Banks' Leverage in Foreign Exchange Derivatives in Times of Crises: A Tale of Two Countries

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Abstract

Before the outbreak of the Global Financial Crisis, on May 6, 2007, the Colombian central bank imposed a cap on the Gross Leverage Position in Foreign Exchange Derivatives of financial intermediaries. It was the only country in the world in implementing this prudential policy. By leveraging insights from synthetic control literature we construct counterfactual scenarios and show that this policy intervention, while costly in financial stability terms in the pre-GFC period, was effective in reducing Colombia's financial stability risks during the crisis. A trade-off between "calm" and "turbulent" periods emerges from our results, which should be taken into account when deciding on the right policy tools to use before a crisis breaks out.

Keywords: PBA, synthetic-control, macroprudential policy.
JEL: E58, E63, F38

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I. Introduction[1]

We examine the effects of the implementation of a macroprudential policy in Colombia on May 6, 2007, consisting of a cap on the banks' ratio of gross exchange rate derivatives to capital (PBA for its name in Spanish) of financial intermediaries. We analyze the evolution of Colombia's financial stability index constructed by UNCTAD (Bouhia *et al.*, 2022) after the implementation of the policy, and compare it with the evolution of a "synthetic Colombia" in which the PBA was not implemented. Comparing the results with those of a "placebo" test for Mexico, in the spirit of the synthetic control literature (Abadie *et al.*, 2010), we conclude that the effects of the policy can be divided into two parts: i) between its implementation and before the outbreak of the Global Financial Crisis (GFC) in September 2008, in which the policy resulted in a worsening of the country's financial stability conditions and, ii) after the crisis started, in which the policy acted as a shield that generated a notable increase in terms of stability compared to the counterfactual of no policy implementation. Inter-temporal aggregate gains from the policy are positive from the second quarter of 2007 to the last quarter of 2010.

The GFC was a powerful reminder that economic fragility can develop beneath the surface of apparently stable macroeconomic conditions. External and financial imbalances can silently develop during periods of sustained growth dynamics, calling into question the adequacy of conventional tools to monitor economic risks and assess longer-term financial stability. While major global crises are infrequent, the severe recessions they generate entail significant costs in terms of foregone income and persistently high unemployment, justifying efforts for developing better tools and policies for assessing and guaranteeing economic resilience.

One important source of macroeconomic vulnerability, especially in emerging market economies, relates to the volatility of large capital flows. While they can deliver substantial benefits for countries, they also have the potential to contribute to the buildup of large imbalances and systemic financial risk. The recent literature has shown that the benefits of capital flows are greater in countries in which institutional arrangements, and financial, macroeconomic, and fiscal policies enable them to intermediate capital flows safely (e.g., Igan *et al.*, 2016; Schroth, 2016).

Many countries have recently implemented reforms, including the development of macroprudential policies, that are helping to strengthen the resilience of financial systems to shocks, including those emerging from the volatility of international capital flows. Macroprudential policies, in support of sound macroeconomic policies and strong financial supervision and regulation, can play an important role in helping countries harness

[1] The opinions in this paper are those of the authors and do not commit FLAR or its directory board.

the benefits of capital flows, while reducing the negative effects related to their volatility. This is particularly meaningful in commodity-dependent economies in which these flows are strongly related to international commodity price cycles, such as Latin America and Caribbean countries.

Central banks have played a special role in building macroprudential policy tools for enhancing country resilience, especially through the implementation of prudential international capital control and the accumulation of international reserves. However, while necessary, policies for "having the house in order" are clearly not enough for strengthening economic resilience and reducing the vulnerability of small open economies to large external shocks and high capital flow volatility. The increasing level of financial globalization, which comes in hand with a larger volatility of economic and financial cycles (Rodrik, 1997; Scheve and Slaughter, 2001), demands the development of better insurance mechanisms against international shocks.

In the midst of a period of massive portfolio capital inflows, the central bank of Colombia implemented in May 2007 a heatedly debated prudential policy tool with the objective of reducing the country's vulnerability to a capital flows sudden stop. The policy tool, called the Gross Leverage Position in Foreign Exchange Derivatives, imposed a cap on a bank's ratio of gross exchange rate derivatives to capital. The Banking Association of the country protested the PBA, as they considered it an extreme measure that would not effectively control credit and counterparty risk in the banking sector and could instead limit the capacity banks had to offer firms and households reliable financial instruments to hedge against exchange rate risk.

