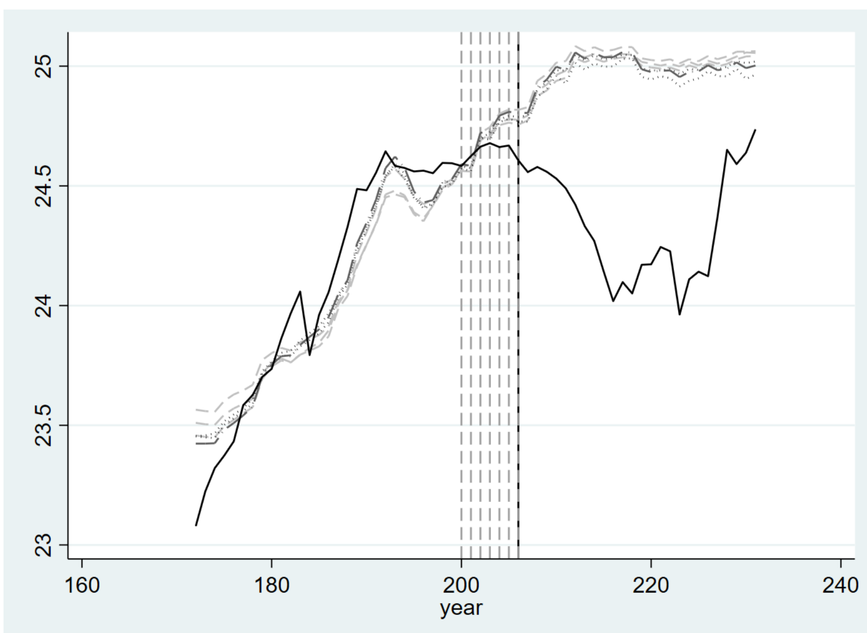


Figure 6: In Time Placebo

Note: The vertical axis measures the foreign reserves of Argentina (solid) and Synthetic Argentina (dashed, grey, dotted) in natural logarithms. The vertical lines indicate the placebo dates from 2010Q1 to 2011Q2. We also include a vertical line for the period of the introduction of exchange rate controls in 2011Q3.

To do this placebo we need, by construction, to slightly change the model as we need to remove the lagged values of the log reserves as predictors. We only keep those on 2008. As a consequence, the fit of the pre-trends worsens compared to the baseline model. Yet the post intervention gap between Argentina and the synthetic remains.

Leave-one-out robustness exercise

A standard exercise for this methodology is to see how robust the results are to the inclusion of certain units. We now repeat the analysis removing one of the units with positive weights at a time.

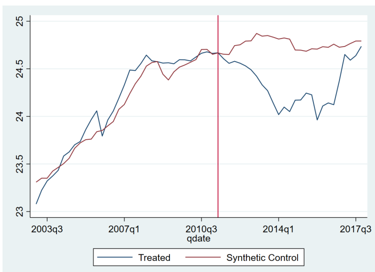
The results of the baseline analysis obtain a positive weight for six economies. Hence, we run six exercises. The results are in Figure 7.

As the figure shows, there is no specific unit driving the results. The pre-sample trends mimic the observed data and removing one country at a time does not affect the main results of the paper, the introduction of exchange rate controls drastically reduce the level of external reserves.

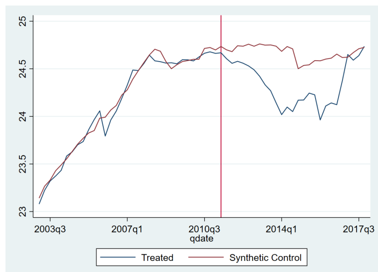
There is, however, some evidence that Peru has a stronger effect on the counterfactual dynamics. When we remove Peru from the sample the differences are slightly smaller than in the other exercises. However, the differences are still substantial.

Donor Pool of Emerging Economies

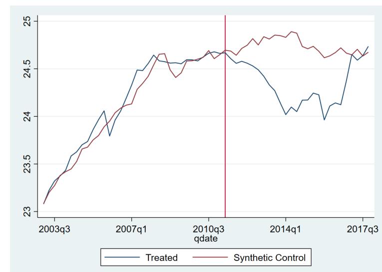
For the last robustness exercise we construct the synthetic economy considering only a set of Economies that are usually considered to share similar features with Argentina, mostly Emerging Economies. To this end, from the baseline donor pool we drop UK, Norway, Hong Kong, Denmark and Japan. In this way we keep a set of Emerging Economies (Brazil, Bulgaria, Chile, Colombia, Ecuador, Estonia, Georgia, Hungary, India, Indonesia, Israel, Mexico, Morocco, Nicaragua, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Turkey, Ukraine, Uruguay) and small developed economy (Australia, Canada, Sweden, Iceland).



