The Impact of Colombia's Gross Leverage Position in Foreign Exchange Derivatives on Housing Market Stability

Working paper

April 2025

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Abstract

We assess the effectiveness of the Gross Leverage Position in Foreign Exchange Derivatives (PBA), a macroprudential policy implemented by the Colombian central bank in 2007, in regulating housing price fluctuations. Using the synthetic control method, we demonstrate that the PBA significantly reduced the pace of housing price growth, particularly during the Global Financial Crisis from 2008 to 2010. Prior to the introduction of the PBA, Colombia experienced unsustainable housing price increases fueled by rapid credit expansion and substantial capital inflows. The PBA successfully reversed this trend, contributing to a decline in housing price appreciation and enhancing financial stability during times of uncertainty. The convergence of housing price growth rates between Colombia and the synthetic control further supports the notion of the PBA's causal influence. Our findings highlight the value of targeted macroprudential policies for maintaining stability within housing markets and preventing asset bubbles. This study provides insights for emerging economies facing similar challenges, emphasizing the importance of responsive policy measures tailored to specific economic contexts while also suggesting avenues for future research on the long-term effects of such interventions.

Keywords: Macroprudential policy; PBA; Housing price growth; Synthetic control method; Emerging economies.
JEL Codes: E58; G18; R31.

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Content

1. Introduction

Housing prices are among the most crucial determinants of a country's financial and macroeconomic stability. As a key macroeconomic indicator, they significantly influence both consumption and investment, shaping economic and financial cycles. Given that housing represents a substantial share of household wealth, price fluctuations have far-reaching effects on consumption, savings, and labor market decisions.

Moreover, housing prices play a critical role in investment, particularly within the real estate sector, which is a leading indicator of future economic activity. Real estate assets, including housing, also serve as essential collateral for bank loans, exerting considerable influence on credit expansion. When housing prices rise, the value of collateral increases, enabling greater lending activity and fueling economic growth. However, excessive credit growth driven by rising property values can also heighten financial vulnerabilities. As Schularick and Taylor (2012) demonstrated, the interplay between credit expansion and housing price appreciation is a key determinant of financial stability, with sharp increases in both variables significantly increasing the probability of financial crises.

Given the destabilizing effects that excessive credit growth and surging housing prices can have on the economy, many countries have introduced macroprudential measures to restrain these dynamics and strengthen financial and macroeconomic stability. In small, open emerging economies such as those in Latin America, capital flow fluctuations play a pivotal role in shaping housing price and credit cycles (Unsal, 2013; Ali and Iness, 2020; Pagliari and Hannan, 2024).

To address these challenges, macroprudential policies in such economies have primarily sought to contain credit expansion and housing price inflation through direct interventions, including loan-to-value (LTV) and loan-to-income (LTI) limits. At the same time, policy-makers have also implemented measures to curb destabilizing capital inflows, which are often linked to heightened economic and financial volatility. These measures include taxes on certain capital flows—such as unremunerated reserve requirements—and quantitative restrictions or outright prohibitions on specific inflows during periods of heightened vulnerability.

The effectiveness of macroprudential measures has been the subject of vigorous debate among scholars and policy-makers. While numerous studies have found that certain policies contribute to financial stability, more recent research has pointed to their significant costs, particularly in terms of lower productivity and slower economic growth (see, for example, Madeira, 2024).

Understanding the impact of specific measures implemented at given times in different countries is crucial

for assessing their broader economic consequences. A careful evaluation of their costs and benefits across key macroeconomic and financial variables can inform the design of more effective policies. This, in turn, can help policy-makers determine when and under what conditions these measures should be adopted, depending on their policy priorities.

In May 2007, during a period marked by significant capital inflows, rapid credit growth, and soaring real estate prices in Colombia, the central bank introduced an unprecedented macroprudential measure that had not been adopted by any other country. This policy established a cap on the *Posición Bruta de Apalancamiento* (PBA), i.e., Gross Leverage Position in Foreign Exchange Derivatives, which limited the ratio of a bank's gross exposure in foreign exchange derivatives to its capital. While facing opposition from the banking association, the central bank argued that the PBA was necessary to mitigate the credit risk exposure of Colombian banks and protect the stability of the financial system. Consequently, a 500% limit on the PBA was implemented, effective May 6, 2007. The primary goal of this policy was to slow down the rapid credit growth that central bank officials believed could lead to financial imbalances and housing market bubbles.

While Colombia had previously enacted taxes on foreign debt and portfolio investments—measures similar to those introduced in Brazil and Chile—this cap on the PBA was unique to Colombia. In fact, no other country had ever adopted such a policy. The measure was announced and implemented without prior notice to banks. Given the surprise of the measure, its unique nature, and its specific application in Colombia at a particular point in time, it serves as an ideal case for studying its effectiveness as a macroprudential policy. To the best of our knowledge, only one published paper has examined the effect of this measure: Giraldo et al. (2023), who investigated the impact of the PBA on financial stability and demonstrated that it had a positive effect during the global financial crisis of 2008-2010. In this study, we analyze the effect of the PBA on housing prices in Colombia using the synthetic control method (SCM).