The central bank, arguing that the PBA would limit the credit risk exposure of Colombian banks safeguarding the stability of the financial system, imposed a 500% limit to the PBA effective on May 6, 2007. In brief, the intention of this policy was to moderate the credit growth rate in Colombia, which according to central bank officials was too high and could lead to the development of undesirable financial sector imbalances and house price bubbles. While economic authorities in Colombia had already imposed a tax to foreign debt and to portfolio investment in the country one year before, these measures were not unique to the country as Brazil and Chile had undertaken similar policies at roughly the same time. The PBA, however, was implemented by Colombia alone. In fact, such a policy had never been implemented before in any other country. Our results show, however, that similar prudential policies can be successfully implemented in other small open economies when sudden capital inflow upsurges may threaten the stability of the financial sector.

While in various issues of the Financial Stability Report and in their report to Congress the central bank of Colombia assured this prudential policy tool fulfilled the purpose for which it was created, no formal policy evaluation was conducted to show the validity of their conclusion. To the best of our knowledge, there is only one paper formally studying the effectiveness of the macroprudential policy measures undertaken by the central

bank of Colombia between 2006 and 2007 (Gomez et al., 2020). However, they focus on two macroprudential policies, marginal reserve requirements and dynamic provisions. Their results suggest that dynamic provisions, the countercyclical reserve requirement, and an aggregate measure of the macroprudential policy stance had a negative effect on credit growth, which varies according to bank and debtor-specific characteristics. However, their results cannot be interpreted as causal because they do not use an adequate counterfactual analysis.

We evaluate the causal effect of the PBA implementation on the stability of the financial system of a representative medium-sized emerging market economy, Colombia. We use synthetic control methods following the seminal papers of Abadie and Gardeazabal (2003) and Abadie *et al.* (2010). These methods, which have been recently used in the literature to evaluate the effects of several economic policies, such as right-to-carry laws (Donohue *et al.*, 2019), immigration policy (Bohn *et al.*, 2014), taxation (Kleven *et al.*, 2013), and pay-equity laws (McDonald and Thornton, 2015), are useful when evaluating the causal effects of aggregate interventions. They are tools for disentangling causal effect when interventions are implemented at an aggregate level affecting a small number of large units (like countries), on some aggregate outcome of interest.

II. Methodology

Let Y_{it}^{N} be the outcome that would be observed in the financial stability index for the country i at time t in the absence of PBA, for countries $i = 1, \ldots, J + 1$, and time periods $t = 1, \ldots T$. Let T_0 denote the number of periods before the PBA intervention, which satisfies $1 \leq T_0 < T$. Let Y_{it}^{I} be the outcome that would be observed from country i at time t if country i is exposed to the intervention from $T_0 + 1$ to T. We assume that the PBA did not have effects before March 31, 2007, which marks the last day of the quarter before the actual implementation of the policy on May 6, 2007. That is, before the first quarter we assumed there were not any "anticipation effects" on the policy.

Let $\alpha_{it} = Y_{it}^{I} - Y_{it}^{N}$ be the effect of the PBA in country i at time t, and D_{it} denote and indicator that takes value one if country i is exposed to the PBA at time t, and zero otherwise. Thus, the observed outcome for country i is given by:

$$Y_{it}^{N} = Y_{it} + \alpha_{it} D_{it} \qquad (1)$$

If only the first country is exposed to the intervention and only after period T_0, it follows that:

$$Dit = \begin{cases} 1 \text{ if } \quad i=1 \text{ and } t > T_0 \\ 0 \qquad \text{otherwise} \end{cases} \qquad (2)$$

Our goal is to estimate $(\alpha_{1T_0+1},\ldots,\alpha_{1T})$. *For* $t > T_0$,

$$\alpha_{1t} = Y^I_{1t} - Y^N_{1t} = Y_{1t} - Y^N_{1t} \tag{3}$$

Due to the fact that Y^I_{1t} is observed, to assess α_{1t} we just need to estimate Y^N_{1t}. Following Abadie *et al.* (2010) we can assume that Y^N_{it} dynamics is driven by a factor model in the following way:

$$Y^N_{it} = \delta_t + \theta_t \mathbf{Z}_i + \lambda_t \mu_i + \varepsilon_{it}, \tag{4}$$

where δ_t is an unobservable common factor, with constant factor loadings across countries, $\mathbf{Z}_i$ is a *(r x 1)* vector of observed covariates (unaffected by the PBA implementation), θ_t is a *(r x 1)* vector of unknown parameters, λ_t is a *(F x 1)* vector of unobserved factor loads, and ε_{it} are random noise at the country level.

