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ESCOLA DE ECONOMIA DE SÃO PAULO

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**STOCK PERFORMANCE OF BRAZILIAN SECTORS AFTER THE 2014
RECESSION: A SYNTHETIC CONTROL APPROACH**

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Dissertação apresentada à Escola de Economia de
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requisito para obtenção do título de Mestre em
Economia

Área de concentração: Microeconomia Aplicada

Orientador: Prof^a. Dr^a. Priscilla Albuquerque
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Abstract

Identifying whether recessions are caused by domestic or external factors demands methodological rigor on choosing the most appropriate quantitative approach. The synthetic control method has been used to evaluate drivers of the Brazilian economic performance over the last decade from a comparative perspective, specifically concerning macroeconomic aggregates. This dissertation aims to identify which sectors of the Brazilian economy decoupled from international benchmarks during the post-2014 recession, potentially due to domestic factors crystallized by the government that was re-elected in October/2014. I utilize the synthetic control approach to compare domestic sectorial indexes - built upon data gathered from shares of Brazilian listed companies - with international peers before and after the elections of 2014. The findings show a general deterioration in most of the Brazilian sectors in US dollar terms, as an indirect effect of the exchange rate depreciation during the period. Moreover, non-cyclical consumption, machinery and real estate sectors underperformed the comparable ones even in local currency terms, hypothetically signaling domestic causes for the momentum of these industries, which are highly correlated with macroeconomic variables and policies.

Keywords: Synthetic Control. Comparative Analysis. Brazilian Economy. Recessions.

Resumo

Identificar em que medida recessões são causadas por fatores domésticos ou externos demanda rigor metodológico na escolha do método quantitativo mais apropriado. A metodologia do controle sintético tem sido utilizada para avaliar, numa perspectiva comparativa, os determinantes da performance econômica brasileira ao longo da última década, especificamente no que tange a agregados macroeconômicos. Esta dissertação tem como objetivo identificar quais setores da economia brasileira descasaram de referenciais internacionais durante a recessão pós-2014, potencialmente devido a fatores domésticos cristalizados pelo governo que foi reeleito em outubro/2014. Utilizar-se-á a metodologia do controle sintético para comparar índices setoriais domésticos - construídos a partir de informações de companhias de capital aberto - com referenciais internacionais antes e depois das eleições de 2014. Os resultados mostram uma deterioração generalizada na maior parte dos setores econômicos brasileiros valorados em dólares, o que constitui um efeito indireto da depreciação da taxa de câmbio durante o período. Ademais, os setores de consumo não-cíclico, de máquinas e equipamentos e imobiliário performaram abaixo de seus comparáveis mesmo quando considerado o desempenho em moeda local, hipoteticamente sinalizando que causas domésticas explicam a tendência dessas indústrias, que são diretamente correlacionadas com variáveis e políticas macroeconômicas.

Palavras-Chave: Controle Sintético. Análise Comparativa. Economia Brasileira. Recessões.

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1. INTRODUCTION

Understanding the causes of the 2014-2017 recession in Brazil is an effort undertaken by many researchers that analyze the New Economic Matrix (Schymura, 2017). This nomenclature was explicitly utilized by the Brazilian Government in 2012¹ to identify a set of economic drivers that led to gradual interest rate cuts combined with exchange rate devaluation and other interventions such as sectorial subsidies. The New Economic Matrix has been considered by a few authors (Pessoa, 2016 and Almeida Jr., 2015) as a major cause for the recent recession, inducing some criticism from others that attribute the economic downturn to external factors.

Pessoa (2016) describes the New Economic Matrix as the strengthen of discretionarity policies to the detriment of markets functionality. Some stylized factors exemplify the new matrix according to the author: 1) more frequent governmental interventions in the foreign exchange market; 2) adoption of accounting strategies in order to match the governmental budget; 3) lower tolerance to inflation implied by interest rate cuts; 4) artificial price controls, specially in the energy and oil and gas sectors; 5) governmental interventions eclipsing regulatory agencies of different industries; 6) subsidized-credit expansion through public and development banks; 7) lower degree of economic openness and 8) utilization of state owned companies to intervene in energy prices and credit spreads.

Table 1 provides a good overview of two different stages of the Brazilian economy since the 2008 crisis: a positive momentum from 2010 to 2013 and a downturn from 2014 to 2017. The first part comprises positive GDP growth, falling unemployment rate and dropping interest rates. From 2014 on, a massive GDP devaluation upstretched government debt (as a percentage of GDP) together with inflation, leading the Brazilian Central Bank to raise domestic interest rates. The combination of these factors created a perfect storm for worsening economic conditions.

¹ Schymura (2017) points that the expression was first utilized in 2012 by the Secretary for Economic Policy, Márcio Holland, in an interview with a local newspaper. According to the Secretary, lowering interest rates, a more competitive currency and some gradual fiscal adjustments were part of a “new economic matrix”. The author also explains that the nomenclature has started to be used by the Minister of Finance in order to describe a somehow innovative economic policy framework put in place by the government of Dilma Rousseff.

Table 1: Selected Brazilian macroeconomic indicators

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GDP (% YoY)	-0.1	7.6	4.0	1.9	3.0	0.6	-3.5	-3.3	1.1	1.1
Unemployment (%)	9.7	8.5	7.8	7.4	7.2	6.8	8.3	11.3	12.8	12.3
Government debt (% of GDP) ^a	59.2	51.8	51.3	53.7	51.5	56.3	65.5	69.9	74.1	77.2
CPI (% YoY)	4.3	5.9	6.5	5.8	5.9	6.4	10.7	6.3	2.2	3.8
Interest rate (% , yearly average) ^b	9.8	10.0	11.8	8.5	8.4	11.0	13.6	14.2	9.8	6.5

^a Gross figure

^b Selic (Central Bank target)

Source: Refinitiv, World Bank, Brazilian Central Bank

According to CODACE (2017), the 2014-2016 recession was the longest amongst the nine events monitored by the committee² since 1980. It lasted eleven quarters (between the second quarter of 2014 and the fourth quarter of 2016), accumulating a decline of c.8.6% in GDP terms and resulting in record high unemployment rate (12.8%) in 2017. The causes of the recession are analyzed through different perspectives and researchers commonly consider domestic and exogenous factors.

Before the recession, Holanda Filho and Pessoa (2014) utilized long term growth models to decompose drivers of the Brazilian economy from 1982 to 2013. They find that a shrinking Total Factor Productivity (TFP) had a negative contribution to macroeconomic growth from 2009 to 2013. According to the authors, diminishing productivity is primarily due to a high degree of governmental interventionism, which is inherent to the New Economic Matrix. Moreover, citing a study from the International Monetary Fund, Holanda Filho and Pessoa (*ibidem*) point that Brazil deaccelerated more than the global economy during this period: from 2009 to 2013, the world economy grew 0.54% less than 2003 to 2010, whilst the analogous delta for the Brazilian economy is circa 2.01%. The researchers emphasize that such a discrepancy could not be explained by the international market, especially because Brazil had a low degree of economic openness at that time.

Although domestic events and policy decisions weighted on macroeconomic performance, we cannot deny that the Brazilian economy faced worsening international market conditions after

² CODACE (*Comitê de Datação de Ciclos Econômicos*) is an independent committee formed by researchers from universities, think tanks and consultancy firms whose objective is to track economic events and stages of economic cycles.

2011, primarily the euro crisis and the Chinese slowdown (Ferrari Filho and De Paula, 2015). In 2012, when the euro crisis began to affect the Brazilian economy, the Brazilian Central Bank introduced several macroprudential measures – a rise in reserves requirements on sight and fixed term deposits, additional taxation on financial transactions (IOF) affecting all credit operations and new foreign loans and, more importantly, domestic interest rate cuts (from a peak of 12.50% in 2011 to 7.25% in 2013).

The Brazilian economy did not respond to the new policy framework, posting a modest 1.9%/annum GDP growth rate in 2012. As a result, the fiscal surplus relative to GDP, which peaked at 4.8% in 2005, deteriorated and became a deficit of -0.6% in 2014. The fiscal imbalance led the government to cut discretionary expenses and implement hawkish monetary actions, boosting domestic interest rates to 14.25%.

Serrano and Summa (2015) highlight that the fiscal adjustment plus higher interest rates were the main causes of the subsequent crisis. The authors argue that contractionary policies, mainly higher interest rates, weighted on household consumption, heavily dependent on personal credit. Moreover, gross fixed capital formation, that was growing at an average annual rate of 8% from 2004 to 2010, collapsed to a negative rate of -4.3% in 2014.

It is well established that the economic downturn was a combination of internal and external factors. ECB (2016) pointed, through a Bayesian structural VAR, that shrinking commodity prices and internal policies have statistical influence in the recession. Matos (2016) also highlights that a conjunction of different drivers, including external prices, should be considered in the analysis, although policy makers appear to excel as a major influence.

I present a different approach to identify whether the recession can be assessed by idiosyncratic, i.e. internal factors, or by external influences from a sectorial perspective. The method consists in analyzing the stock market performance of different sectors through a synthetic control approach. The rationale behind the method is the intuitive correlation between stock market returns and economic growth. Levine and Zervos (1998) show that stock market attributes - such as liquidity, capital stock growth, capitalization, volatility and CAPM integration - are positively and robustly

correlated with current and future rates of economic growth even after controlling for many other factors associated³.

Assuming the re-election of Dilma Rousseff in 2014 as an intervention to be examined, I create counterfactuals of sectorial stock market indexes from sectorial donor pools formed by various foreign listed companies. Intuitively, if there is a mismatch between the actual performance of Brazilian sectors and the counterfactuals, then a treatment effect should be considered. It means that idiosyncratic factors, i.e. internal policies, may be affecting the indexes behaviors during the post-treatment period.

The global economy faced deteriorating conditions in 2014. UNCTAD (2015) shows that global foreign direct investments (FDI) fell by 16% to US\$ 1.23 trillion in 2014 and large divestments offset new inflows. On the other hand, FDI flows to developing economies increased by 2% to a historically high level in 2014. Developing Asia drove the increase while flows to Latin America and the Caribbean declined. UNCTAD (*ibidem*) highlights that falling commodity prices helps to explain the shrinking investors' appetite for Latin America. Specifically in Brazil, FDI flows remained constant in 2014 (as of 2013), but with a different balance: lower investments in the primary sector and new inflows to manufacturing and services.

With weak investments from a global perspective, internationally integrated sectors could hypothetically follow similar patterns across different countries. Sectors like oil and gas and manufacturing, which are affected by international commodity prices such as crude oil and metals, are natural candidates to couple with the synthetic controls along the post-intervention period. Other sectors, such as utilities and cyclical consumption, are more vulnerable to internal and Brazil-specific dynamics. Obviously, there are cross-sector linkages and externalities that are not directly captured by the synthetic controls approach and this is a potential limitation for the methodology.

The intervention analyzed in the quantitative exercise is the re-election of Dilma Rousseff in October/2014. Dilma re-election represented the continuity of the New Economic Matrix and high frequency data gathered from the Brazilian capital market would provide instant signals and

³ The idea is that a greater ability to trade ownership of an economy, i.e. company shares, facilitates resource allocation, capital formation, and economic growth.

expectations from investors with regards to specific economic sectors immediately after the elections. Applying the synthetic control to indexes built upon listed companies' shares is a feasible solution to capture sectorial nuances and causality evidences.

Even though the precise starting day of the recession is difficult to measure, this dissertation considers the re-election of Dilma Rousseff in October/2014 as the treatment to be analyzed in two perspectives. Positioning the treatment within the year 2014 allows one to assess the relative performances of Brazilian sectors along the recession period (that lasted from 2014 to 2016), but also enables one to assess whether the re-election of Dilma Rousseff had an immediate effect on stock performance of various sectors.

The remainder of this dissertation is divided into five sections. Section 2 introduces an overview of the synthetic control approach, with a summary of cases and seminal papers. Section 3 presents the methodology and formal procedures. Section 4 details the data utilized in this publication. Sections 5 and 6 present results and robustness tests, respectively.

2. OVERVIEW OF THE SYNTHETIC CONTROL APPROACH

Effects of events and policy interventions that take place at an aggregate level and affect economic variables are difficult to measure. Social scientists often utilize comparative studies, since experimental designs do not constitute a feasible alternative for many research initiatives in economics.

Researchers often select comparison groups according to measures of affinity between affected and unaffected units, but challenges arise when electing a set of treated units is not permitted due to the nature of the treatment. When the treatment affects only one unit at an aggregate level, it is often difficult to find a single unexposed unit that approximates the most relevant characteristics of the unit exposed to the event of interest. Therefore, comparative case studies are only feasible when some units are exposed and others are not.