This study reveals that the implementation of the PBA significantly reduced the rate of housing price growth in Colombia. Notably, this policy initiated a trend reversal, leading to a gradual decline in the rate of increase after it had been positive and accelerating prior to the introduction of the PBA. We substantiate this causal effect by comparing housing price growth in Colombia to a synthetic counterfactual. After the PBA was implemented, the gap in housing price growth between Colombia and synthetic Colombia narrowed, particularly following the Global Financial Crisis, resulting in near-total convergence. This finding demonstrates the PBA's effectiveness as a macroprudential measure, especially in periods of financial instability. By stabilizing housing prices and preventing asset bubbles, the PBA enhances financial resilience and helps institutions withstand external shocks, thus reinforcing economic stability and investor confidence.

Our findings are bolstered by placebo tests, which validate the identified impact. This research enhances our understanding of how macroprudential measures influence housing prices during periods of rapid expansion, and it provides valuable insights for the effective implementation of such policies in small, open economies where credit dynamics and housing prices are heavily influenced by international capital flows. Ultimately, our results suggest that policies such as the PBA are effective in moderating housing price growth during surges, serving as a crucial complement to more traditional measures such as the LTV and LTI ratios.

The remainder of this paper is structured as follows: Section 2 offers a concise literature review exploring the interplay between capital flows, credit, macroprudential policies, and housing prices. Section 3 outlines the methodology, detailing the fundamentals of the synthetic control model employed in this research. Section 4 provides a description of the data used. Section 5 presents our key findings, and the final section concludes with a discussion of the policy implications of our results.

2. Capital flows, credit, macroprudential policies, the PBA, and housing prices

International capital flows offer significant benefits, but they can also intensify financial instability, especially in small, open economies susceptible to global capital fluctuations. Studies show that non-FDI capital inflows can drive credit expansion, increasing the likelihood of credit booms in both the corporate and household sectors (Igan & Tan, 2017). Additionally, large capital inflows are linked to increased risks of banking crises through excessive lending (Caballero, 2016), they and can trigger sharp rises in housing prices (Kelly et al., 2018). When they burst, housing bubbles can severely disrupt financial and macroeconomic stability (Asadov et al., 2023). Credit growth and rising property values often reinforce each other; real estate is frequently used as loan collateral, while easier access to credit fuels property purchases (Lambertini et al., 2013).

Excessive credit and housing price growth, especially in small, open economies, is widely recognized as a precursor to severe financial crises (e.g., Schularick & Taylor, 2012). Several studies have emphasized the pro-cyclical nature of excessive credit growth and its connection to credit risk. (e.g., Amador et al., 2013; Caporale et al., 2014; Soedarmono et al., 2017; Bouvatier et al., 2022). However, curbing credit expansion and housing price growth presents challenges, as doing so can impede financial deepening and slow down economic growth (e.g., Richter et al., 2019). Balancing these trade-offs is complex, as interventions can produce unintended consequences. The evidence suggests that credit booms and housing price bubbles are often inefficient from an ex ante perspective, warranting policy interventions. For instance, Lorenzoni (2008) argues that excessive borrowing can occur in equilibrium, resulting in exaggerated contractions in investment and asset

prices during crises. By preemptively curbing excessive investment, macroprudential measures can mitigate the severity of asset price decreases in downturns, ultimately generating aggregate welfare gains that private agents overlook.

Furthermore, moral hazard plays a crucial role in driving suboptimal overborrowing and in fueling housing price surges. Research by McKinnon and Pill (1996), Schneider and Tornell (2004), and Fahri and Tirole (2012) indicates that banks may assume excessive lending risks, anticipating potential government bailouts. Bianchi (2011) shows that individual borrowing decisions, although optimal in isolation, can lead to societal overborrowing within a dynamic stochastic general equilibrium model, where financial constraints exacerbate amplification effects. Additional factors, such as borrower optimism and delays in information processing, further contribute to these inefficiencies.

Considering this volatility, how should policy-makers in these economies respond? The conventional perspective posits that flexible exchange rates are the most effective means of absorbing external shocks. However, when financial markets are imperfect, exchange rate flexibility may not offer sufficient protection. Policy-makers typically employ a mix of strategies, including currency market interventions, macroprudential tools, and capital flow management measures. Although these responses vary across countries and over time, recent studies suggest that macroprudential policies can help mitigate capital flow volatility and, more importantly, prevent credit booms that threaten financial stability.

The primary objective of macroprudential policy is to ensure financial stability, although the definition of stability can vary by country and period. The Bank for International Settlements (BIS) defines it as actively addressing financial imbalances and distorted asset price valuations. Macroprudential policies designed to manage capital inflows can significantly influence housing prices through various interconnected mechanisms. The effectiveness of these policies relies on the specific instruments employed, the broader economic environment, and how market participants adapt their behavior. One key transmission channel is the restriction of credit supply, which directly affects housing demand. Many housing markets are influenced by capital inflows, either from foreign purchases or by enhancing liquidity in the banking sector. When authorities implement measures such as higher reserve requirements on foreign currency deposits or limitations on external borrowing, they can reduce the credit available for mortgage lending. Furthermore, regulations that impose lower LTV and LTI ratios help curb excessive leverage among domestic borrowers. By capping borrowing relative to income or property value, these policies moderate demand and mitigate speculative price increases. Empirical evidence from various economies shows that tighter LTV and DTI regulations can slow housing price appreciation, particularly in markets experiencing rapid credit growth (Mendicino and Punzi, 2014; Kelly et al., 2018; LinLin et al., 2024).