Abadie *et al.* (2010) show that, given a *(J x 1)* vector of weights $\mathbf{W} = (w_2,\ldots, w_{J+1})'$ such that $w_j \geq 0$ *for* $j=1,\ldots,J+1$ and all weights sum up to unity, we have that each particular vector $\mathbf{W}$ represents a potential synthetic control, or in other words, a particular weighted average of control countries in the "donor pool". In this case, the outcome of the financial stability indicator for each synthetic control indexed by $\mathbf{W}$ is given by:

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt} \tag{5}$$

Suppose that there exist $(w^*_2,\ldots, w^*_{J+1})$ which are optimal, in the sense that they are set as to minimize the distance between the outcome pre-treatment series and the synthetic control series before the policy intervention, and minimize $\sum_{j=2}^{J+1} w^*_j \mathbf{Z}_j - \mathbf{Z}_1$. In cases where the number of pre-intervention periods is large compared to the scale of the country errors we can use $\hat{\alpha}_{1t}$ as an estimator of α_{1t}. Such that:

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w^*_j Y_{jt}, \tag{6}$$

for $t \in \{T_0+1,\ldots,T\}$. These equations naturally do not hold exactly in practice, as none convex combination of the control countries can perfectly replicate the pre-intervention dynamics of the treated country. Thus, optimal weights of both control units and predictors are simultaneously set such that these equations hold approximately. We use the "synth" package in R, to estimate both sets of weights.

III. Data

We acknowledge the caveats of synthetic control methods. Namely that even if there exists a synthetic control that offers a good fit for Colombia (see Table 1), interpolation biases may be significant if the factor model represented by Equation 4 does not hold relatively well over the entire set of countries in our sample. In this case, researchers aiming to minimize the biases caused by interpolating across many heterogeneous countries with largely dissimilar characteristics should restrict the donor pool to countries with similar characteristics to the country exposed to the policy intervention.

In our case, this means that we opted for keeping a reduced number of control units following two economic reasons: first, the macroeconomics literature emphasizes on the fundamental role of regional characteristics to explain international capital flows to countries (e.g. Kaminsky, 2005). Therefore, our control units must belong to Latin America. Second, there is a great heterogeneity of countries within Latin American countries, including dollarized economies (i.e., Ecuador, El Salvador), and economies that are perceived as likely defaulters from their international debt obligations (e.g., Argentina, Venezuela). Our selection of controls is restricted to those countries that possibly resemble Colombia most, economically and in terms of regulation. In Table 1 we present the summary statistics of our variables for Colombia and the control countries: Brazil, Chile, Mexico, Peru.

In our set of predictor variables for the model in equation 4 we include: real output growth (real.growth), the investment to GDP ratio (investment.to.gdp), the unemployment rate (unemployment), inflation rate (inflation), the growth of real estate prices (real.estate.prices), the monetary base (monetary.base), the central bank policy rate (rate), foreign reserves as percentage of GDP (foreign.reserves), and the following balances: fiscal (fiscal.balance), trade (trade.balance), current account (current, balance), financial account (capital.balance), total direct investment (direct.investment.balance), total portfolio (portfolio.balance), the other investments (other.balance), all of them as percentage of GDP. We also include the index of multilateral real exchange rate (real.exchange.rate). The sample mean of these statistics is shown in the fourth column of Table 1.

IV. Results

1. Policy evaluation in Colombia

Table 1 presents summary statistics on relevant variables for Colombia (treated) and for the synthetic control. Notably, mean data for the synthetic are closer to observed mean data for Colombia than (unweighted) sample means for the countries included for building the control. This is especially true for variables which are usually considered as highly related to financial stability and still unaffected by the policy, like real estate prices.