Dealing with this methodological context, the synthetic control approach assumes that a combination of units often provides a better comparison for the unit exposed to the intervention than any single unit alone. The method constructs a weighted average of control units that is as similar as possible to the treated unit regarding the pre-treatment outcome variable and other covariates of interest (predictors).

Abadie and Gardeazabal (2003) inaugurated the synthetic control technique using a combination of two Spanish regions to approximate the economic growth that the Basque Country would have experienced in the absence of terrorism. The synthetic control is a weighted average of the available control units and it emphasizes the relative contribution of each control unit to the counterfactual of interest. It also takes into consideration similarities between the unit affected by the event of interest and the synthetic control. In comparison with other econometric techniques, the model extends the difference-in-differences framework (Abadie et al., 2010), allowing that the effects of unobserved variables on the outcome vary with time.

The results obtained by Abadie and Gardeazabal (2003) indicate that there is a measurable effect of terrorism⁴ within economic indicators of the Basque Country after the 1970s. During the 1960s, the Basque Country had higher per capita income relative to the whole Spain economy, higher

⁴ ETA (*Euskadi Ta Askatasuna*) was founded in 1959 to fight for the Basque state independency. ETA produced its first victim in 1968, but the group did not implement a large-scale terrorist activity until the mid 1970s (Abadie and Gardeazabal, 2003).

investment ratio (investment/GDP), was more densely populated, had a higher percentage of industrial production and a better educated labor force. Provided with these particularities, a simple comparison between the Basque Country and the rest of Spain during the terrorism period may not only reflect the impact of terrorism itself, but also other pre-terrorism differences which affected subsequent economic growth. The synthetic control, which is a weighted combination of other Spanish regions resembling characteristics of the Basque Country, is a valid counterfactual for a better comparison.

The authors show a 10% average gap (over a two-decades period) between Basque per capita GDP and the per capita GDP of a comparable synthetic region without influence of terrorism. Furthermore, changes in per capita GDP gap appear to be associated with the intensity of terrorist attacks.

Several papers have included the synthetic control as a tool to evaluate policy interventions since the seminal work above mentioned. Abadie et al. (2010) analyzed the first modern-time large-scale tobacco control program, known as Proposition 99, issued in California in 1988⁵. The authors created a synthetic California state, with weights chosen so the result best reproduces the set of predictors of Californian cigarette consumption before the intervention.

The predictors of smoking prevalence were: average retail price of cigarettes, per capita state personal income, the percentage of the population age 15–24, and per capita beer consumption. The results suggested that between 1989–2000 cigarette consumption was reduced by an average of almost 20 packs per capita, a decline of circa 25%.

Billmeier and Nannicini (2013) used the synthetic control method to investigate the impact of economic liberalization on real GDP per capita in a worldwide sample of countries. The authors find that liberalizing the economy has a positive effect overall, but more recent liberalizations, in the 1990s and mainly in Africa, had dubious effect as shown per the lack of significance observed in the synthetic controls post-intervention.

Abadie et al. (2015) studied the effect (in per capita GDP terms) of the re-unification process in West-Germany in 1990. They used 16 countries as potential controls and 30 years of data prior to

⁵ The program has increased California's cigarette excise tax by 25 cents per pack and funded anti-smoking campaigns.

re-unification to create a synthetic control. The German reunification did not have much of an effect on West German per capita GDP in the first two years immediately following the intervention. From 1992 onward, however, the results suggest a negative effect of the reunification on West German income: over the entire 1990–2003 period, per capita GDP was reduced by about 1,600 USD per year on average, which accounts for approximately 8% of the 1990 reference level.

Grier and Maynard (2016) use the synthetic control approach to assess the impact of Hugo Chavez on the Venezuelan economy. They find that Venezuelan average income lagged behind the synthetic control, although inequality has fallen faster than it would have without Chavez⁶.

Chamon et al. (2017) used the synthetic control approach to estimate the impact of the Brazilian Central Bank program of sterilized foreign exchange in 2013 on the level and volatility of the exchange rate. The synthetic control, based on other emerging markets, indicated that the program led to an appreciation of the Brazilian real in excess of 10 percent. Moreover, the authors found evidence of decreasing option implied volatilities. On the other hand, a second announcement extending the program had weaker effects and subsequent extensions had no impact.

Possebom (2017) applied the synthetic control method in order to evaluate the economic impact of the Free Trade Zone of Manaus (FTZM). The results show that FTZM had positive effects on real GDP per capita, but, on the other hand, had significantly negative effects on Agriculture Total Production per capita. The dichotomic outcome makes the author reject the view that industrialization policies benefit all economic sectors due to positive spill-overs from the manufacturing sector.

In order to understand the Brazilian GDP positive momentum in the early 2000s, Carrasco et al. (2014) show, using the synthetic control approach, that the Brazilian counterfactual, built upon a donor pool of 19 countries, overperformed Brazil's actual performance within the 2003-2011 period. Analogously, to explain the Brazilian downturn post-2011, Balassiano (2017) utilizes the same 19 countries to create another synthetic control, that also overperformed the Brazilian economy from 2011-2016. With a similar objective, Cytrynowicz (2017) also finds that the Brazilian economy failed to match its counterfactual during the referenced period. Intuitively,

⁶ Even though the placebos do not show strong evidence that Chavez clearly contributed to that phenomenon.

these results demonstrate that internal factors, i.e. governments and policies, matter and cause-effect relationships can be better assessed with the synthetic control approach.

3. METHODOLOGY

Observing data for $(J + 1) \in \mathbb{N}$ regions during $T \in \mathbb{N}$ time periods. If there is an intervention that affects only region 1 from time $T_0 + 1$ to period T uninterruptedly, being $T_0 \in (1, T) \cap \mathbb{N}$, then scalar $Y_{j,t}^N$ is the potential outcome that would be observed for unit j in period t assuming no intervention for $j \in \{1, \dots, J + 1\}$ and $t \in \{1, \dots, T\}$. Let scalar $Y_{j,t}^I$ be the potential outcome that would be observed for unit j in period t if j faced an intervention at period t . We define the intervention effect as per:

$$\alpha_{j,t} = Y_{j,t}^I - Y_{j,t}^N$$

Let $D_{j,t}$ be a dummy that assumes value 1 if unit j faces the intervention in period t and value 0 otherwise. The outcome for unit j in period t is given by $Y_{j,t} = Y_{j,t}^N + \alpha_{j,t}D_{j,t}$ and we aim to estimate $(\alpha_{1,T_0+1}, \dots, \alpha_{1,T})$.

Let $\mathbf{Y}_j = [Y_{j,1} \dots Y_{j,T_0}]'$ be the vector of observed outcomes for unit j during the pre-treatment period and \mathbf{X}_j a $(K \times 1)$ vector of predictors of \mathbf{Y}_j . We want to make the synthetic control of unit 1 as similar as possible to the actual values of unit 1, in such a way that we obtain $\hat{Y}_{1,T}^N = \sum_{j=2}^{J+1} \hat{w}_j Y_{j,t}$ as an estimator of $Y_{1,t}^N$.

The weights \hat{w}_j are given within the vector $\hat{\mathbf{W}} = [\hat{w}_2 \dots \hat{w}_{J+1}]' = \hat{\mathbf{W}}(\hat{\mathbf{V}}) \in \mathbb{R}^J$, which is a solution for the following optimization problem:

$$\hat{\mathbf{W}}(\hat{\mathbf{V}}) = \arg \min (\mathbf{X}_1 - \mathbf{X}_0 \mathbf{W})' \mathbf{V} (\mathbf{X}_1 - \mathbf{X}_0 \mathbf{W})$$

Being $w \geq 0$ for each $j \in \{2, \dots, J + 1\}$ and $\sum_{j=2}^{J+1} w_j = 1$. \mathbf{V} is a diagonal positive semidefinite matrix of dimension $(K \times K)$. In addition:

$$\hat{\mathbf{V}} = \arg \min (\mathbf{Y}_1 - \mathbf{Y}_0 \hat{\mathbf{W}}(\mathbf{V}))' (\mathbf{Y}_1 - \mathbf{Y}_0 \hat{\mathbf{W}}(\mathbf{V}))$$

We define $\hat{\mathbf{W}}$ as a weighting vector that measures the relative importance of each unit in the synthetic control of unit 1 and $\hat{\mathbf{V}}$ measures the relative importance of each one of the the K predictors. This approach makes the synthetic control of unit 1 as similar as possible to the actual values assumed by unit 1 considering the K predictors and the pre-intervention values of the outcome variable. As a result, $\hat{\alpha}_{1,t} = Y_{1,t} - \hat{Y}_{1,t}^N$ provides the estimated gap, or the treatment effect.

3. 1. Inference

The synthetic control method implies a data-driven process to select the comparison units, providing more transparency and less discretionary power to the researcher, but it does not provide clear guidance on the choice of predictor variables used to estimate the weights (Ferman et al., 2016). Another limitation is the scarcity of inference tools. In this specific matter, several researchers have published seminal papers to formalize an inference framework for the synthetic control methodology.

Abadie et al. (2010) and Abadie et al. (2015) developed inference procedures for small samples. Using placebo tests, they compare an observed test statistic to its empirical distribution “in order to verify whether there is enough evidence to reject the null hypothesis of no effect whatsoever” (Firpo and Possebom, 2017).

Abadie et al. (2010) tried to assess how often they would obtain results of the same magnitude if they had chosen a random unity for the study instead of California. The authors ran placebo studies by applying the synthetic control method to states that did not implement a largescale tobacco control program during the period of their study. If the placebo studies create gaps of magnitude (and direction) similar to what is observed for California after the intervention, then the interpretation is that the original analysis does not provide significant evidence of efficiency of the tobacco control program.

The researchers have found that, among the placebos, the probability of having a treated unit with a gap versus its counterfactual as wide as California had was 1/39. This result has been attained with the comparison of the root mean squared prediction error (RMSPE) obtained in the post-intervention sample for the various placebos with the RMSPE obtained for California.

The RMSPE measures lack of fit between the path of the outcome variable for the treated unit and its synthetic control (Abadie et al., 2015). The statistic is defined as follows:

$$RMSPE_j = \frac{[\sum_{t=T_0+1}^T (Y_{1,t} - \hat{Y}_{j,t}^N) / (T - T_0)]}{\left[\frac{\sum_{t=1}^{T_0} (Y_{1,t} - \hat{Y}_{j,t}^N)^2}{T_0} \right]}$$

Abadie et al. (2010) highlight an alternate version of a p value given by:

$$p = \sum_{j=1}^{J+1} [RMSPE_j \geq RMSPE_1] / (J + 1)$$

Abadie et al. (2015) considers the p value as the probability of obtaining an estimate at least as large as the one obtained for the unit representing the case of interest when the intervention is randomly reassigned within the data set.

The RMSPE approach is utilized in its mathematical formulation but also intuitively through graphical analysis. The placebos are plotted in the same chart in comparison with the effective treated unit and its counterfactual. Whenever the synthetic control of the treated unit detaches from the placebos within the post-treatment period (meaning that its gap is wider compared to the other units), there is a strong evidence of a treatment effect. Abadie et al. (2010) considers excluding placebos with a poor pre-treatment fit from the graphical analysis in order to enhance the inference approach.

The placebo graphical analysis is criticized by Ferman and Pinto (2017). According to them, “excluding placebos with a poor pre-treatment fit from the graphical analysis can be misleading as, under this strategy, placebos with a better pre-treatment fit relative to the treated unit would still be considered. Since placebos with a lower pre-treatment MSPE would tend to have a less volatile post-intervention prediction error, this may lead researchers to over-estate the significance of their results.”

Although the RMSPE is extensively used in various papers, researchers are developing new techniques aiming to improve the inference procedures in synthetic control exercises. Firpo and Possebom (2017), as an example, invert the test statistic to estimate confidence sets and extend the inference tools to other test statistics (other null hypothesis rather than no effect whatsoever) and to problems with multiple treated units.

4. DATA

The 62 constituents of the Ibovespa Index were segregated into 11 sectors: machinery and transport, cyclical consumption, non-cyclical consumption, banks, financial (others), manufacturing, oil and gas, health, telecommunications, utilities and real estate. The components of each segment were then gathered into sectorial weighted indexes, henceforth compounding 11 treated units, being the market capitalization the weight. Each individual sectorial unit was independently compared with a counterfactual selected from the 11 donor pools accordingly.