In addition to influencing credit supply, macroprudential policies affect exchange and interest rates, further impacting housing demand. Capital inflows often lead to currency appreciation and lower domestic interest rates, which make mortgage financing more affordable and stimulate demand for housing. By restricting these inflows, macroprudential measures can prevent excessive monetary easing, thus stabilizing the currency and avoiding potential asset price bubbles that arise from misallocated capital. Moreover, increased interest rates resulting from limited external borrowing or stricter macroprudential controls increase mortgage financing costs, which can lower housing demand and curb price inflation.

Foreign investment plays a significant role in driving housing prices in many urban areas, often exacerbating the affordability concerns of local buyers. Countries such as Canada, Australia, and Singapore have introduced taxes on foreign buyers and restrictions on nonresident property ownership to mitigate speculative demand. By implementing such measures, they can effectively slow housing price growth. When macroprudential policies restrict foreign capital inflows, institutional investors may also reduce their exposure to the local real estate market, further alleviating upward price pressures. Finally, the effectiveness of these policies is influenced by the structural characteristics of housing markets, particularly their supply elasticity. In markets constrained by strict zoning regulations or limited land availability, demand-side restrictions may have a weaker effect on price dynamics. In contrast, in more elastic markets, restricting capital inflows and tightening lending conditions can significantly slow price appreciation. Policy-makers must also be aware of potential spillover effects, as the enactment of stricter macroprudential measures in one region may drive capital into less regulated areas, leading to localized housing booms.

The PBA is a macroprudential policy tool introduced by the Central Bank of Colombia during a phase of rapid credit expansion driven by significant capital inflows, which inflated asset prices, including housing prices. Although some capital inflows were countered by capital controls instituted in 2006, Colombian banks continued to replicate foreign credit through local currency loans and foreign currency swaps. The PBA aimed to limit the capacity of Colombian banks to create synthetic foreign debt instruments, thus reducing their exposure to foreign credit risks.

Recent research (Schroth, 2021) suggests that optimal regulation necessitates that banks hold more equity during periods of high loan supply and less equity during periods of low supply. By curtailing the use of derivative markets to replicate foreign credit, the PBA ensures that bank credit growth remains consistent with the capital levels of banks. This regulatory approach reflects the current stance of the International Monetary Fund (IMF) on capital flow management measures and macroprudential policies, which advocate for enhanced flexibility for countries to implement tools that span both categories. According to the IMF, these measures can aid countries in managing capital inflows and mitigating risks to financial stability, not only during

capital flow surges but also in more stable periods (Biljanovska et al., 2023).

While the Central Bank of Colombia framed the PBA as a banking regulation, certain sectors, including the Colombian Banking Association and financial analysts, interpreted it as a form of capital control. It complemented other macroprudential measures adopted in Colombia, some of which are also utilized in countries such as Chile, Brazil, Mexico, and Peru. However, from the introduction of the PBA in 2007, its design and implementation were unique to Colombia.

The primary drawback of such policies is their potential to restrict the ability of banks to extend credit at an optimal level from the perspective of an individual institution. This restriction may be perceived as inefficient, potentially diminishing profitability and market share and causing some clients to be underserved. From a broader perspective, policies that limit credit growth can impede financial deepening. Nevertheless, their benefits lie in significantly lowering the likelihood of banking crises, which have detrimental effects on output and welfare. Additionally, macroprudential measures that address bank exposure to foreign exchange risks can diminish the vulnerability of banks to currency fluctuations and the global financial cycle (Ahnert et al., 2021). This aspect is especially critical during financial crises, when currency devaluations can amplify negative impacts on financial and macroeconomic stability.

3. Methodology

In this paper, we utilize the SCM developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010) to assess the causal impact of macroprudential policies on housing price growth in Colombia. This method has recently been employed in the literature to assess the effects of various economic policies on aggregate and macroeconomic variables. It has proven to be particularly valuable for evaluating the causal effects of aggregate interventions. By facilitating the disentangling of causal relationships, this method is effective when interventions are implemented at an aggregate level that influences a limited number of large entities, such as countries, with respect to specific aggregate outcomes of interest.

The SCM presents several notable advantages over traditional econometric techniques, including difference-in-differences (DiD) estimation, regression models, and propensity score matching, especially when studies assess the effects of macroprudential policies that may influence or target housing market dynamics. One of the key strengths of the SCM lies in its ability to create a counterfactual entity that closely resembles the treated unit—such as a country or region implementing a macroprudential policy—by forming a weighted combination of untreated units. This approach allows for a more accurate estimation of policy effects by

providing a comparison group that reflects what would likely have occurred without the intervention. The challenge of identifying a suitable control group is a well-known issue in observational studies, and the SCM effectively addresses this concern by facilitating a more robust and credible comparison.

The SCM improves upon traditional methods by ensuring that the treated unit and its synthetic counterpart share similar pretreatment trends, thus reducing bias from differing pretreatment characteristics. It also addresses the heterogeneity of treatment effects, allowing for tailored synthetic controls that account for variations in institutional structures and economic conditions across regions. Furthermore, the SCM is effective even for small sample sizes, as it can construct synthetic controls from a larger pool of untreated units, increasing precision. By incorporating information from multiple donor units, the SCM strengthens the generalizability of the results, minimizing potential biases. The method provides clear visual representations that facilitate effective communication of findings to policy-makers and the public. Additionally, the SCM accommodates varying treatment timings and effectively addresses confounding factors that could simultaneously influence housing prices. Overall, the SCM constitutes a vital tool for analyzing the complex relationships between macroprudential policies and housing price dynamics.