Table 1. Summary statistics for relevant variables: Colombia, synthetic Colombia, and sample averages

Variable	Treated	Synthetic	Sample.Mean
real.growth	6.2	4.0	4.8
investment.to.gdp	22.1	22.2	20.2
unemployment	11.7	4.8	8.1
inflation	4.7	3.7	3.4
real.estate.prices	11.5	3.3	2.0
monetary.base	6.2	3.7	4.0
rate	6.7	7.3	8.5
foreign.reserves	10.1	9.2	11.6
fiscal.balance	-4.0	1.2	0.9
trade.balance	0.6	3.0	5.2
current.balance	-1.4	0.3	1.3
capital.balance	1.3	-0.2	-1.1
direct.investmente.balance	3.4	2.8	2.8
portfolio.balance	-0.9	-1.7	-0.9
other.flows	-0.1	-0.4	-1.6
real.exchange.rate	110,334	93,314	92,121

Note: the table shows the sample means of the treated Colombia (column 2), synthetic Colombia (column 3), and the unweighted sample mean of control units (colum 4).

Table 2 shows the optimal weights used for constructing the synthetic. Both predictor weights (Panel A) and country weights (Panel B) are reported. Variables corresponding to the external sector, such as the current account balance and the capital balance, variables related to capital flows, such as the real exchange rate and foreign direct investment, are among the variables with highest weights in building the synthetic. Important to note, synthetic Colombia is basically a convex combination of Mexico and Chile.

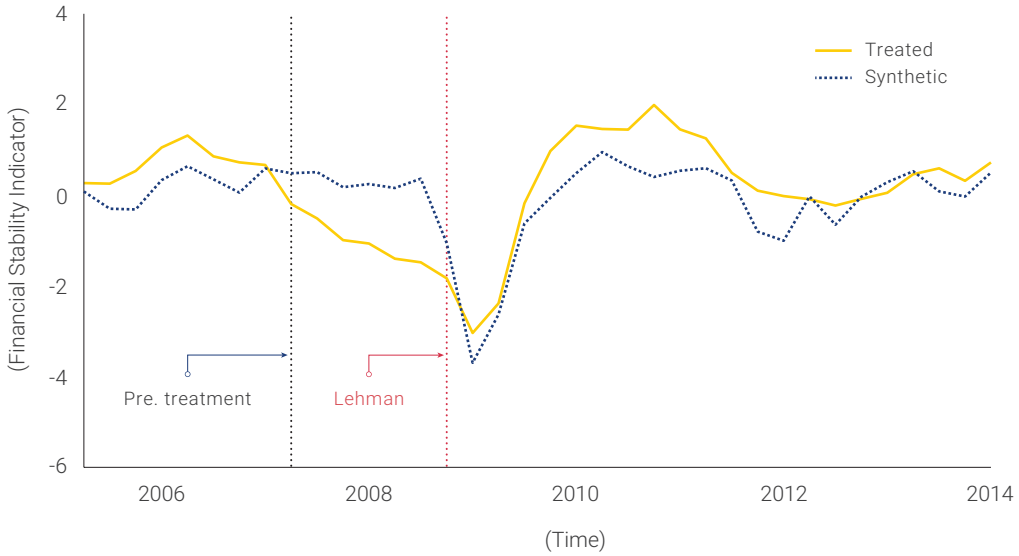
Figure 1 shows the effect of the PBA implementation on the Financial Stability Index. Both the factual and counterfactual values for this index are depicted. The continuous line represents the behavior over time of the index for Colombia (treated). The dotted line represents the behavior of the index for synthetic Colombia (control). Two moments in time are highlighted, namely the date in which the PBA was implemented (quarter corresponding to May 6, 2007) and the date of the Lehman Brothers default in September 2008. Recall that higher (lower) values of the index correspond to situations of higher (lower) financial stability. According to our results, the PBA had an impact on financial stability in Colombia. However, the impact was not homogeneous over time. Interestingly, when the policy measure was undertaken, before the beginning of the Global Financial Crisis, the PBA was detrimental to the overall financial stability of the Colombian financial sector. This apparently counterintuitive result may be explained by the fact that this macroprudential policy constrains the ability

Table 2. Weights used for constructing the synthetic Colombia

Predictor	v.weight	Country	v.weight
real.growth	5.6	Chile	27.24
investment.to.gdp	7.52	Brazil	0
unemployment	2.26	Mexico	72.76
inflation	4.19	Peru	0
real.estate.prices	1.45		
monetary.base	0.45		
rate	2.15		
foreign.reserves	8.22		
fiscal.balance	1.52		
trade.balance	9.8		
current.balance	8.3		
capital.balance	13.95		
direct.investmente.balance	12.11		
portfolio.balance	5.52		
other.flows	6.19		
real.exchange.rate	10.76		

Note: estimated optimal weights for control units (w) and predictors (v), according to equation 6.

