# Exchange Rate Pass-Through: An Analysis for Brazil

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**Abstract**

The present article aims to empirically analyze the relationship between the exchange rate and the Brazilian price index, IPCA, from 2010 to 2022. For this purpose, a thorough review of the literature will be conducted, followed by the presentation of empirical results obtained through the Vector Autoregressive (VAR) methodology. Regarding the theoretical aspect, there are various approaches to the subject, both in the microeconomic and macroeconomic realms. However, this work will focus solely on the macroeconomic approach to highlight the impact of exchange rates on domestic prices in a more aggregate manner. As for the results, the estimation reveals a low degree of exchange rate pass-through to prices, as the analyzed period exhibits vectors that limit this type of dynamics.

*Keywords:* Prices, Time Series, Macroeconomics

# 1 Introduction

The central idea of the article is to examine how changes in the exchange rate affect the domestic price index, a phenomenon commonly known in the literature as exchange rate pass-through to inflation. In this sense, the degree of exchange rate pass-through to inflation is defined as the impact of the nominal exchange rate on domestic prices, with empirical evidence reporting a degree lower than unity, according to Campa & Goldberg (2002). The motivation behind the work stems from the lack of studies of this nature for the Brazilian case, as there is no consensus on the degree of pass-through in these reports.

In recent years, Brazil faced an economic crisis in 2015 and the global health crisis, resulting in the depreciation of the national currency and an increase in price levels. On the domestic side, we observed some deviations of inflation from its target, as in the case of the year 2021. Externally, both crises resulted in a scenario of increased risk aversion by agents towards Brazil, leading to a local appreciation of the dollar. Works such as Goldberg & Knetter (1997) and Campa & Goldberg (2002) have shown that domestic prices are becoming less volatile in relation to the exchange rate.

From a theoretical perspective, the subject can be elaborated both in microeconomic and macroeconomic theory, with the latter being the focus of this article. Furthermore, even the macroeconomic perspective can be divided among sectors; however, the work will only focus on the aggregate aspect. As for the empirical part, the article develops a Vector Autoregressive (VAR) model to measure the contamination of nominal exchange rates on prices.

# 2 Theoretical Framework

Within the theory, we can reference several macroeconomic approaches to the degree of pass-through. In general, there are various vectors of inflation contamination by exchange rates; however, this dynamic becomes more evident with a higher degree of trade openness, heated domestic demand, the share of imports within the consumption basket of households and firms, and, finally, larger deviations between the realized exchange rate and the equilibrium exchange rate. In other words, pass-through is intensified when do-

mestic consumption shows a high dependence on international trade, so external shocks impact these nations more strongly, either through relative price adjustments or supply and demand issues. Some more sector-specific studies can more efficiently test the above assertions, as in the case of Krugman & Obstfeld (1994), who claim that prices of non-tradable goods should be determined exclusively by domestic supply and demand factors, so that an increase in prices given domestically favors a reduction in the purchasing power of the country's currency.

The empirical literature on the subject gained more emphasis within academia from 1980. One of the initially raised strands was based on testing Purchasing Power Parity (PPP), which argued that there should be a complete pass-through of exchange rate variations to prices. However, the results refuted this hypothesis and concluded that pass-through would not be complete either in the short or long term, according to Maciel (2006). In its new contours, Taylor's (2000) work brings relevant insights to the topic. According to the author, a context of a low or stable inflation regime is capable of reducing pass-through through the reduction of firms' power regarding price formation. Thus, the phenomenon should be determined endogenously concerning the inflationary context. In summary, Taylor (2000) argues that reduced inflation and monetary policy lead to low pass-through through guiding expectations about frequent changes in costs and prices.