More formally, let Y_{it}^N be the housing price growth for country i at time t in the absence of the PBA for countries $i = 1, \dots, J+1$ and time periods $t = 1, \dots T$. 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 (price growth) 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 had no effect before March 31, 2007, the end of the quarter preceding the official policy implementation on May 6, 2007. In other words, we assume that there were no "anticipation effects" prior to the first quarter.

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

$$Y_{it} = Y_{it}^N + \alpha_{it} D_{it}. \tag{1}$$

When only the first country is exposed to the intervention and only after period T_0, we have the following:

$$D_{it} = \begin{cases} 1 & if \quad i = 1 \; and \; t > T_0 \\ 0 & \text{otherwise} \end{cases}. \tag{2}$$

In this context, our aim is to estimate $(\alpha_{1T_0+1}, \ldots, \alpha_{1T})$, and for $t > T_0$, we have the following:

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N. \tag{3}$$

Since Y_{1t}^I is observed, to assess α_{1t}, we are only required to estimate Y_{1t}^N. Consistent with Abadie et al. (2010), we assume that Y_{it}^N follows a factor model, as shown in the following equation:

$$Y_{it}^N = \delta_t + \boldsymbol{\theta}_t \boldsymbol{Z}_i + \boldsymbol{\lambda}_t \boldsymbol{\mu}_i + \varepsilon_{it}, \tag{4}$$

where δ_t can be understood as an unobservable 'common factor' with constant factor loadings across countries, $\boldsymbol{Z}_i$ is an $(r \times 1)$ vector of covariates that are observed (and unaffected by PBA implementation), $\boldsymbol{\theta}_t$ is an $(r \times 1)$ vector of parameters that must be estimated, $\boldsymbol{\lambda}_t$ is an $(F \times 1)$ vector of unobserved factor loads, and ε_{it} represents random disturbances by country and time.

Following Abadie et al. (2010), we have that, given a $(J \times 1)$ vector of weights $\boldsymbol{W} = (w_2, \ldots, w_{J+1})'$ such that $w_j \geq 0 \text{ for } j = 1, \ldots, J+1$ with all weights summing to one, each particular vector $\boldsymbol{W}$ represents a possible synthetic control, that is, a particular weighted average of control countries in the *donor pool*. In our context, the outcome of the housing price growth for each synthetic control indexed by $\boldsymbol{W}$ behaves according to the following equation:

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \boldsymbol{\lambda}_t \sum_{j=2}^{J+1} w_j \boldsymbol{\mu}_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt}. \tag{5}$$

If there is a vector of optimal weights that minimizes the distance between the outcome pretreatment and the synthetic control before the policy intervention and we denote this vector as $(w_2^*, \ldots, w_{J+1}^*)$, then, when the number of preintervention periods is large compared with the scale of the country errors, we can leverage $\hat{\alpha}_{1t}$ as an estimator of α_{1t}, as indicated in Equation 6:

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

We have that $t \in \{T_0 + 1, \ldots, T\}$. In practice, these equations only hold approximately, as no combination of the control countries can perfectly replicate the preintervention dynamics of the treated country. Therefore, the optimal weights of both the control units and the predictors are simultaneously set such that these equations hold approximately. We employ the "synth" package in R to estimate both sets of weights.

4. Data

In this section, we present the data used to estimate the impact of the introduction of the PBA in May 2007 on housing price growth in Colombia, applying the synthetic control method described above. Estimating causal effects using macroeconomic data presents significant challenges. The observation units are large, in this case, entire countries, which naturally raises concerns about cross-sectional dependence. Moreover, the selection of suitable control units is limited. In our specific case, identifying a credible aggregate counterfactual for housing price growth in Colombia—had the PBA not been introduced in May 2007—is particularly complex. In studies such as ours, the synthetic control method is the most appropriate approach for identifying causal effects, as outlined at the beginning of the Methodology section. However, we acknowledge some limitations of this methodology, such as potential interpolation biases that may arise if the underlying factor model does not hold consistently across all countries in the sample. To minimize such biases, we limit the donor pool to countries with characteristics similar to those of Colombia, the country affected by the policy intervention.

Our selection of control units is based on two key criteria. First, the macroeconomic literature underscores the importance of regional characteristics in influencing international capital flows (Ftiti et al., 2024), leading us to restrict our control group to Latin American countries. Second, significant diversity exists among Latin American economies, including countries that have adopted the dollar as their currency, such as Ecuador and El Salvador, and those that have faced considerable challenges related to sovereign debt crises, such as Argentina and Venezuela. To increase the reliability of our analysis, we focus our control group on countries that share economic and regulatory characteristics similar to those of Colombia. This approach allows for more meaningful comparisons and strengthens the overall validity of our results. Table 1 provides the summary statistics for the variables included in our analysis, covering Colombia and the selected control countries: Brazil, Chile, Mexico, and Peru.

Colombia, Brazil, Chile, Peru, and Mexico share several important macroeconomic and financial characteristics that highlight their status as emerging markets. Each of these countries relies heavily on commodity exports, making their economies sensitive to global price fluctuations, which in turn affects their economic growth and trade balances. They have implemented inflation targeting as a core monetary policy strategy to maintain price stability and encourage economic growth, with their central banks actively adjusting interest rates to achieve these goals. Fiscal challenges are prevalent, as these nations work to balance budgets, manage public debt, and meet social spending demands. Their financial markets are relatively well developed, facilitating investment and financing opportunities, and they participate in regional trade agreements that enhance economic cooperation. While these economies have diverse sectors—ranging from agriculture to manufacturing and services—they also face external vulnerabilities linked to global economic conditions and

interest rate changes. Additionally, social inequality remains a significant concern, requiring targeted policies to foster inclusive growth.