Figure 1. Observed (treated) versus synthetic Colombia

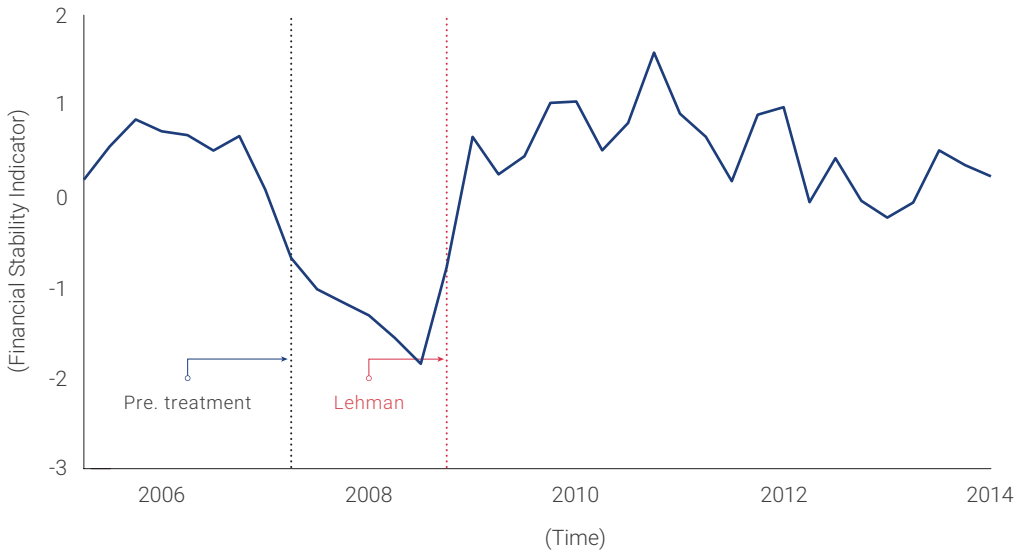


Note: observed values of the financial stability index of Colombia and the synthetic index constructed as a weighted average of the indexes for Mexico (72.76%) and Chile (27.24%).

of banks to extend foreign currency loans to firms. In fact, firms that had high levels of foreign currency debt may have found it harder to refinance loans and had to pay higher interest rates on newly issued loans. This, in fact, may have had a negative impact on financial stability.

However, soon after the Lehman Brothers collapse, the effect of the PBA on Colombia's financial stability inverted. Liquidity became scarce during the Global Financial Crisis. The PBA had a preventive effect, limiting the exposition of Colombian banks and firms to debt denominated in foreign currency before this happened. Therefore, these firms and banks were less exposed to the developments in international financial markets during the Global Financial Crisis. This isolation effect produced by the PBA was beneficial for safeguarding the stability of the Colombian financial system during times of strong financial distress in global financial markets.

Figure 2. Treated minus synthetic Colombia (FSI-gaps)



Note: gap between observed values of the financial stability index of Colombia and the synthetic index constructed as a weighted average of the indexes for Mexico (72.76%) and Chile (27.24%).

The causal effect of the PBA implementation can be more easily observed in Figure 2, which presents the Financial Stability Index gap between treated and synthetic Colombia. Interpretation of the gap is based upon the sign of the gap. A negative (positive) gap indicates a worsening (an improvement) of financial stability in Colombia with respect to the counterfactual of no PBA implementation. The short-term effect of the PBA was a worsening of financial stability. In fact, probably in a scenario without any major financial crisis, the PBA would have been detrimental overall for the stability of the Colombian financial system. However, clearly during the Global Financial Crisis and in its aftermath, the PBA was beneficial for the stability of the country's financial

system. Importantly, the effectiveness of the PBA after the failure of Lehman Brothers decreased over time. A possible explanation is that, as it usually happens with other regulations, banks learned ways of adjusting and innovating for overcoming the lending restrictions caused by this policy measure.