In the same line as Taylor (2000), Goldfajn & Werlang (2000) suggest that a low inflation environment hinders pass-through. In this sense, as price and cost variations are more stable, firms tend to pass on fewer costs given via the exchange rate. Moreover, Goldfajn & Werlang (2000) conclude that the main determinants for pass-through are the output gap, the degree of trade openness, and the real exchange rate. In this sense, there is evidence that the greater the slack in the economy, the greater the difficulty of exchange rate pass-through to prices. That is, in a scenario of economic expansion, where factors of production are underutilized, firms tend to have more ease in passing on costs related to the exchange rate. Regarding the real exchange rate, studies mention that such overvalued rates contribute to future depreciation. Thus, Goldfajn & Werlang (2000) reinforce this perspective by stating that currency corrections through abundant depreciations would imply an environment of inflationary acceleration.

Another important contribution came from Romer (1993), mainly on the side of trade openness. Romer (1993) comments that openness generates effects on the determinants of inflation when the government exerts an unexpected shock on prices in the face of a currency devaluation. In this line, there would be an impact on the benefits of an expansion of output in relation to its trade-off with inflation. Therefore, according to the author, the degree of openness has a negative influence on the incentives for domestic production and, therefore, corroborates the idea that pass-through will be greater when this scenario of external demand prevails over internal demand, except for substitute goods. Regarding the trade-off between output and inflation, Romer (1993) argues that a higher degree of trade openness contributes to high inflation when output grows, which, in turn, should generate a depreciation of the exchange rate and, consequently, an increase in domestic prices. The author reports two transmission channels of this contamination. The first refers to a rapid increase in exchange rate costs for inflation via imported products. While the second occurs with the rise in the general price level that positively impacts individual goods. Thus, assuming flexible wages and perceiving this, firms' costs would tend to increase, and thus, also the positive effects on the prices of domestic goods. In general, a scenario of output growth linked to an economy with a high degree of trade openness causes monetary expansion and increases in domestic prices.

# 3 Empirical Analysis

## 3.1 Database

1. IPCA - Index number (base 1993 = 100) - released by the Brazilian Institute of Geography and Statistics (IBGE)

2.Exchange Rate (R$/USD) - free/sale - Average for the period - released by the Central Bank

3.Brent Crude Oil Futures (R$/USD) - released by the Fred St. Louis

4. Monthly Industrial Production (PIM) - Seasonally adjusted index (base 2012=100) - released by the Brazilian Institute of Geography and Statistics (IBGE)

The data used are in monthly frequency, and a logarithmic function has been applied to them. Furthermore, the estimation used data on prices and economic activity, with the PIM and oil variables acting as control proxies to establish a demand and supply relationship, respectively, as suggested in Alves & Souza (2011). Finally, the period considered is from January 2010 to February 2022, and all variables were treated as endogenous.

## 3.2 Stationarity Test

Using the Augmented Dickey-Fuller (ADF) test, it was found that the series at levels accepted H0, meaning the data are non-stationary. However, by taking the first difference, we reject the null hypothesis, as demonstrated in the table below.

**Table 1: Unit Root Test**

| Variável | Estatística | P-Value | Status |
|---|---|---|---|
| IPCA | -1.6282 | 0.7313 | Level |
| Exchange Rate | -2.9474 | 0.1819 | Level |
| Brent Crude Oil Futures | -1.4739 | 0.7955 | Level |
| PIM | -2.8466 | 0.2239 | Level |
| IPCA | -3.8991 | 0.01616 | First Difference |
| Exchange Rate | -3.7768 | 0.02214 | First Difference |
| Brent Crude Oil Futures | -4.6761 | 0.01< | First Difference |
| PIM | -6.2335 | 0.01< | First Difference |

The ADF test results indicate that taking the first difference leads to stationarity in the series. The status “Level” means the series at its original level, and “First Difference” indicates the series after applying the first difference.