The underlying data for the donor pools comprises daily market information of 1,466 companies⁷ from 30 countries, operating in the same 11 sectors above mentioned. These assets are the constituents of various regional stock indexes: S&P 500 (United States), S&P/TSX 60 (Canada), Nikkei 225 (Japan), IPC (Mexico), Merval (Argentina), IPSA (Chile), ASX (Australia), STOXX 600 (Europe), SSE (China), MOEX (Russia), JSE (South Africa) and Sensex (India). Each of the 11 sectors has an associated donor pool formed by companies from numerous countries, but same respective sectors, in such a way that every synthetic control is run independently.

The main outcomes utilized in the optimization process for the synthetic controls are i) stock price (daily settlement), ii) price/earnings ratio, iii) market capitalization, iv) total debt/enterprise value, v) enterprise value/EBIT and vi) exchange rate. The database was built with monthly average prices gathered from market portals, specifically from the Refinitiv platform.

The price/earnings ratio (P/E ratio) assigns a value for a firm that measures its share price relative to its earnings per share proportion. A common interpretation for a high P/E ratio implies that investors are anticipating higher earnings prospects, whilst the opposite (low P/E) is often related to less optimistic forecasts. Goodman and Peavy III (1986) point that, as a matter of fact, a low P/E ratio indicates either a firm is presently undervalued, or it is performing exceptionally well relative to its historical figures. The utilization of the P/E ratio in this analysis aims to approximate firms with similar valuation standards among investors.

⁷ The companies were categorized under the 11 above mentioned sectors, i.e. banks (102 companies), cyclical consumption (135 companies), financial (45 companies), health (114 companies), machinery and transport (238 companies), manufacturing (335 companies), non-cyclical consumption (206 companies), oil and gas (35 companies), real estate (129 companies), telecommunications (72 companies) and utilities (55 companies).

The market capitalization refers to the nominal market value of a company's outstanding shares (combined). Enterprise value, on the other hand, adds to the market capitalization the total debt, preferred stock and short-term investments minus any cash balance shown within a firm's balance sheet. As a result, dividing the total debt by the enterprise value is an alternative way of assessing the indebtedness of the company on a high frequency basis. This is an important risk metric for capital structure, as companies are dynamically choosing its funding alternatives according to economic trade-offs and implied default risk (Myers, 1984), which is usually correlated with indebtedness.

Analogously, enterprise value/EBIT⁸ provides an indicative of the firm's operating performance, or, in other words, how much a company is valued per each monetary unit of EBIT. Considering both the indebtedness and operating performance for the elements in the donor pool is another method to account for similarities among companies along the optimization process.

The foreign exchange (FX) component is a fundamental piece for smoothing distortions at country and macroeconomic levels. Differences among trade terms across different geographies may change local stock prices behavior, particularly when a specific company benefits either from imports or exports. Not only the FX component is considered in the analysis, but synthetic controls are also built in US\$-denominated terms for comparison with price trends in local currencies.

The idiosyncratic intervention that I analyze is the re-election of Dilma Rousseff in October/2014, having four years before and four years after the intervention within the modelling framework. As afore mentioned, the election event enables one not only to understand what happened along the 2014-2016 recession, whose boundaries are not time-precise, but also permits the assessment on whether the re-election immediately affected stock performance of various sectors.

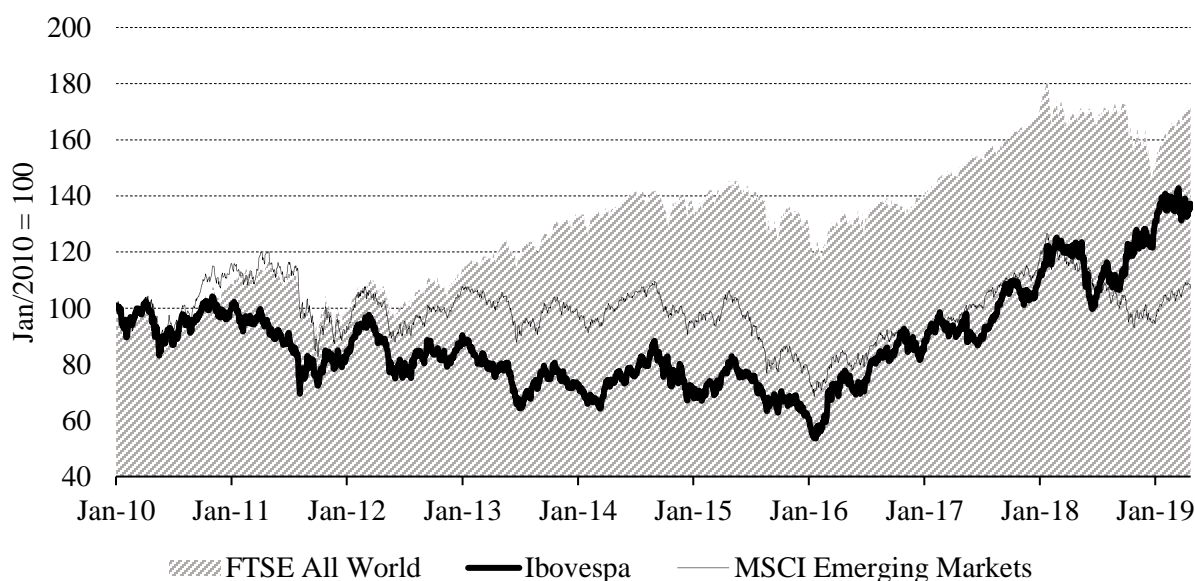
According to Chang (2010), the interaction between electoral uncertainties and international capital flows may result in magnified responses to exogenous shocks and self-fulfilling crisis. The high volatile scenario emerged from the 2014 elections in Brazil was particularly exacerbated: Carvalho (2016) shows, using probability density estimates embedded in Brazilian stock options prices, that a company's market value could dramatically change conditional to election results.

⁸ EBIT stands for Earnings Before Interest and Taxes

Moreover, increasing odds of Dilma Rousseff winning the presidential race were associated with negative price moves.

Figure 1 shows the behavior of a major Brazilian equity index (Ibovespa) versus two analogous price components, that represent i) the global equity market (FTSE All World⁹) and ii) the stock market performance of emerging markets (MSCI Emerging Markets¹⁰). Irrespective of any embedded exchange rate influence in the various components, the global market momentum from 2010 to 2018 appears to outstand emerging markets, which is partially explained by the prominent performance of equity prices in advanced economies within the period.

Figure 1: Performance of selected equity indexes



Source: Refinitiv

The comparison of equity indexes is justified under assumptions of pairwise directional connectedness. However, given that volatility spillovers amid financial markets was transformed from unidirectional into bidirectional (Diebold and Yilmaz, 2015) after the crisis of 2008, causality inference deserves special attention.

⁹ The FTSE All World Index is a stock market index that covers over 3,100 companies in 47 countries. It is published by the FTSE Group, which is a subsidiary of the London Stock Exchange (created from a joint venture between the Financial Times and the Exchange).

¹⁰ The MSCI Emerging Markets Index is published by MSCI, a global provider of equity, fixed income and other assets. MSCI Emerging Markets Index covers over 1,100 constituents from 24 countries.

The Brazilian stock market underscores asymmetries among different sectors. Taking the oil and gas industry as an example, with such a global player like Petrobras listed as one of the largest public Brazilian companies, it is reasonable to assume that not only the Brazilian oil and gas framework is affected by the global petroleum market, but also the opposite can be true. From an aggregate perspective, however, the general case sets the causality vector from international developed markets affecting local returns and volatility (Oliveira and Maranhão, 2019).

The synthetic control method provides a useful alternative to test causality in this environment of cross-country volatility spillovers. By emulating the Ibovespa sectorial indexes before 2014, the counterfactuals deliver valuable insights on possible trends considering the theoretical absence of the intervention (i.e. the re-election of Dilma Rousseff), already taking into consideration intra-firm similarities such as capital structure, profitability and earnings prospects. For illustrative purposes, table 1 summarizes mean and standard deviation for the outcomes utilized in the synthetic controls.

Table 2: Descriptive statistics of variables utilized in the synthetic control

Sector ^a	Price ^b	Capitalization ^c	P/E ^d	Debt/EV ^e	EV/EBIT ^f
Oil and gas	131 (95)	28 (41)	22 (110)	31 (19)	18 (76)
Oil and gas (Ibovespa)	77 (10)	57 (40)	12 (14)	52 (16)	14 (4)
Banks	137 (117)	25 (40)	20 (13)	75 (69)	48 (70)
Banks (Ibovespa)	151 (59)	99 (51)	9 (3)	82 (19)	53 (57)
Machinery	170 (116)	8 (19)	32 (198)	35 (26)	21 (109)
Machinery (Ibovespa)	58 (17)	16 (8)	12 (3)	37 (20)	14 (4)
Financial, others	170 (97)	19 (22)	29 (29)	26 (26)	15 (18)
Financial, others (Ibovespa)	214 (87)	16 (5)	17 (9)	5 (3)	16 (3)
Utilities	183 (235)	21 (32)	24 (33)	37 (20)	19 (20)
Utilities (Ibovespa)	125 (39)	17 (9)	8 (2)	44 (3)	8 (2)
Telecom	189 (216)	24 (39)	29 (135)	29 (20)	18 (32)
Telecom (Ibovespa)	182 (46)	13 (5)	13 (5)	16 (4)	13 (3)
Non cyclical	199 (174)	20 (41)	27 (171)	24 (23)	17 (17)
Non cyclical (Ibovespa)	141 (24)	46 (13)	20 (9)	16 (4)	15 (4)
Real estate	211 (240)	18 (44)	38 (333)	28 (18)	25 (57)
Real estate (Ibovespa)	140 (28)	7 (2)	11 (14)	33 (6)	22 (4)
Cyclical	213 (150)	31 (66)	29 (70)	20 (16)	19 (31)
Cyclical (Ibovespa)	128 (83)	14 (5)	29 (12)	26 (7)	20 (20)
Health	219 (230)	26 (44)	32 (156)	18 (15)	22 (109)
Health (Ibovespa)	159 (86)	5 (1)	6 (3)	28 (5)	15 (9)
Manufacturing	219 (1148)	18 (37)	38 (367)	24 (19)	32 (645)
Manufacturing (Ibovespa)	80 (28)	60 (45)	11 (4)	37 (13)	13 (4)

^a First row shows statistics for the whole sample, whilst the second relates to the Brazilian indexes built upon the Ibovespa sectorial constituents

^b Average rice variation from January/2010 to December/2018 (January/2010 = 100)

^c Market capitalization in US\$ bi

^d Price/Earnings

^e Total Debt/Enterprise Value in %

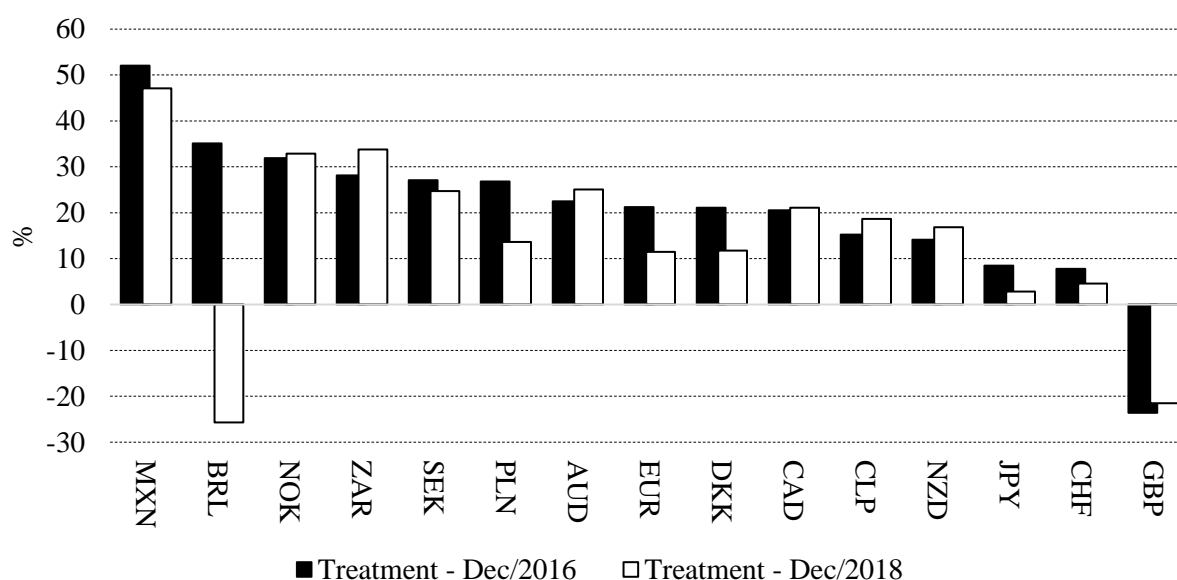
^f Enterprise Value/EBIT

5. RESULTS

In this section I present the synthetic controls obtained for the various sectors denominated in two currencies: local (Brazilian Real, or R\$) and convertible (US dollar, or US\$). The multi-currency approach aims to incorporate different optics to the comparison. Firstly, there is a direct relationship between stock market returns and the exchange rate in Brazil, as shown by Machado et al. (2017). Secondly, as the donor pools comprise companies from several countries, the comparison of returns in US\$ partially solve for local currencies asymmetries.