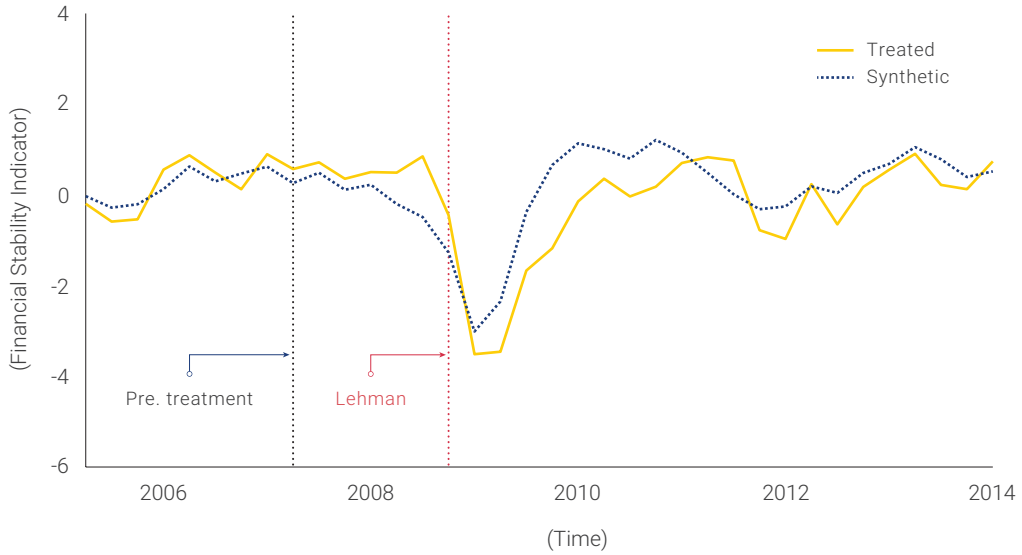
2. Placebo test: Mexico

Inference in our context is challenging, given the small number of countries in the donor pool that we are forced to consider and given the proximity of the GFC to the policy that we are evaluating. The former limitation renders inappropriate exact inference by permutation across individuals, and the second renders inference by permutation in time, as recommended by Abadie *et al.* (2010; 2015), unfeasible too.

Thus, instead of conducting exact inference to assess the significance of our estimates we follow Abadi and Gardeazabal (2003) and McDonald and Thornton (2015) and carry out a "placebo" test with the closest unit to Colombia in our set of controls: Mexico.

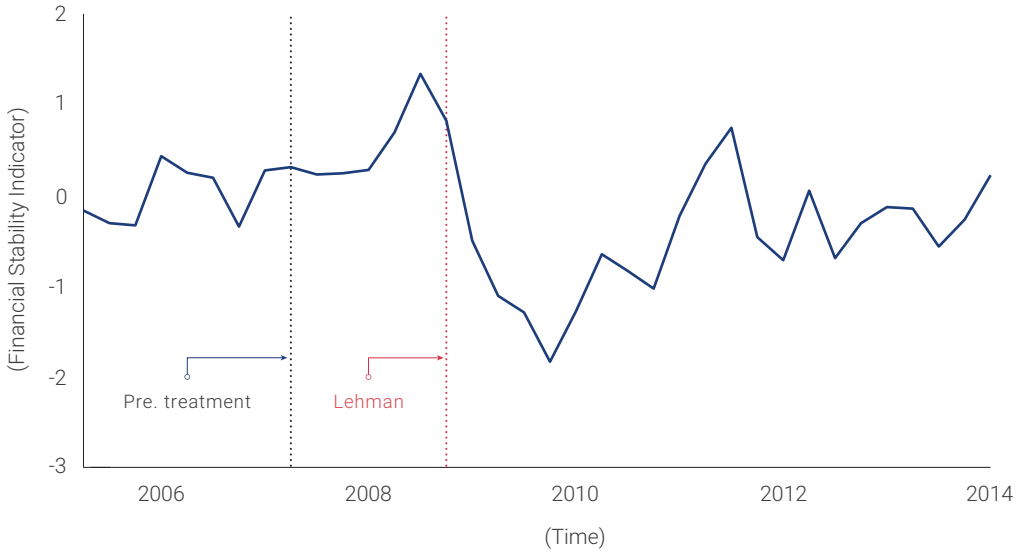
Recall that the weight of Mexico in the construction of synthetic Colombia is above 70%. Figures 3 and 4 provide the same information shown in Figures 1 and 2, but in this case the control corresponds to the Mexican Financial Stability index. The results for Mexico contrast sharply with the results for Colombia. As before the