## 3.3

Lag Selection This section presents the lag selection to be used in the VAR model, with a maximum lag of 12 months ahead. The criteria considered are:

AIC: Akaike Information Criterion HQ: Hannan-Quinn Information Criterion SC: Schwarz Information Criterion FPE: Final Prediction Error Criterion Table 2: Criteria Statistics

**Table 2: Criteria Statistics**

| Lag | AIC(n) | HQ(n) | SC(n) | FPE(n) |
|---|---|---|---|---|
| 1 | -30.01287 | -29.83625 | -29.57823 | 0 |
| 2 | -29.90253 | -29.58461 | -29.12018 | 0 |
| 3 | -29.85442 | -29.39521 | -28.72436 | 0 |
| 4 | -29.94904 | -29.34853 | -28.47127 | 0 |
| 5 | -29.84363 | -29.10182 | -28.01814 | 0 |
| 6 | -29.73242 | -28.84932 | -27.55923 | 0 |
| 7 | -29.74114 | -28.71674 | -27.22024 | 0 |
| 8 | -29.70645 | -28.54075 | -26.83783 | 0 |
| 9 | -29.63678 | -28.32979 | -26.42045 | 0 |
| 10 | -29.48321 | -28.03492 | -25.91917 | 0 |
| 11 | -29.35174 | -27.76215 | -25.43999 | 0 |
| 12 | -29.34115 | -27.61027 | -25.08169 | 0 |

Unanimously, the criteria suggest that the lag within the model should be 1 period, as evidenced below.