Figure 2 shows that most of the currencies utilized in our analysis have depreciated against the US Dollar (positive return meaning depreciation), except for the British Pound. However, the Brazilian Real also displays a very peculiar dichotomous behavior: a 35% depreciation from the election of Dilma Rousseff in 2010 to December/2016, followed by a strong appreciation along the last two years of the sample, accumulating a 26% appreciation in the whole post-treatment period.

Figure 2: Accumulated performance of selected currencies^a (in %) versus the treatment level^b



^a MXN (Mexican Peso), BRL (Brazilian Real), NOK (Norwegian Krone), ZAR (South African Rand), SEK (Swedish Krona), PLN (Polish Zloty), AUD (Australian Dollar), EUR (Euro), DKK (Danish Krone), CAD (Canadian Dollar), CLP (Chilean Peso), NZD (New Zealand Dollar), JPY (Japanese Yen), CHF (Swiss Franc), GBP (British Pound) – all against the US dollar

^b Two periods: from treatment to December/2016 and from treatment to December/2018

Source: Refinitiv

Discussing the Brazilian Real appreciation against the US dollar after 2016 is not a primary objective of this dissertation. Presenting the dichotomous behavior of the Brazilian currency along the period is, on the other hand, important to understand how the synthetic controls behave in both local and convertible currencies.

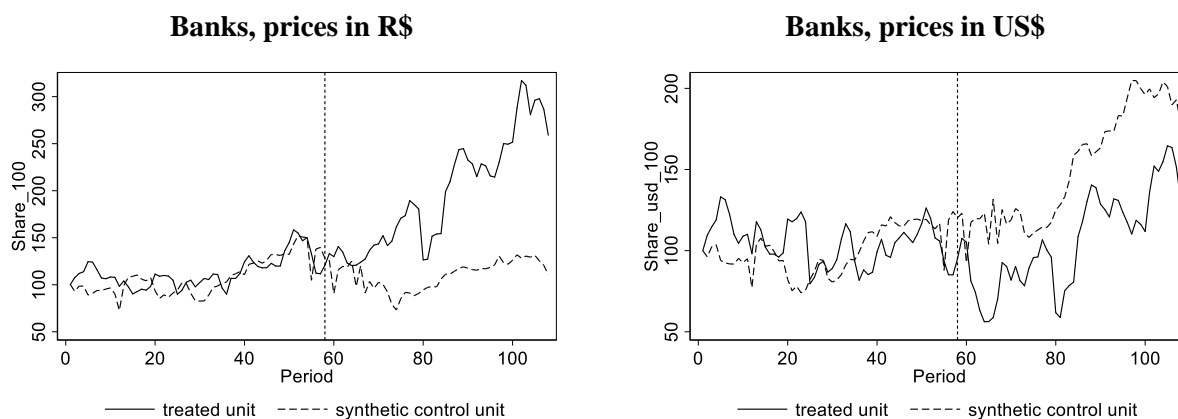
5.1. Performance of individual sectors

5.1.1. Performance of the banking sector

The performance of the Brazilian banking sector outperforms the synthetic control in local currency after the treatment. As per the Brazilian Central Bank (2017), the delinquency component of the average cost of outstanding loans (ICC) rose from 21% in 2015 to 24% in 2017¹¹ due to the recession, but it did not hamper the positive momentum of banking shares. This is partially explained by the also increasing credit spread within the period, which apparently offsets part of the negative effect arising from a shrinking credit-to-GDP ratio in Brazil.

Running the same analysis with US dollar returns, the immediate FX devaluation in Brazil after the re-election of Dilma Rousseff in 2014 appears to negatively weight on the relative performance of Brazilian banks. From an international perspective, the Brazilian banking sector did not replicate its counterfactual performance along the post-treatment period.

Figure 3: Synthetic controls for the banking sector



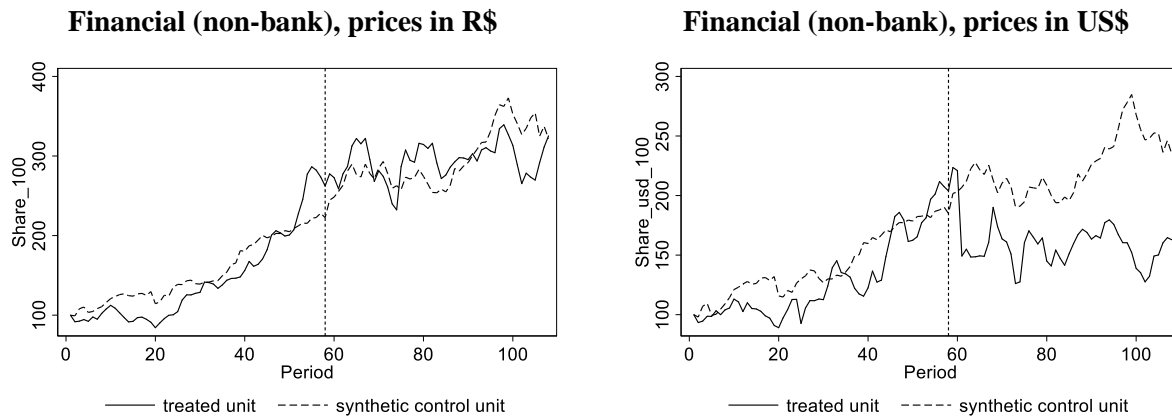
¹¹ The ICC decomposition, for the period from 2015 to 2017, indicated "Funding Cost" as the main component of credit costs (average contribution of 39.2% over the period), followed by "Delinquency" (22,7%).

5.1.2. Performance of financial companies (non-banks)

Different from the banking sector, the non-banking financial industry does not decouple from its synthetic control after the treatment in local currency. A primary conclusion related to this observation is that *a priori* the recession did not affect directly the performance of the financial sector denominated in local currency.

A mismatch can be visually detected when the analysis considers US dollar returns due to the weaker Brazilian Real during the post-treatment period. From an international perspective, the non-banking financial sector underperformed its counterfactual and decoupled immediately after the re-election, as a potential direct result of the treatment.

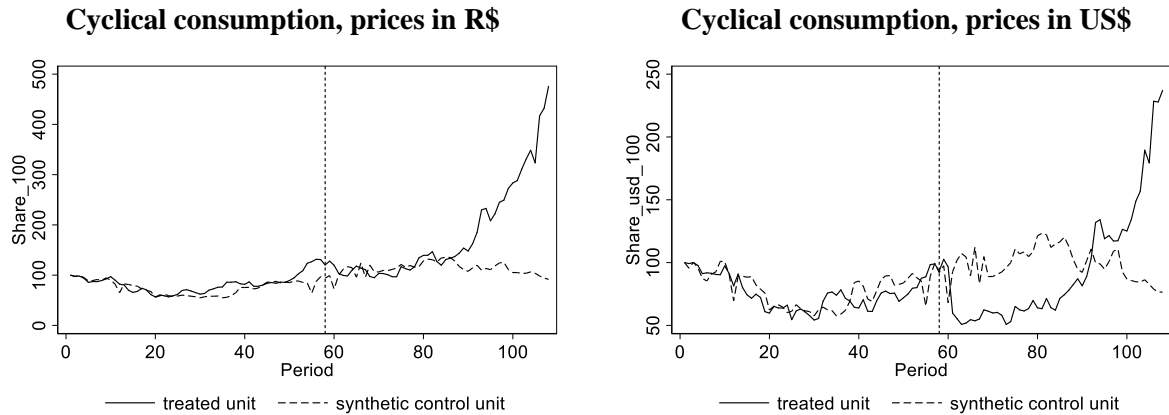
Figure 4: Synthetic controls for financial companies (non-banks)



5.1.3. Performance of the cyclical consumption sector

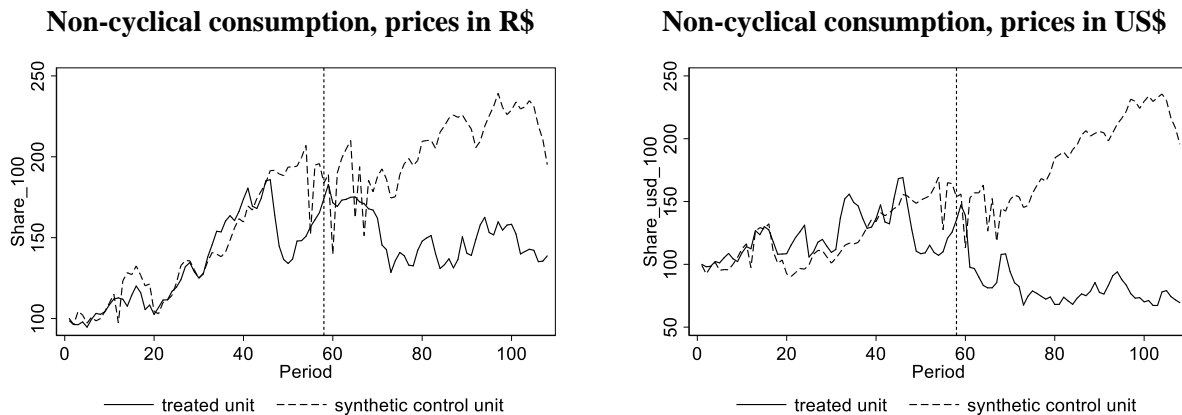
The performance of the cyclical consumption sector surprisingly outperforms the synthetic control in local currency after the treatment. The FX devaluation immediately after the 2014 elections negatively impacts the index performance, however, the sector shows an outstanding performance after 2016 in US dollar terms, influenced not only by the operating performance of the sector itself, but also by the stronger Brazilian Real from 2016 to 2018.

Retail sales in Brazil contracted circa 20% from December/2014 to December/2016 (Berriel, 2018), which makes the cyclical consumption index behavior out of sync when compared to general conditions of the real economy. Part of the astonishing index performance can be particularly attributed to one specific large retail company (Magazine Luiza), whose profitability and market share have grown systematically over the recent years (Félix et al., 2018).

Figure 5: Synthetic controls for the cyclical consumption sector

5.1.4. Performance of the non-cyclical consumption sector

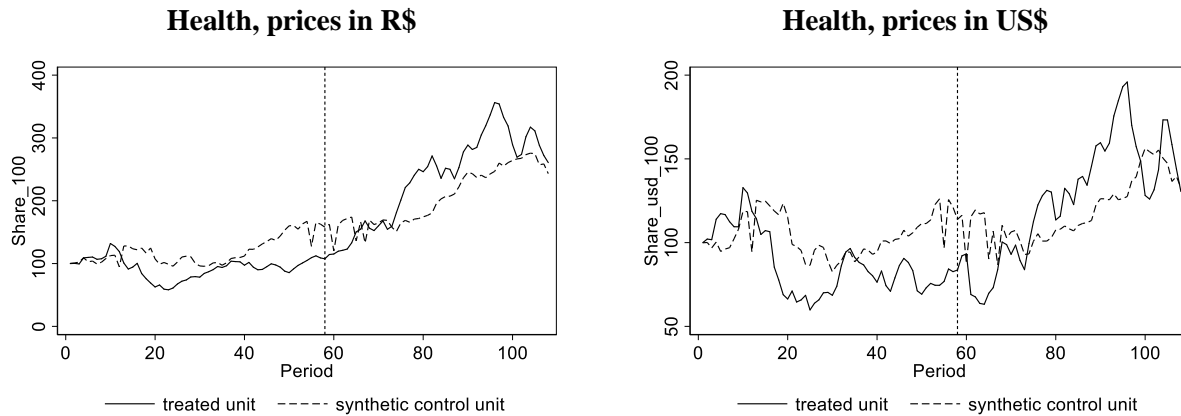
The non-cyclical consumption sector underperforms the synthetic control after the treatment in both Brazilian Real and US dollar terms. The index performance underlies a stagnation component, indicating that the economic downturn affected even theoretically stable sectors, such as food commerce and general retail. Agricultural commodities prices directly affect these segments, that includes exporters of primary goods, and it is known that relevant commodities exported by Brazilian companies (e.g. sugar and soybeans) dropped from 2014 to 2016 (European Central Bank, 2016).