In our estimation, we utilize a robust array of predictor variables, including real GDP growth, the investment-to-GDP ratio, inflation, and the growth in real estate prices. We also examine the unemployment rate, monetary base figures and the central bank policy rate. Foreign reserves are included as a percentage of GDP to capture external financial stability. To provide a comprehensive economic context, we account for various balance indicators: the fiscal balance, trade balance, current account balance, financial account balance, direct investment balance, portfolio investment balance, and other investment balance, all expressed as percentages of GDP. Moreover, we incorporate the multilateral real exchange rate index into our analysis, with sample means detailed in the fourth column of Table 1.

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

Variable	Treated	Synthetic	Sample.Mean
real.growth	6.2	3.9	4.8
investment.to.gdp	22.1	17.2	20.2
unemployment	11.7	12	8.1
inflation	4.7	5.1	3.4
monetary.base	6.2	4.2	4
rate	6.7	16.5	8.5
foreign.reserves	10.1	6.6	11.6
fiscal.balance	-4	-2.9	0.9
trade.balance	0.6	1.7	5.2
current.balance	-1.4	1.3	1.3
capital.balance	1.3	-1.2	-1.1
direct.investment.balance	3.4	0.8	2.8
portfolio.balance	-0.9	0.4	-0.9
other.flows	-0.1	-1	-1.6
real.exchange.rate	110.334	84.702	93.121

Note: The table shows the sample means of the treated Colombia (Column 2) and the synthetic Colombia (Column 3) as well as the unweighted sample mean of the control units (Column 4)

Given the wide array of covariates available, we explore various model specifications by testing different subsets of these variables. These specifications include a model that relies solely on historical outcomes as predictors. Our findings demonstrate that, regardless of the specification applied, the results remain qualitatively consistent. This consistency across different configurations strengthens the reliability of our conclusions and highlights the significance of the selected covariates for capturing the relevant economic dynamics.

5. Results

5.1. Causal effect of PBA implementation on housing prices in Colombia

Table 1 presents the summary statistics for key economic variables across three groups: the treated unit, Colombia; the synthetic Colombia; and the unweighted sample mean of the control countries. The variables included are real GDP growth, the investment-to-GDP ratio, the unemployment rate, inflation, the monetary base, the central bank policy rate, foreign reserves as a percentage of GDP, and various balance indicators (fiscal, trade, current, capital, direct investment, portfolio, and other flows). Additionally, the real exchange rate is included.

In comparison, Colombia has a real GDP growth rate of 6.2%, which is higher than that of its synthetic counterpart (3.9%) and the average GDP growth rate of the control units (4.8%). The investment-to-GDP ratio is 22.1% for Colombia, surpassing the synthetic and sample means. The unemployment rate is relatively high at 11.7% for Colombia, whereas the synthetic and sample means are lower. Inflation is slightly lower for the synthetic Colombia (5.1%) than for Colombia (4.7%), whereas the other indicators reveal differences in balance and reserve statistics, indicating distinct economic profiles among the groups. Overall, this table highlights the economic characteristics of Colombia relative to its synthetic counterpart and the control group.

Notably, the mean values for the synthetic Colombia closely resemble the observed mean data for the actual Colombia, in contrast to the unweighted sample means from the countries included in the control group. This is especially true for variables commonly linked to housing prices, which are expected to remain unaffected by the policy intervention.

Table 2. Weights used for constructing the synthetic Colombia

Panel A. Predictor weights

predictor	*v.weight*
real.growth	0.108
investment.to.gdp	0.001
unemployment	21.878
inflation	13.448
monetary.base	15.698
rate	0.001
foreign.reserves	0.083
fiscal.balance	16.796
trade.balance	12.794
current.balance	0.008
capital.balance	0
direct.investment.balance	0.003
portfolio.balance	7.081
other.flows	12.085
real.exchange.rate	0.017

Panel B. Country weights

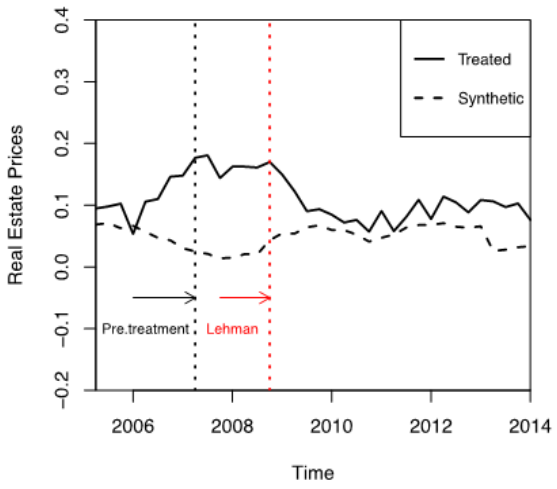
country	*w.weight*
Chile	0
Brazil	99.998
Mexico	0.002
Peru	0

Note: Estimated optimal weights for the control units (w) and predictors (v), according to Equation 6.