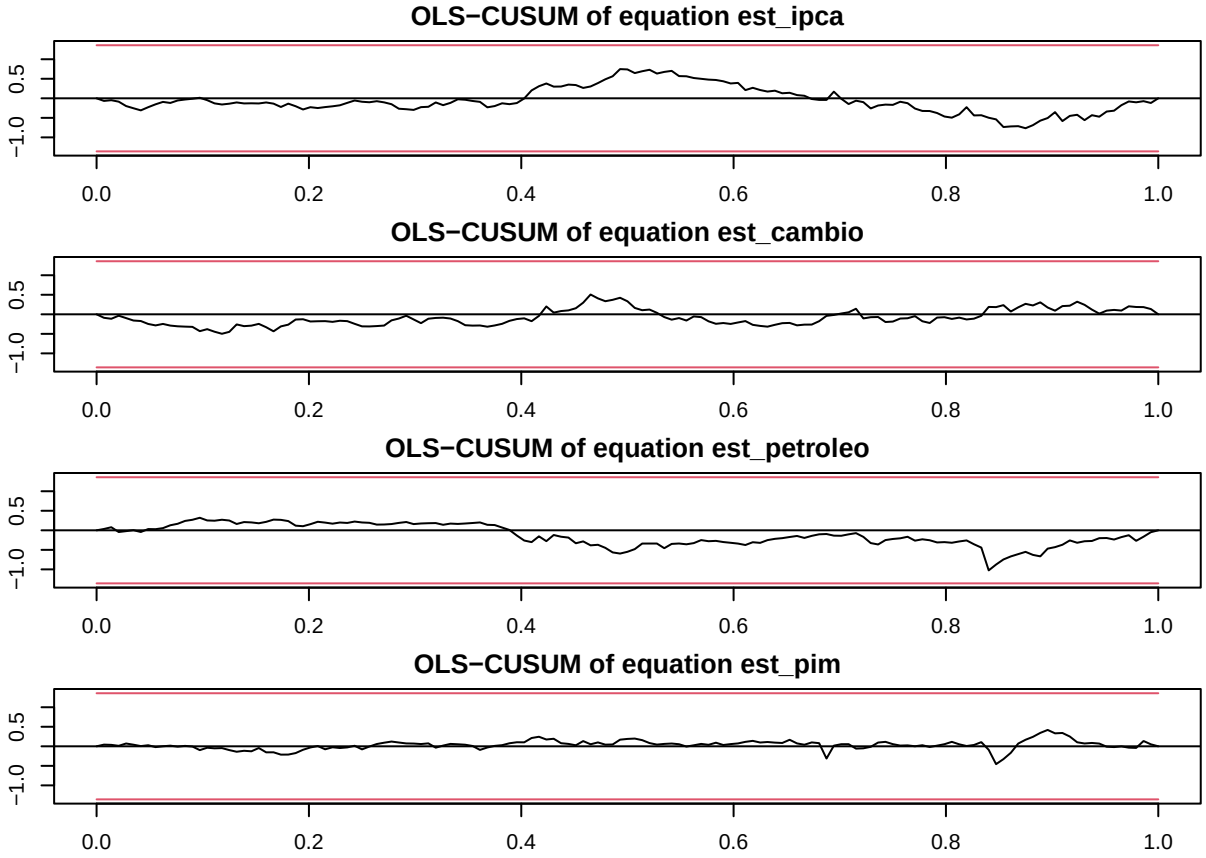
**Table 3: Lags**

| AIC(n) | HQ(n) | SC(n) | FPE(n) |
|---|---|---|---|
| 1 | 1 | 1 | 1 |

## 3.4 Structural Break Test

The purpose behind this test is to check for any structural breaks in the series, thereby understanding if there is a significant difference between the estimated parameters that establish the relationship between variables. To do so, the article used the CUSUM method,

which is based on the cumulative sum of recursive residuals and detects the instability of the variable when the data surpass the area delimited by two critical lines of 5% significance. At the end of the test, it was found that there are no structural breaks in the series.




##Model The system of equations generated from the methodology mentioned and the criteria listed above produced the following parameters:

Table 4.1: IPCA

**Table 4.1: IPCA**

| est_ipca.l1 | est_cambio.l1 | est_petroleo.l1 | est_pim.l1 | const |
|---|---|---|---|---|
| 0.5892862 | 0.0081637 | 0.0068322 | -0.0048094 | 0.0019451 |

**Table 4.2: Exchange Rate**

| est_ipca.l1 | est_cambio.l1 | est_petroleo.l1 | est_pim.l1 | const |
|---|---|---|---|---|
| 0.0186154 | 0.1815868 | -0.066272 | -0.1025657 | 0.0056735 |

**Table 4.3: Brent Crude Oil Futures**

| est_ipca.l1 | est_cambio.l1 | est_petroleo.l1 | est_pim.l1 | const |
|---|---|---|---|---|
| -1.475793 | 0.160552 | 0.2038139 | -0.5266126 | 0.0068239 |

**Table 4.4: PIM**

| est_ipca.l1 | est_cambio.l1 | est_petroleo.l1 | est_pim.l1 | const |
|---|---|---|---|---|
| -0.6239632 | -0.0210411 | 0.138887 | -0.097003 | 0.0017495 |

## 3.5 Serial Correlation

To test whether the residuals are independent and do not carry any relevant information for the model, the Portmanteau Test is used, where the null hypothesis of the test is that the residuals are autocorrelated. são autocorrelacionados.

**Table 5: Portmanteau Test**

| Chi - Square | P-Value |
|---|---|
| 198,94 | 0,1135 |

Since the P-Value $> 0.05$, we can reject H0 and conclude that there is no serial correlation in the model.

## 3.6 Heteroskedasticity

To test whether the residuals exhibit constant variance, we take the Multivariate ARCH Test, assuming H0 as the presence of heteroskedasticity.

**Table 6: ARCH Test**

| Chi - Square | P-Value |
|---|---|
| 1258,8 | 0,1162 |

Since the P-Value $> 0.05$, we can reject H0 and conclude that the residuals are homoskedastic.

## 3.7 Causality

Within the VAR model universe, correlation is not the most appropriate way to infer relationships between series. In this sense, establishing causality between variables can provide stronger evidence of relationships. Therefore, the Granger Causality Test was applied, where our null hypothesis is based on the absence of causality. First, it is necessary to assess whether there is causality in an aggregated manner, and the results are presented in Table 7. Second, it is important to trace causality individually between variables, and the results are exposed in Table 8.