Figure 6: Synthetic controls for the non-cyclical consumption sector

5.1.5. Performance of the health sector

The visual adjustment of the synthetic control in the health sector does not provide a satisfactory indication of the treatment effect. It is reasonable to assume, however, that the Brazilian health sector follows the international momentum after 2014.

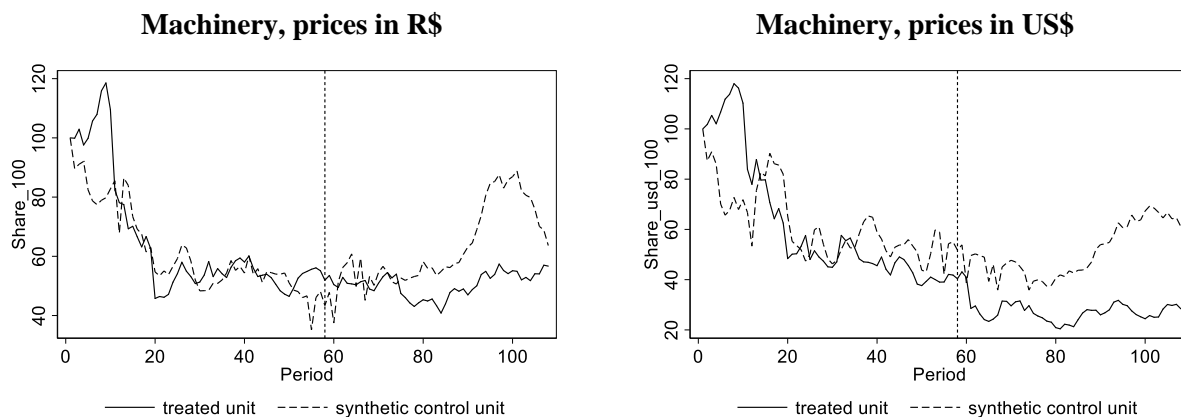
Figure 7: Synthetic controls for the health sector



5.1.6. Performance of the machinery and equipment sector

The machinery and equipment sector index have been moving sideways since 2012 and the treatment does not result in a sharp discontinuity in this rangebound pattern in local currency (only in US dollar terms). However, the synthetic control decouples during the recession period, indicating that the Brazilian industry does not follow the counterfactual positive momentum in both local and convertible currencies from 2016 on. Insights on the development stage of the Brazilian industry can be found on Hiratuka and Sarti (2017).

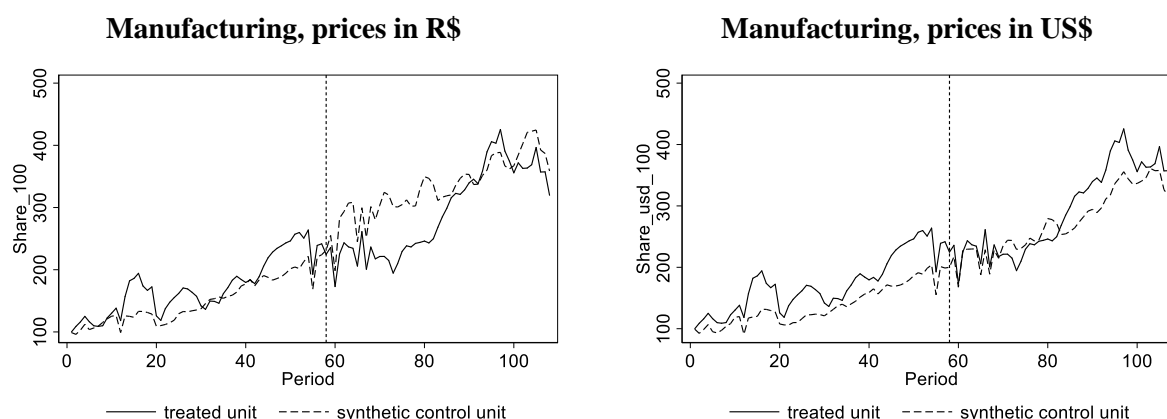
Figure 8: Synthetic controls for the machinery and equipment sector



5.1.7. Performance of the manufacturing sector

The visual adjustment of the synthetic control in the manufacturing sector does not provide a satisfactory indication of the treatment effect. It is reasonable to assume, however, that the Brazilian manufacturing sector follows the international momentum after 2014.

Figure 9: Synthetic controls for the manufacturing sector



5.1.8. Performance of the oil and gas sector

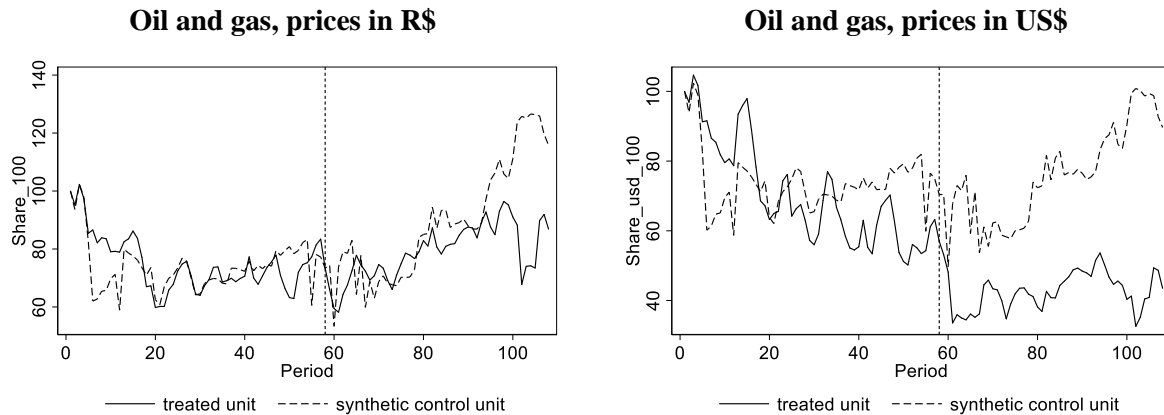
The treatment does not result in a sharp discontinuity in the Brazilian oil and gas sector compared with its counterfactual right after the treatment in local currency. In US dollars, however, the mismatch is more evident. The synthetic control decouples after 2016 - after the recession - indicating that the Brazilian industry does not follow the counterfactual uptrend along the last two years of the sample.

Interestingly, there is no abrupt negative effects that could have possibly arisen from Operation Car Wash, which, according to Medeiros and Silveira (2017), has positioned Petrobras, the largest oil company in Brazil, as a protagonist of the Brazil's greatest recent corruption scandal. As displayed in the charts, the Brazilian oil and gas index remains rangebound for the whole period, but there is a mismatch between the index denominated in US dollar and its synthetic control due to the Real depreciation within the period.

According to the World Bank (2018), the 70% crude oil price drop between 2014 and 2016 was one of the three largest declines since World War II and the most persistent since 1986. The collapse happened primarily due to a combination of surging U.S. shale oil production, receding geopolitical risks involving key producers in the Middle East, shifts in policies by the Organization

of Petroleum Exporting Countries (OPEC), and weakening global growth prospects. The petroleum price recovery that took place after 2017 helped international oil companies to regain market value, but the Brazilian oil and gas index has been struggling to reach the same pace.

Figure 10: Synthetic controls for the oil and gas sector

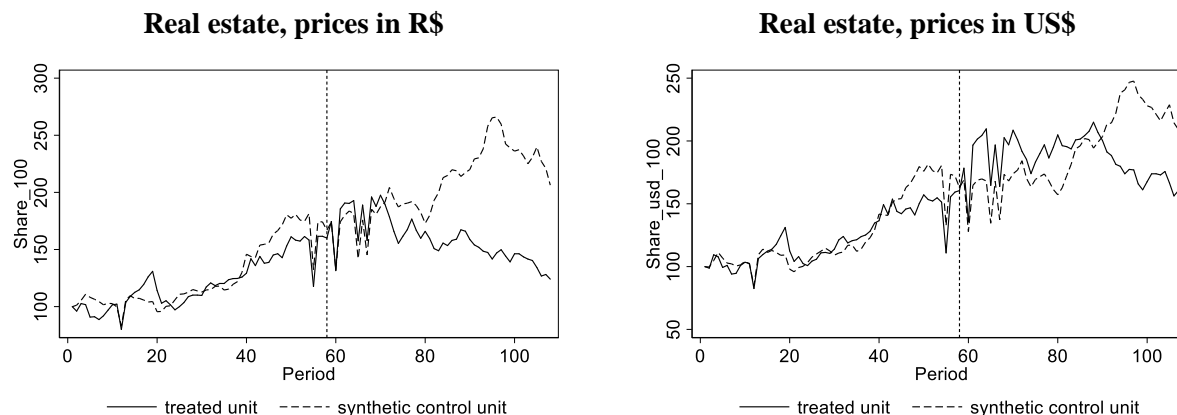


5.1.9. Performance of real estate sector

As expected, the Brazilian real estate sector suffered the negative effects of the economic downturn and the mismatch between the real estate index and its synthetic control after the treatment is a possible symptom of the recession.

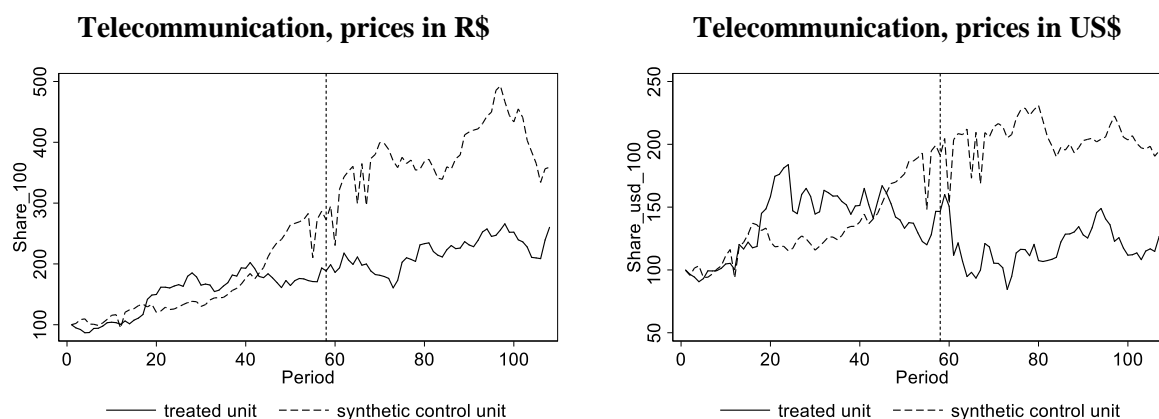
In the 2010s, a significant increase in property prices has been detected in Brazil (Locatelli et al., 2017), due to decrease in interest rates, rent transfers, real wage increases, and cheap credit programs for the construction. With GDP growth under pressure, it is reasonable to assume that deteriorating economic conditions have disintegrated such a price bubble, especially with increasing default cases.

The crisis in the real estate sector implicates some externalities to other sectors and this is a possible limitation of the synthetic control approach, which assesses each sector individually and not interacting among them. Silva et al. (2018) suggest that when a debtor has a relevant overdue exposure in credit lines with a high degree of contagion (vehicle and real estate financing), their exposures in highly contaminated types of loan (non-payroll-deducted personal credit and overdraft) should increase the general risk of default of loan portfolios held by financial institutions. Consequently, negative externalities could hamper other economic sectors.