Table 2 displays the optimal weights assigned in the construction of the synthetic control, with predictor weights presented in Panel A and country weights in Panel B. The analysis reveals that variables associated with the external sector—such as the current account balance and capital balance—along with those related to capital flows—specifically the real exchange rate and foreign direct investment—carry the highest weights in the synthetic construction. Significantly, the synthetic Colombia is predominantly a convex combination of Brazil and Mexico, with a substantial emphasis placed on Brazil. This outcome is anticipated, given the numerous economic and structural similarities that exist between Brazil and Colombia (see, for instance, De Mello and Moccero, 2011).

Figure 1 provides a visual representation of the effect of the implementation of the PBA on housing price growth in both the factual Colombia and the synthetic Colombia, which serves as the counterfactual. The figure marks two pivotal moments: the date of the implementation of the PBA and the date of the collapse of Lehman Brothers, which signaled the beginning of the global financial crisis from 2008 to 2010. It is clear from the data that prior to PBA implementation, housing prices in Colombia were rising at a significantly accelerated rate compared with those in the synthetic Colombia. However, after the PBA was put into effect, the growth rate of housing prices in Colombia experienced a pronounced moderation relative to the synthetic Colombia.

Figure 1. Observed (treated) versus the synthetic Colombia



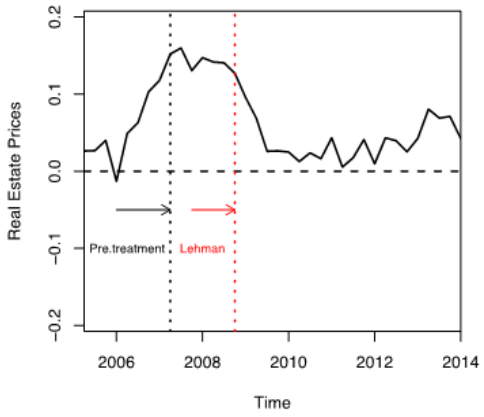
Note: Observed values of the real estate prices of Colombia and the synthetic index constructed as a weighted average of the indices for Brazil (99.99%) and Mexico (0.01%).

Furthermore, following the triggering of the global financial crisis, the rate at which housing price growth decelerated in Colombia increased even more sharply. This trend resulted in a convergence between the growth rates of housing prices in Colombia and those of the synthetic Colombia. This pattern suggests that the PBA had a substantial causal effect on the trajectory of housing prices in Colombia. Indeed, this intervention led to a notable decrease in housing prices, which likely played a role in enhancing financial stability within the country. This assertion aligns with the findings presented by Giraldo et al. (2023), who argue that the stabilization of housing prices positively contributed to the overall economic environment in Colombia during a period marked by significant financial uncertainty.

Figure 2 provides a clearer illustration of the causal impact of the implementation of the PBA on housing prices in Colombia. This figure specifically highlights the difference in housing price growth between Colombia and the synthetic Colombia, effectively showcasing the effects of the policy intervention. Importantly, following the implementation of the PBA, the gap in housing price growth between Colombia and the synthetic Colombia began to decrease. This reduction became even more pronounced after the global financial crisis, leading to a near-total convergence of the two trajectories. Our findings indicate that the PBA serves as an effective macroprudential measure, particularly in times of financial turbulence, which enhances its overall effectiveness.

This increased efficacy during periods of instability is significant for several reasons. First, it illustrates the capacity of the PBA to stabilize the housing market and prevent overheating that can occur during economic upturns. By managing housing prices, the PBA helps avert the formation of asset bubbles that often precede broader financial crises.

Figure 2. Treated minus the synthetic Colombia (real estate gaps)



Note: Gap between the observed values of the financial stability index of Colombia and the synthetic index constructed as a weighted average of the indices for Brazil (99.99%) and Chile (0.01%).

Additionally, our results emphasize the role of the PBA role in addressing systemic vulnerabilities within the financial system. During times of global financial stress, the interconnectedness of markets can amplify risks and lead to rapid economic downturns. The PBA acts as a protective mechanism, ensuring that financial institutions remain resilient and capable of withstanding external shocks. This resilience is critical for sustaining economic stability and maintaining investor and consumer confidence.

In summary, the PBA proves to be a highly effective macroprudential tool that achieves its objectives of reducing systemic vulnerabilities in the financial sector and the overall economy. Its ability to adapt and remain effective during periods of financial distress positions it as a key element of Colombia's macroeconomic policy framework, especially as the nation navigates the challenges of a globalized financial environment.

5.2. Placebo test: Brazil

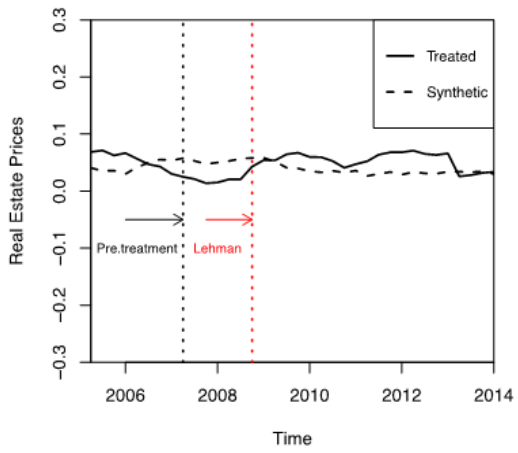
Drawing inferences in this context is particularly challenging because of two key factors. First, the limited number of countries available in the donor pool prevents the use of standard permutation-based inference across units. Second, the proximity of the Global Financial Crisis (GFC) to the implementation of the policy under evaluation complicates the use of inference methods based on time permutations, as proposed by Abadie et al. (2010, 2015). These constraints make conventional approaches to assessing statistical significance unfeasible.