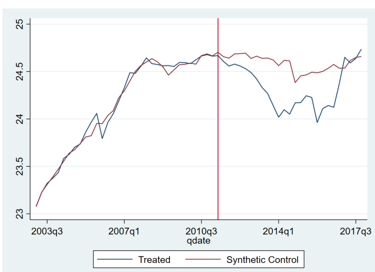
(a) Remove Ecuador



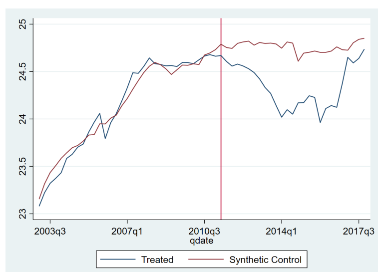
(b) Remove Hong Kong



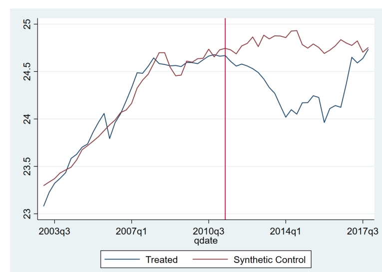
(c) Remove Norway



(d) Remove Peru



(e) Remove Russia



(f) Remove UK

Figure 7: Leave-one-out robustness exercise

Note: The vertical axis measures the foreign reserves of Argentina (blue) and Synthetic Argentina (red) in natural logarithms. The red vertical line indicates the introduction of exchange rate controls in 2011Q3. Each subplot presents a robustness exercise where we remove one country at a time from the donor pool.

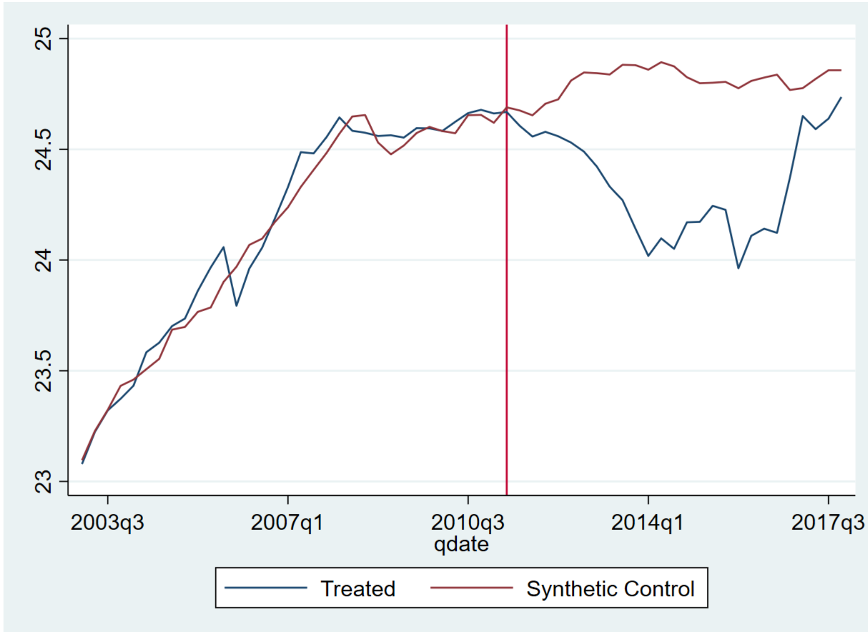


Figure 8: Synthetic control with a reduced set of countries

Note: The vertical axis measures the foreign reserves of Argentina (blue) and Synthetic Argentina (red) in natural logarithms. The red vertical line indicates the introduction of exchange rate controls in 2011Q3. The Synthetic Argentina only includes a subsample of the original set of donors as explain in the text.

Figure 8 presents the dynamics of foreign reserves for Argentine (as before in a blue line) and the Synthetic Argentina (red line) together with the period where the exchange rate controls were introduced for the case of a smaller donor pool were we consider only more similar economies. As seen in the figure the differences with respect to the baseline analysis are nil. The introduction of exchange rate controls seems to have a strong negative impact on the accumulation of foreign reserves.

Table 2 presents the optimal weights for this analysis. As seen, the counterfactual economy includes Ecuador, Russia and Peru, as in the baseline, but now there is substantial weight on Israel and Brazil, that was not in the baseline case.

Unit	Weight
Ecuador	0.247
Brazil	0.162
Israel	0.095
Peru	0.266
Russia	0.23

Table 2: Optimal weights for the synthetic pre-trend (reduced set)

Note: optimal weights implied by the Synthetic Control Method. We only include in the table the countries with non-negligible weights. The Synthetic Argentina only includes a sub-sample of the original set of donors as explain in the text.

7 Conclusions

Exchange rate controls are used by many countries. We use the case of Argentina in 2011 to study the impact of this type of government controls as a source of defending exchange rates via the accumulation of foreign reserves.