Figure 11: Synthetic controls for the real estate sector

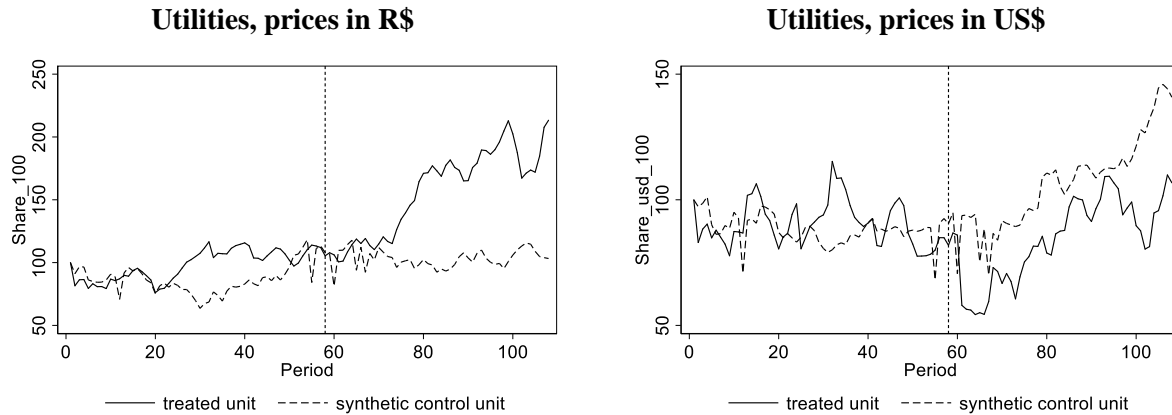
5.1.10. Performance of the telecommunication sector

The synthetic control fit was not satisfactory for the telecommunication sector. Nevertheless, it is very apparent in the charts that the Brazilian industry is lagging behind international peers. Statistics reported by Telebrasil (2018) demonstrate the lack of dynamism after 2014: both television and mobile phone sales in Brazil peaked in 2011 and have declined since then (sales of computers and tablets peaked in 2013 and also declined in the following years).

Figure 12: Synthetic controls for the telecommunication sector

5.1.11. Performance of the utilities sector

The synthetic control fit was not satisfactory for the utilities sector. Nevertheless, it is possible to identify that the Brazilian sector outperformed its counterfactual in local currency, but there is a negative FX effect right after the treatment when the analysis considers prices in US dollars.

Figure 13: Synthetic controls for the utilities sector

5.2. Overview of root mean square prediction errors (RMSPE) and partial conclusions

Table 2 reports the root mean square prediction errors (RMSPE) as per Abadie et al. (2015) with sectors ranked from best to worst adjustment. More heterogeneous industries, such as health, telecommunication were the ones with worse adjustments.

Table 3: Root Mean Square Prediction Errors (RMSPE) per sector

Sector	Local Currency (R\$)	Convertible Currency (US\$)
Oil and gas	8.3	14.43
Utilities	11.54	11.18
Machinery	11.67	18.08
Real Estate	12.71	12.45
Banks	15.65	24.35
Cyclical	15.83	9.91
Manufacturing	21.69	28.13
Non cyclical	22.29	22.71
Financial, others	25.29	20.62
Health	38.25	25.84
Telecommunication	44.84	31.83

The analysis of the RMSPE itself does not provide enough clarification on causality effects, as robustness needs to be considered. Nevertheless, primary results indicate that:

- 1) The oil and gas sector did not catch up with international peers along the 4-years period post-treatment. Still, there was not a relevant discontinuity between the Brazilian index and

its counterfactual immediately after the re-election of Dilma Rousseff rather than an indirect FX mismatch.

- 2) The Brazilian industry shows signs of stagnation since 2012, but the apparent lethargy is also replicated in the synthetic control. What comes to attention is that the treatment apparently deteriorates the index behavior in US dollar terms.
- 3) Brazilian banks do not appear to be negatively affected by the treatment. On the contrary, the local currency index outperforms the synthetic control.
- 4) The real estate sector and cyclical consumption sectors seem to be a good thermometer of the real economy inanimation as its index decouples from its counterfactual. Surprisingly, an opposite trend is verified in the utilities and cyclical consumption segments.

5.3. Robustness tests

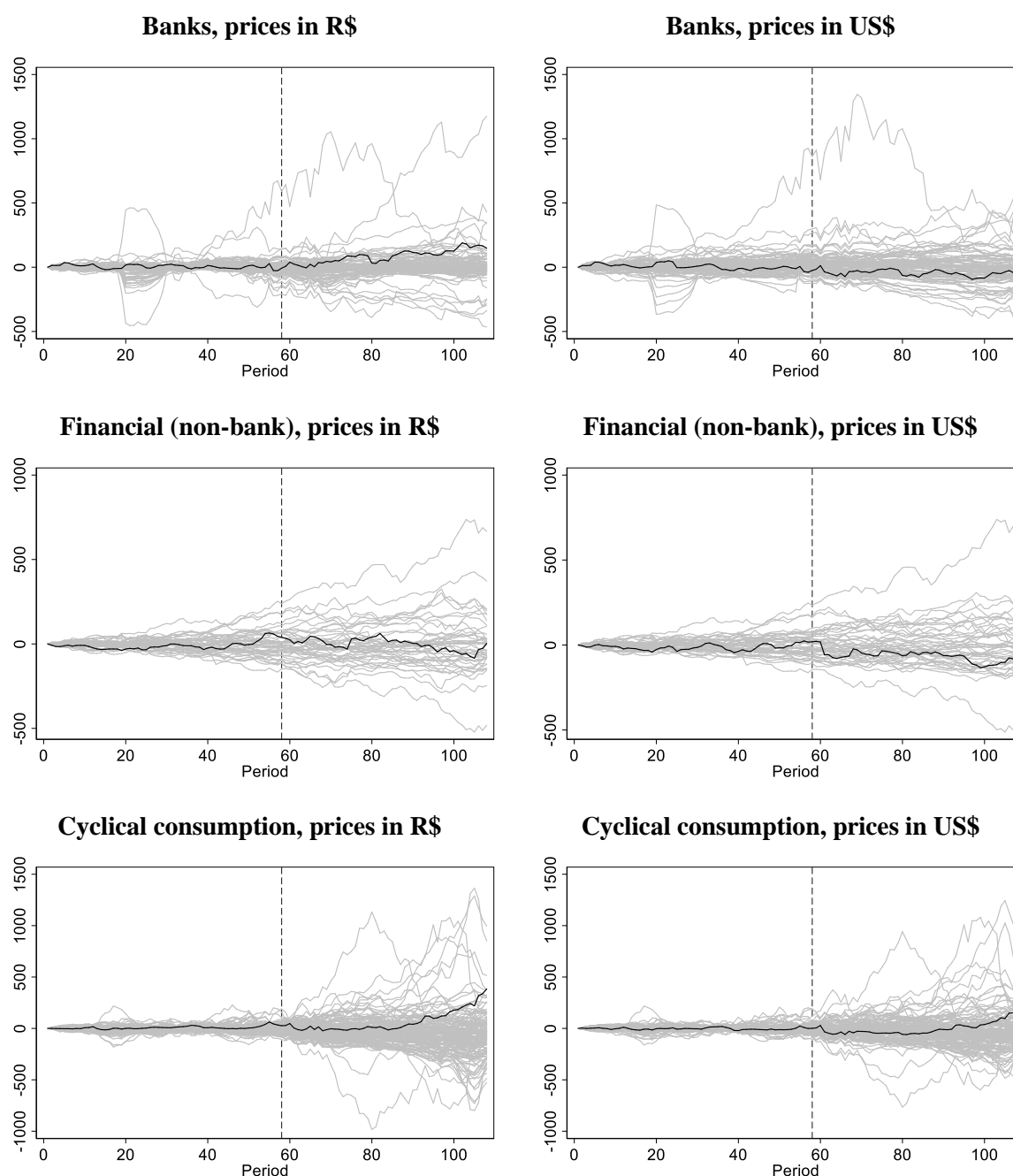
Utilizing the methodology of Abadie et al. (2010), it is possible to build placebo tests with the components of the donor pools in order to assess whether the treatment effect is robust for the Brazilian case. Abadie et al. (*ibidem*) already indicated that a large sample may create problems such as overfitting while adjusting synthetical controls. Moreover, large samples may increase the p value.

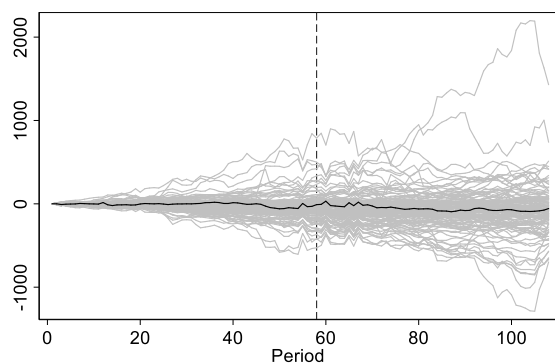
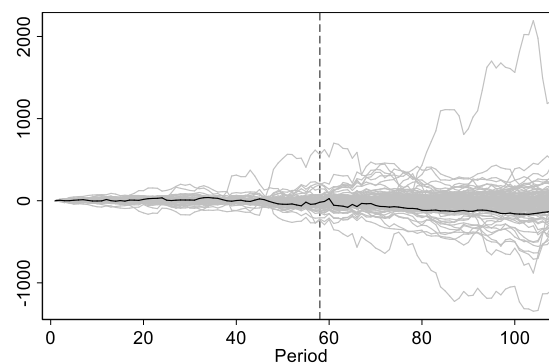
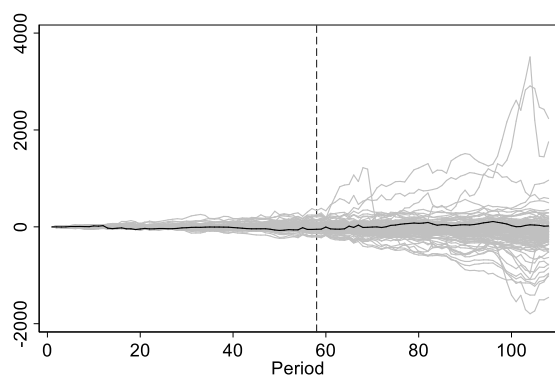
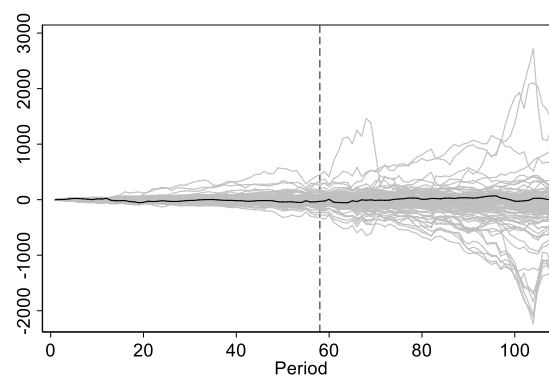
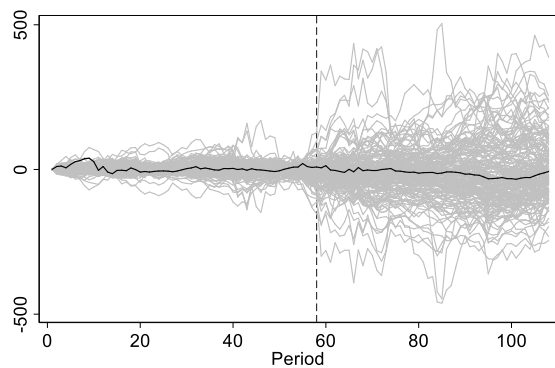
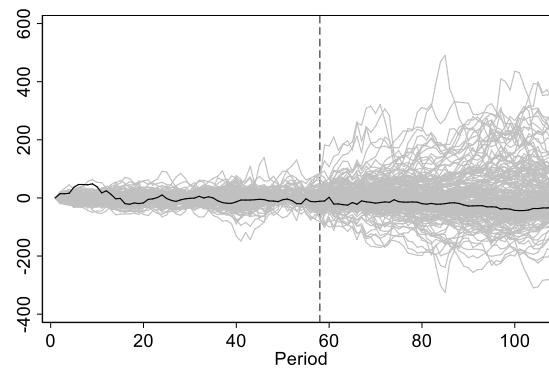
Analyzing the charts, we clearly see that the large sample compromises the inference procedure with a few exceptions. The Brazilian banking sector appears to pass the graphical robustness analysis, as it clearly stays in the upper range among the placebos. The same happens with the cyclical consumption segment in the latter part of the post-treatment period. Real estate is another sector in which the synthetical control appears to be robust, as the Brazilian case is positioned in the lower range among the placebos.