Figure 3. Observed (treated) versus synthetic Mexico



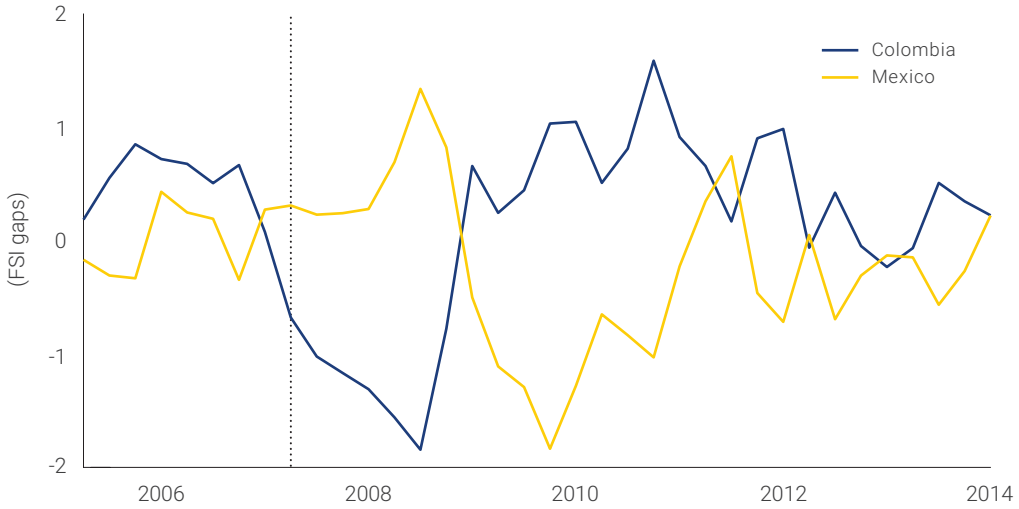
Note: observed values of the financial stability index of Mexico and the synthetic index constructed as a weighted average of the indexes for Colombia (49.8%) and Chile (50.2%).

Figure 4. Treated minus synthetic Mexico (FSI-gaps)



Note: gap between observed values of the financial stability index of Mexico and the synthetic index constructed as a weighted average of the indexes of Colombia (49.8%) and Chile (50.2%).

Figure 5. Colombian versus Mexican FSI gaps



Note: comparison between the estimated gaps for Colombia and Mexico.

crisis, the lack of PBA did not result in a worsening of financial stability, and after the burst of the crisis the protective effect that we document in Figures 1 and 2 is not present for Mexico (if anything synthetic Mexico seems to be above treated Mexico). The same is observed in relation to Figure 4, this time in terms of the gaps.

This contrasting dynamics is more easily appreciated in Figure 5 for the two countries.

3. Response of the gap to the cash position in USD of financial intermediaries

Finally, we have followed again Abadie and Gardeazabal (2003) in estimating a Vector Autoregression of order 1 including the estimated gaps for Colombia, presented in Table 1, and the series of cash-position in dollars of the financial intermediaries in Colombia (PPC for its name in Spanish). In Panel A of Figure 6 we show the two series, while in Panel B we show and impulse-response function with 95% confidence intervals constructed by bootstrapping. It can be observed that the effect of the PPC on the gaps is negative and statistically significant during the first quarter. This means that a reduction in the PPC was associated with an increase in the gap of the financial stability index for Colombia, which in turn means an increment in financial stability compared to a scenario of no PBA.