To address this issue, we follow the approach of Abadie and Gardeazabal (2003) and Giraldo et al. (2023) by conducting a placebo test using Brazil, the country in our sample that most closely resembles Colombia. Given that Brazil accounts for nearly 99% of the weight in constructing the synthetic Colombia, it serves as a natural benchmark for comparison. It allows us to assess whether the observed effects in Colombia stem from the policy itself or reflect broader regional trends.

Figures 3 and 4 present the same analysis as before but compare the housing price growth of Colombia with that of Brazil rather than with that of the synthetic Colombia. The results reveal a stark contrast. While Colombia experienced a marked slowdown in housing price growth following policy implementation, Brazil's housing prices did not decline to the same extent. More specifically, the pattern of convergence observed in Colombia is absent in Brazil, where housing prices continued on a different trajectory. This contrast is even more evident in Figure 5, which illustrates how the housing market adjustment in Colombia was not mirrored in Brazil. This figure clearly illustrates the pronounced decline in the gap between actual and counterfactual housing price growth in Colombia compared with the relatively unchanged gap observed in Brazil.

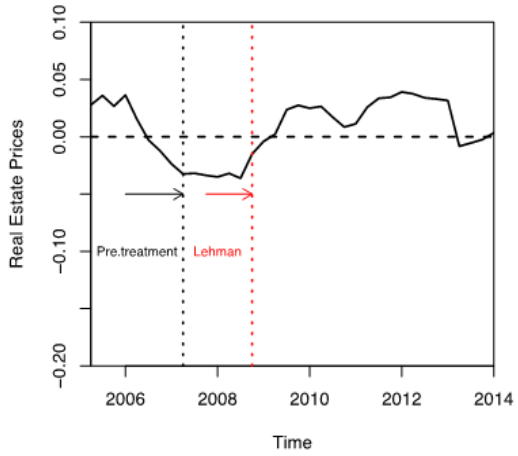
These findings reinforce the conclusion that the policy had a significant effect on curbing housing price growth in Colombia, rather than the observed trend being driven by broader macroeconomic or regional factors.

Figure 3. Observed (treated) versus the synthetic Brazil



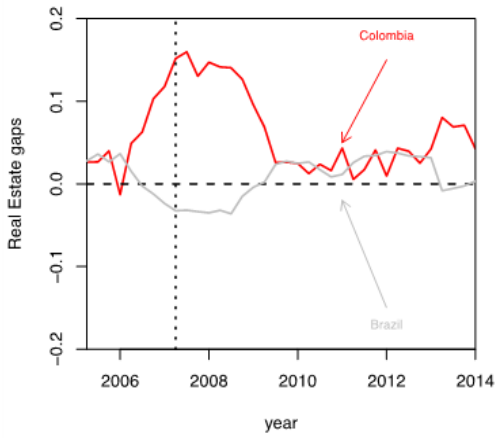
Note: Observed values of the financial stability index of Brazil and the synthetic index constructed as a weighted average of the indexes for Chile (15.2%) and Colombia (84.79%).

Figure 4. Treated minus the synthetic Brazil (real estate price gaps)



Note: Gap between the observed values of the financial stability index of Brazil and the synthetic index constructed as a weighted average of the indexes of Chile (15.2%) and Colombia (84.79%).

Figure 5. Colombian versus Brazilian real estate gaps



Note: Comparison between the estimated gaps for Colombia and Brazil.

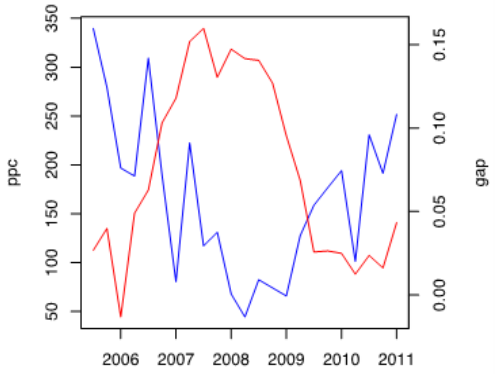
5.3. Response of the gap to the cash position in USD of financial intermediaries

As a complementary analysis, we estimate a first-order Vector Autoregression (VAR) model incorporating both the estimated gaps for Colombia, as shown in Table 1, and the cash position in dollars of financial intermediaries in Colombia (PPC, by its Spanish acronym). This approach enables us to evaluate the dynamic relationship between housing price growth and the liquidity conditions in the banking sector. Panel A of Figure 6 displays the time series for both variables, while Panel B presents the impulse response function with 84% confidence intervals—accounting for the relatively small sample size—constructed by bootstrapping to mitigate potential small-sample bias.