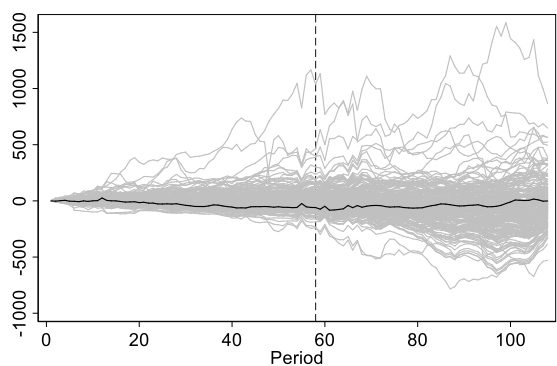
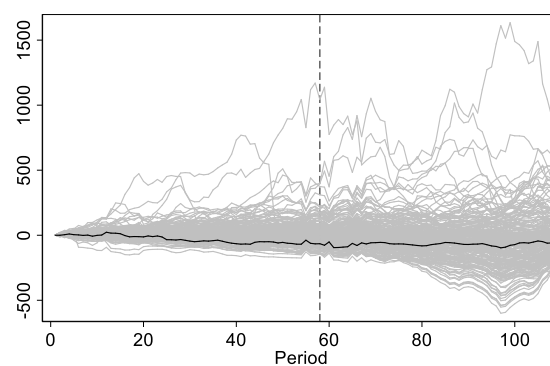
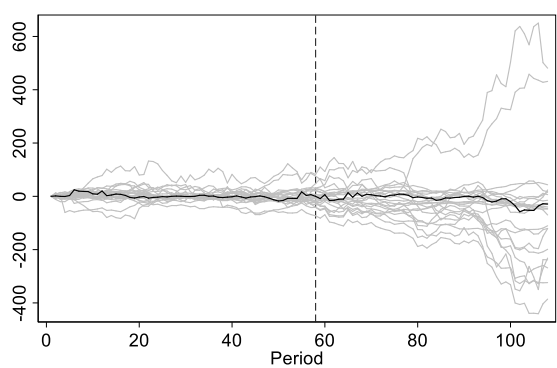
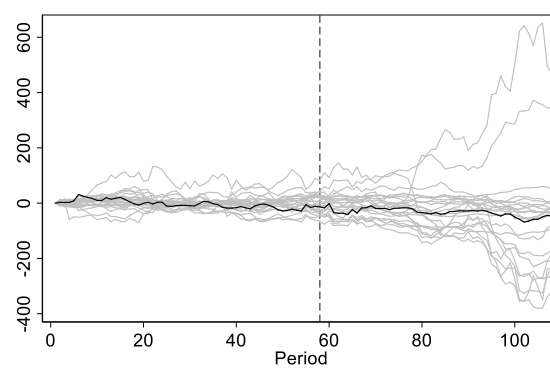
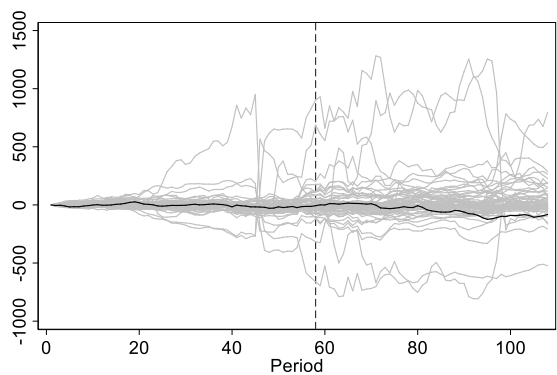
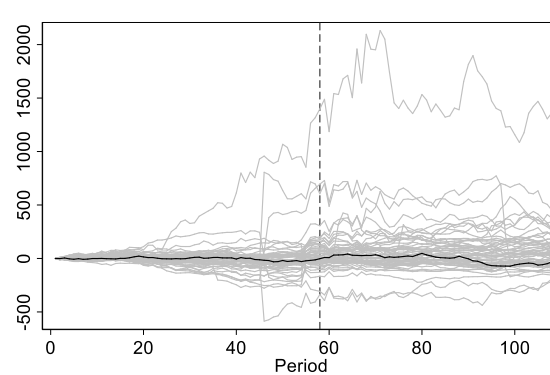
The placebo tests for the other sectors do not provide satisfactory evidences of robustness for the analyzed controls. The diffuse pattern observed in the charts in most of the sectors exemplify the problems that arise from applying the synthetic control methodology to large samples with a plethora of companies. An exercise for future research projects is to refine a methodology that filters what units are selected to a specific donor pool, in such a way that a smaller sample is utilized and a less fuzzy range of placebos is obtained from the robustness tests.

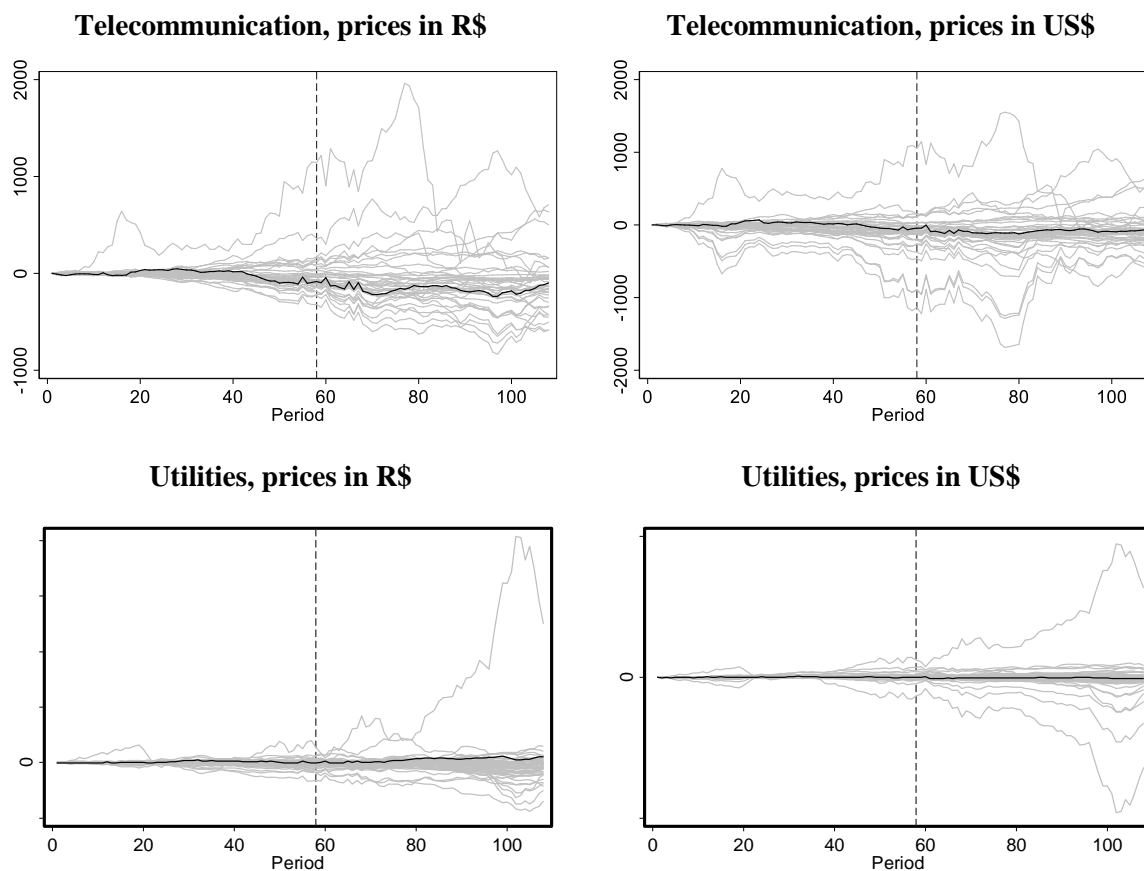
Broadly speaking, all the US dollar-denominated synthetic controls tend to fit the lower part of the range formed by the placebo charts along the post-treatment period. This is consistent with the weakening Brazilian real after 2014 and it places Brazilian shares among the worst performing assets within the period with a reasonable inference background.

Figure 14: Placebo tests



Non-cyclical consumption, prices in R\$**Non-cyclical consumption, prices in US\$****Health, prices in R\$****Health, prices in US\$****Machinery, prices in R\$****Machinery, prices in US\$**

Manufacturing, prices in R\$**Manufacturing, prices in US\$****Oil and gas, prices in R\$****Oil and gas, prices in US\$****Real estate, prices in R\$****Real estate, prices in US\$**



As an additional robustness test, I repeated the experiment anticipating the intervention event to April/2014, i.e. six months prior to the 2014 elections. The objective of this variation is to test whether the re-election of Dilma Rousseff contributed to the mismatch observed in most of the sectors during the recession period. The charts are presented in the appendix and provide two relevant insights.

Firstly, the mismatch during the recession can still be observed, even considering a different treatment, reinforcing the hypothesis that domestic-driven sectors underperformed international peers. Secondly, many discontinuities witnessed in US dollar terms right after the treatment (set in October/2014) are not replicated when we move the treatment backwards to April/2014, meaning that the results of the polls contributed to value destruction, indirectly and through exchange rate depreciation, in all of the sectors.

6. CONCLUSION

The synthetic control method is a feasible alternative to assess causality effects of pre-selected interventions or episodes. The objective of this study was to assess whether the results of the 2014 elections in Brazil and, therefore, the continuity of internal economic policies after the re-election of Dilma Rousseff, contributed to the Brazilian recession post-2014. Furthermore, the proposed methodology is able to shine a light on how these domestic factors affected different economic sectors.

Utilizing public information of exchange-listed companies, I built price indexes for 11 different sectors of the Brazilian economy and compared these indexes with 11 synthetic controls, comprising the same sectors, modelled from a donor pool of international corporations. Sectors with some degree of global integration, e.g. commodity-related industries, were expected to follow the synthetic controls, while domestic-driven segments, e.g. consumption and utilities, were expected to decouple from the counterfactuals.

The results show that Brazilian sectors in general faced some degree of deterioration in US dollar terms after the elections of 2014. This is primarily an effect of the exchange rate depreciation during the analyzed period and, within the synthetic control conceptual framework, this could be interpreted as a consequence of the treatment. Non-cyclical consumption, machinery and real estate also decouples from the counterfactuals in local currency terms along the recession period, in line with the hypothesis that domestic-driven segments should underperform the synthetic controls as a consequence of the economic downturn, but not necessarily as an immediate consequence of the elections. Surprisingly, sectors like banks and cyclical consumption and utilities performed better than the comparables.

Nevertheless, the placebo tests show little graphical evidence of robustness¹² for the majority of the sectors as per the methodology developed by Abadie et al. (2010). This could be partially explained by the large sample utilized in the donor pools (Abadie et al., *ibidem*). Further developments on the synthetic control methodology applied to large samples are needed to enhance the inference exercises.

¹² Curiously, the results of the robustness test for the banking sector are satisfactory, illustrating that in fact not only Brazilian banks were not affected by the crisis, but also overperformed its counterfactual.

Even with the fuzzy placebo tests, the intuition of the results is consistent with the original hypothesis. The charts provide some evidences that domestic factors could have hampered the evolution of some sectors amid the recession, particularly when the results are compared to other studies highlighted on section 2. Moreover, the robustness tests presented also indicate that the results of the 2014 presidential elections contributed to some degree of deterioration of Brazilian stocks in US dollar terms.