We find that exchange rate controls actually induce a country to loose foreign reserves. In particular, we show that in 2014, the level of foreign reserves in Argentina are 40% lower than the external reserves of the counterfactual economy without the intervention.

The economic intuition behind the loss of external reserves is as follows: introducing exchange rate controls induce agents to hoard the foreign currency, it may also incentivize importers to front load the imports in the expectation of the abandonment of the control in the near future. In a context where the government needs foreign currency to repay foreign debt and imports are accelerated, the exchange rate control does not reduce the need of foreign currency, but reduces the capacity of the government to purchase it. This ultimately dampens the accumulation of foreign reserves making costlier the sustainability of a given exchange rate level and accelerating the expectations of abandonment of the control. This interpretation is consistent with the idea of temporary stabilization policies.

We find that within a year of the abandonment of the exchange rate controls, the foreign reserve accumulation catches up with the counterfactual economy.

This evidence casts doubts on the efficiency of exchange rate controls as an instrument to sustain an exchange rate stabilization program.

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9 Appendix

We built our data set collecting data from multiple sources. For most of the countries in the dataset, GDP, exchange rates, the narrow monetary base, the current account balance, and the primary surplus of the government are from Refinitiv Eikon database. The original data comes in different format and currency: current nominal aggregates (CURN), current nominal aggregates seasonally adjusted (CURA) or constant aggregates seasonally adjusted (CONA). We rewrite all variables in domestic currency at constant prices and we remove seasonality for all the cases, except the current account that we write in USD.

We obtain the CPI and export price index from the IMF. The capital and financial account is also from the IMF.

For some series and countries we recovered some missing data from the domestic statistical offices.

A. SOURCES OF THE FOREIGN RESERVES DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	Macrobond, IMF international Financial Statistics (IFS)

Table 3: *Source of the foreign reserves*

The foreign reserves represent the total amount of international reserves held by a country, including gold, and are measured in current US Dollars.

B. SOURCES OF THE CURRENT ACCOUNT DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	IMF

Table 4: *Source of Current Account*

The current account captures all transactions within the balance of payments, including the export and import of goods and services, income payments, and current transfers between residents and nonresidents. The data is reported in millions of USD.

C. SOURCES OF INFLATION DATA

Inflation measures the annual (YoY) percentage change in consumer prices for all items in the economy. It is a key indicator of economic performance, showing how much consumer prices are increasing compared to the same period last year.

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay	IMF-IFS
Colombia, Hungary	IMF
Argentina	InflacionVerdadera.com

Table 5: *Source of Inflation rate*

Notes: Due to the manipulation of official statistics by Argentina's government from 2007 to 2015, we used the alternative price indices provided by InflacionVerdadera.com for the period 1995 to 2017. After 2018, we used the inflation rate provided by Latin Macro Watch Dataset.

D. SOURCES OF GROSS DOMESTIC PRODUCT DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	Macrobond, Global Economic Monitor (World Bank)

Table 6: *Source of GDP*

GDP is the total of gross value added by all domestic producers, plus product taxes and minus subsidies not included in the product value. This data is expressed in current USD.

E. SOURCES OF TERMS OF TRADE DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	World Bank

Table 7: *Source of Terms of Trade*

The net barter terms of trade (ToT) index is the percentage ratio of export unit value indexes to import unit value indexes, with 2015 as the base year. We interpolated the data from annual to quarterly frequency.

F. SOURCES OF PRIMARY DEFICIT DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	Cross Country Database of Fiscal Space (World Bank)

Table 8: *Source of Primary Deficit (% of GDP)*

The primary balance represents the budget balance of a government before accounting for interest payments, expressed as a percentage of GDP. It is a crucial indicator for evaluating whether a government is managing its fiscal policy sustainably in relation to its debt obligations. The data was interpolated from annual to quarterly frequency.

G. SOURCES OF THE EXCHANGE RATE DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay	Macrobond, IMF IFS
Argentina	datos.gob.ar

Table 9: *Source of Nominal Exchange rate*

Notes: For Argentina, we used as the measure of nominal exchange rate the implied exchange rate in ADRs data reported in the 'Apéndice de Información Económica al Día sobre Finanzas' on datos.gob.ar. We interpolated this data from a daily to a quarterly frequency.

The nominal exchange rate reflects the average number of units of national currency per US dollar over a quarter. In other words, it indicates the average amount of national currency required to buy one USD during the specified three-month period.

H. SOURCES OF MONEY SUPPLY DATA

Country	Source
Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Denmark, Ecuador, Estonia, Georgia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Mexico, Morocco, Nicaragua, Norway, Paraguay, Peru, Philippines, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, Ukraine, United Kingdom, Uruguay, Argentina	Macrobond, National Sources, Monetary Statistics

Table 10: *Source of Money supply (M2)*

M2 is the total money supply in an economy in current USD, including cash, checking deposits, and near-money assets such as savings accounts and time deposits.