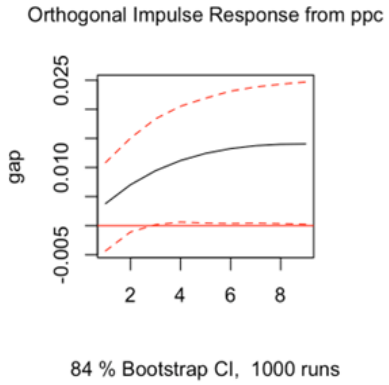
The results reveal a statistically and economically significant effect of the PPC on the estimated gaps, particularly after the fourth period following a shock. In economic terms, this finding implies that a reduction in the PPC—indicating tighter liquidity constraints—was followed by a decrease in the housing gap for Colombia. Given that the index gap measures the difference between observed and counterfactual housing price growth, this finding suggests that the implementation of the PBA contributed to a relative reduction in housing price growth compared with a scenario without the policy. The impulse response analysis confirms that this effect is not only statistically significant but also economically meaningful, highlighting the role of macroprudential measures in mitigating financial vulnerabilities stemming from very high housing price growth during periods of heightened external risks.

Figure 6. Colombian estimated gap and PPC of financial intermediaries

Panel A: PPC (blue) versus FSI gap (red)



Panel B: Gap response to PPC shock



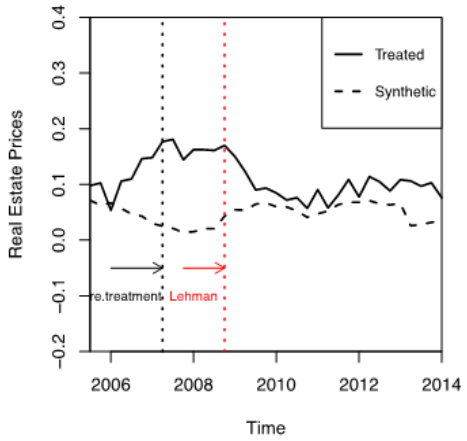
Note: Panel A shows the "cash position in dollars" (PPC) of financial intermediaries in Colombia and our estimated real estate gap (treated minus synthetic). Panel B shows a one-standard deviation shock to the PPC and the response from the Colombian gap from a VAR (1) model with bootstrapped confidence intervals of 84%. The PPC corresponds to the monthly average of the last month in each quarter (i.e., March, June, September, December).

5.4. Robustness: Autoregressive Synthetic Control

Finally, a prevalent concern in studies of this nature is the possibility of cherry-picking covariates, which can undermine the validity of the model (Ferman et al., 2020). This practice refers to the selective inclusion of variables on the basis of their observed effects, potentially leading to biased results. To mitigate this concern, one effective strategy is to estimate the model using only the lags of the dependent variable as predictors.

In this context, Figure 7 illustrates the estimation results from a model that relies exclusively on the lags of housing price growth as covariates. This approach not only addresses concerns regarding the selection of predictors but also enhances the robustness of the findings. The results indicate that the qualitative outcomes of this model remain consistent with those derived from the primary empirical model discussed above. This consistency reinforces the credibility of the findings and suggests that the dynamics captured by the lags of housing price growth are robust across different model specifications.

Figure 7. Observed (treated) versus the synthetic Colombia



Note: Observed values of the real estate prices of Colombia and the synthetic index constructed using the lags of the Colombian real estate price indicator.

6. Conclusions

This study sheds light on the effectiveness of the Gross Leverage Position in Foreign Exchange Derivatives (PBA), a macroprudential policy implemented by the Colombian central bank in 2007. By utilizing the synthetic control method, we find that this policy intervention significantly slowed housing price growth in Colombia, particularly during periods of economic volatility such as the global financial crisis of 2008-2010.

Our analysis indicates that prior to PBA implementation, housing prices in Colombia were rising at an unsustainable pace, driven by rapid credit growth and substantial capital inflows. The introduction of the PBA effectively reversed this trend, leading to a noticeable decrease in housing price appreciation. This effect became especially apparent following the onset of the global financial crisis, suggesting that the PBA not only stabilized housing prices but also played a key role in bolstering financial resilience in the country.

The alignment of housing price growth rates between Colombia and the synthetic control further supports the notion that the PBA had a causal impact, which highlights its role as a safeguard against potential overheating in the housing market. By managing housing prices, the PBA helps mitigate the risk of asset bubbles, which often precede broader financial crises. This finding resonates with the conclusions of Giraldo et al. (2023), who emphasized the positive contribution of stable housing prices to Colombia's overall economic stability during periods of financial turmoil.

Our research contributes to the ongoing discussion regarding the broader implications of macroprudential policies. While some experts have raised concerns about the potential drawbacks of such measures—particularly their impact on economic growth and productivity—our results indicate that well-designed interventions such as the PBA can provide essential stability, especially in small, open economies vulnerable to external shocks. The effectiveness of the PBA in regulating housing prices underscores the value of targeted macroprudential measures as a complement to traditional tools, such as the loan-to-value and loan-to-income ratios, equipping policy-makers with a more comprehensive toolkit for managing financial stability.

Several policy implications can be derived from these findings. First, the PBA serves as a valuable case study for other emerging economies dealing with similar challenges related to housing market dynamics and credit expansion. Policy-makers can learn from Colombia's experience and implement innovative macroprudential measures that are tailored to their unique economic and financial contexts.

Second, the study underscores the importance of understanding the timing and context of policy implementation. The success of the PBA in curbing housing price growth during an economic downturn emphasizes the need for policy-makers to remain responsive to changing market conditions, ensuring that macroprudential measures effectively address emerging vulnerabilities.

Finally, future research should examine the long-term effects of the PBA and similar policies on economic growth, productivity, and housing market dynamics. Gaining insights into these relationships will be crucial for refining macroprudential frameworks and enhancing the resilience of financial systems while considering ongoing global economic challenges.

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