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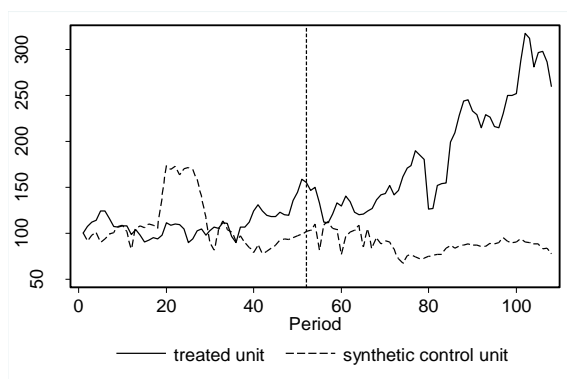
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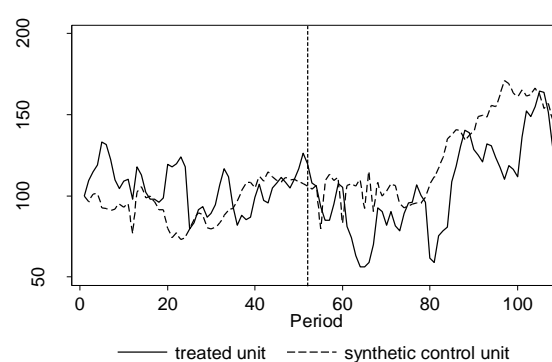
APPENDIX A: Robustness checks

A.1. Change in treatment period (April/2014)

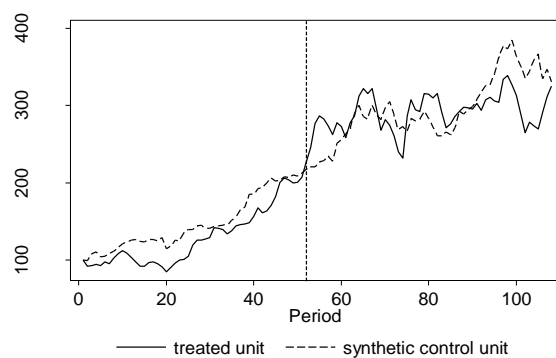
Banks, prices in R\$



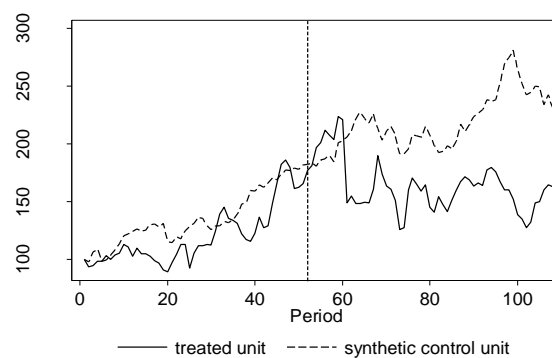
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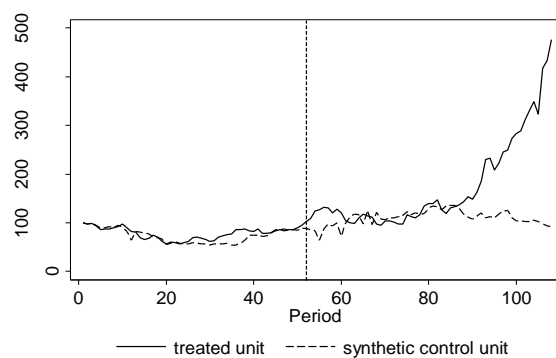
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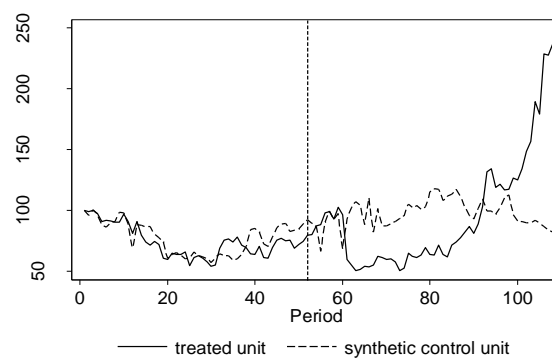
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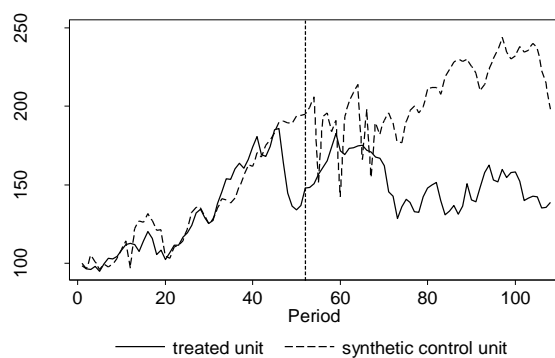
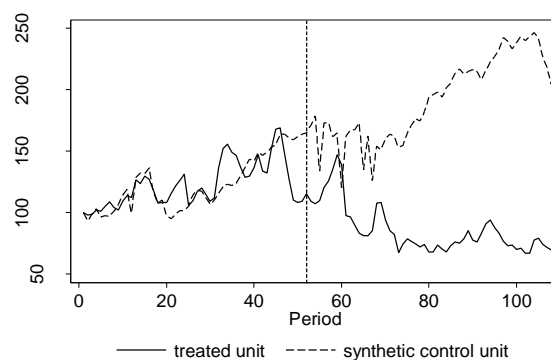
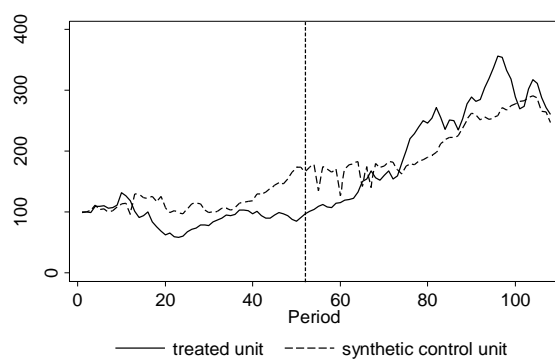
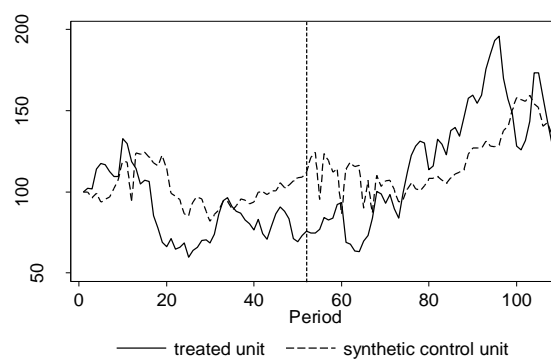
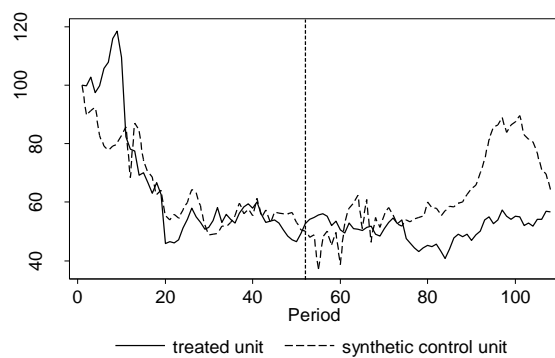
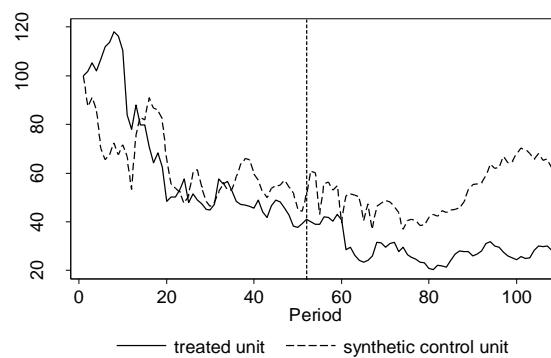


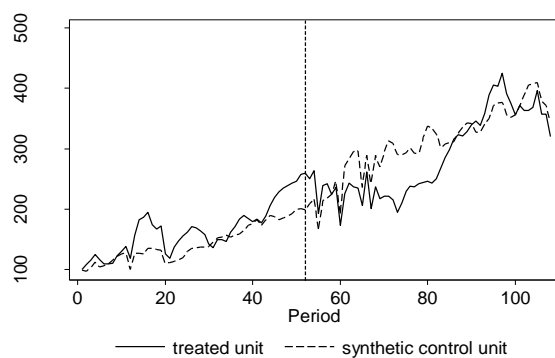
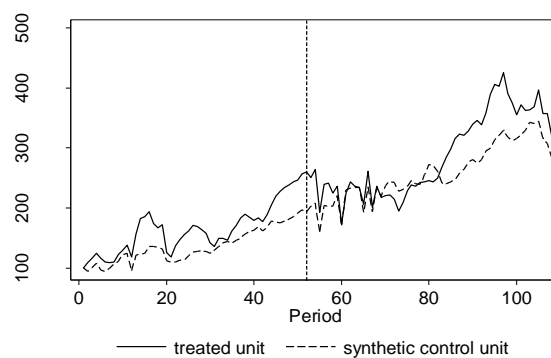
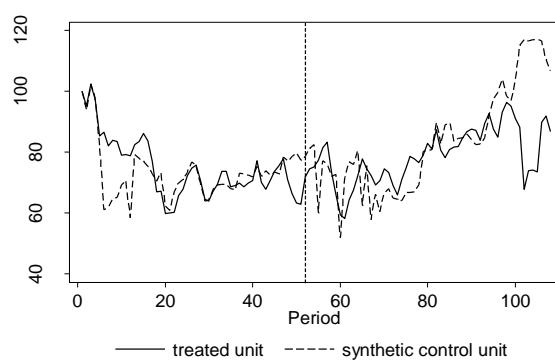
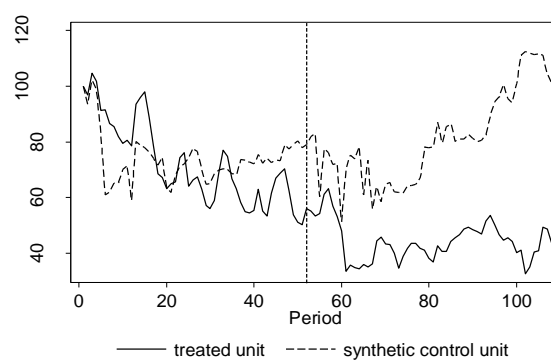
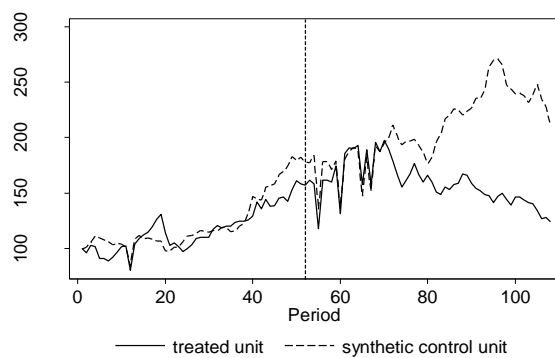
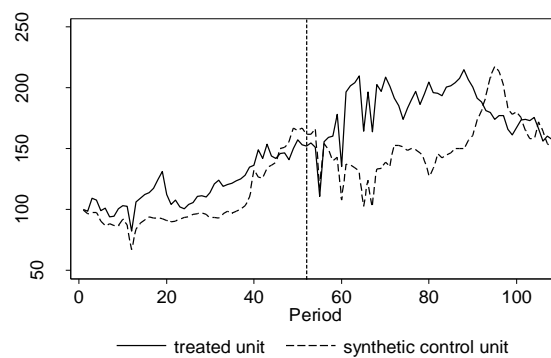
Cyclical consumption, prices in R\$

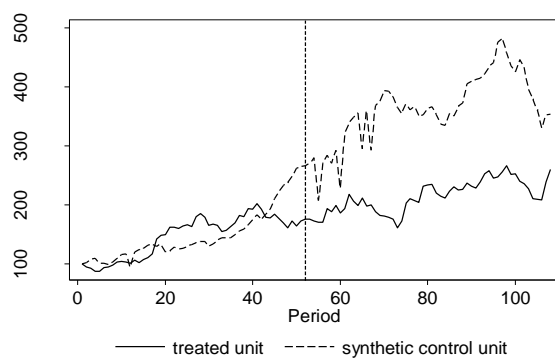
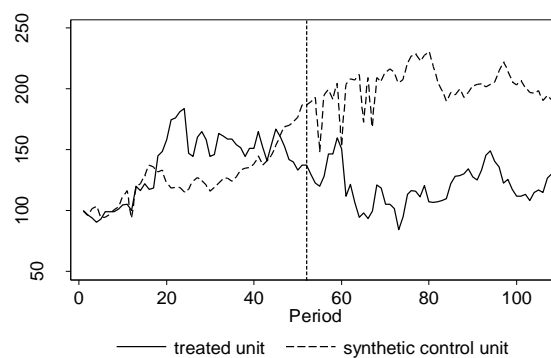
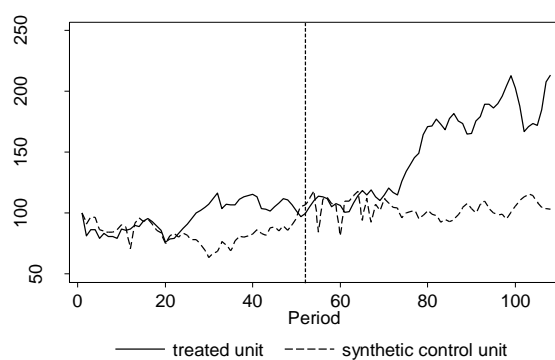


Cyclical consumption, prices in US\$



Non-cyclical consumption, prices in R\$**Non-cyclical consumption, prices in US\$****Health, prices in R\$****Health, prices in US\$****Machinery, prices in R\$****Machinery, prices in US\$**

Manufacturing, prices in R\$**Manufacturing, prices in US\$****Oil and gas, prices in R\$****Oil and gas, prices in US\$****Real estate, prices in R\$****Real estate, prices in US\$**

Telecommunication, prices in R\$**Telecommunication, prices in US\$****Utilities, prices in R\$****Utilities, prices in US\$**