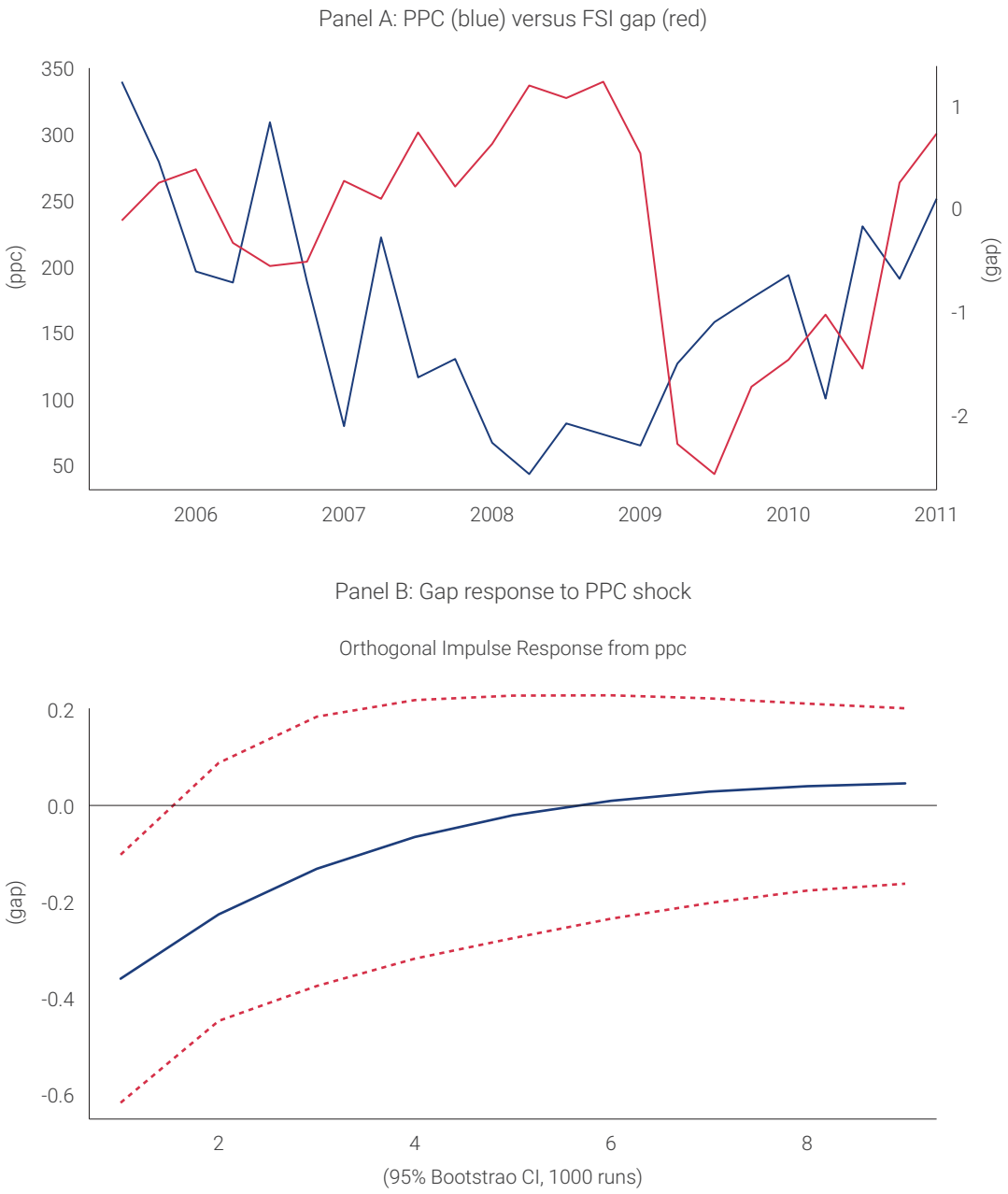
V. Conclusions

Macroprudential policies are not cost free. When well designed they have the potential to improve a country's overall financial stability. However, they entail costs in terms of financial disintermediation. While policymakers from emerging market economies use them widely, and there are a considerable variety of policy tools that have been used in different countries and periods, evaluating their effectiveness is challenging. Most attempts to evaluate their effectiveness have been done by the same policy makers who established them or by economists affiliated with the policy institutions that implement them. Especially relevant, only a very reduced number of papers have followed adequate statistical techniques for establishing causal effects.

In this paper we evaluate the effect of a very special macroprudential policy tool that was firstly designed and implemented in Colombia in May 2007, the PBA, which limits the gross position in foreign exchange derivatives that a bank can have. This policy tool was imposed with the objective of reducing the ability of banks to issue loans denominated in foreign currency in Colombia.

Using synthetic control methods, we show that the PBA had a causal impact on financial stability in Colombia. However, the direction of the impact was not homogeneous over time. The immediate effect of the PBA was a worsening of the Financial Stability Index. However, during the Global Financial Crisis and in its aftermath, the PBA improved the stability of the Colombian financial system.

Figure 6. Colombian estimated gad and PPC of financial intermediaries



Note: Panel A shows the "cash-position in dollars" (PPC) of financial intermediaries in Colombia and our estimated financial stability gap (treated minus synthetic). Panel B shows a one-standard deviation shock to PPC and the response from Colombian gap, from a VAR(1) model with bootstrapped confidence intervals at 95% . PPC corresponds to the monthly average of the last month in each quarter (i.e. March, June, September, December).

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