**Table 7: Granger Causality Test**

| Variable | F-Test | P-Value |
|---|---|---|
| IPCA | 0.40008 | 0.753 |
| Exchange Rate | 0.61943 | 0.6026 |
| Brent Crude Oil Futures | 18.46 | 0.01< |
| PIM | 2.0794 | 0.1019 |

From Table 7, at a significance level of 5%, it was found that there is only Granger causality for the Brent Crude Oil Futures series; for the others, we accept the null hypothesis.

**Table 8: Granger Causality Test**

| Variable | F-Test | P-Value |
|---|---|---|
| IPCA vs Exchange Rate | 0.07126336 | 0.7898962 |
| Exchange Rate vs IPCA | 0.0096 | 0.922 |
| IPCA vs Brent Crude Oil Futures | 7.836 | 0.00584 |
| Brent Crude Oil Futures vs IPCA | 0.4775 | 0.4907 |
| IPCA vs PIM | 0.0862 | 0.7695 |
| PIM vs IPCA | 0.3737 | 0.542 |
| Exchange Rate vs Brent Crude Oil Futures | 6.3853 | 0.01261 |
| Brent Crude Oil Futures vs Exchange Rate | 0.8044 | 0.3713 |
| Exchange Rate vs PIM | 1.6994 | 0.1945 |
| PIM vs Exchange Rate | 4.8334 | 0.02954 |
| Brent Crude Oil Futures vs PIM | 1.1879 | 0.308 |
| PIM vs Brent Crude Oil Futures | 50.36 | 0.01< |

From the table, the interpretation is that the variable on the left causes the one on the right in the Granger sense. Therefore, with 95% confidence, there is evidence that a variation in IPCA causes Brent Crude Oil Futures, as well as the Exchange Rate. Next, there is evidence that the Exchange Rate causes Brent Crude Oil Futures. Regarding PIM, the demand variable, it was found that it causes the Exchange Rate, as expected, given that demand influences the behavior of the variable, according to the theory presented. Another expected relationship is PIM causing Brent Crude Oil Futures, that is, demand causing supply.

Furthermore, it is worth noting the lack of causality between the Exchange Rate and IPCA. Thus, we can list some reasons that align with Taylor (2000) and Goldfajn & Werlang (2000). The first reason is that the analyzed period is characterized by controlled inflation in most years. Even with the change in the band interval from 2 p.p. to 1.5 p.p in 2017, except for 2015 and 2021 when inflation exceeded the established band, in other years, IPCA is within the intervals, meaning it is stable. A second factor for this relates to the years of low growth and high idle capacity, which, in turn, favors null causality between the highlighted series.

**Table 9: Meta e IPCA Realizado**

| Year | Target (%) | Realized (%) | Upper Limit (%) | Lower Limit (%) |
|---|---|---|---|---|
| 2012 | 4.5 | 5.8 | 6.5 | 2.5 |
| 2013 | 4.5 | 5.9 | 6.5 | 2.5 |
| 2014 | 4.5 | 6.4 | 6.5 | 2.5 |
| 2015 | 4.5 | 10.7 | 6.5 | 2.5 |
| 2016 | 4.5 | 6.3 | 6.5 | 2.5 |
| 2017 | 4.5 | 3.0 | 6.0 | 3.0 |
| 2018 | 4.5 | 3.8 | 6.0 | 3.0 |
| 2019 | 4.25 | 4.3 | 5.75 | 2.75 |
| 2020 | 4.0 | 4.5 | 5.5 | 2.5 |
| 2021 | 3.75 | 10.1 | 5.25 | 2.25 |

Source: Central Bank of Brazil

## 3.8 Impulse Response Function

The estimation of impulse response functions, along with causality tests, can provide more insightful evidence for the relationship between variables than correlation alone. The idea behind the procedure is quite intuitive: give a shock to a variable and observe the behavior of another variable until the shock dissipates, considering that stable models exhibit a convergence behavior of variables to their long-term trend.

In the case of the VAR estimated for this article, the results indicate stability, as demonstrated by the CUSUM test and the unit roots within the unit circle. Thus, the article utilized the impulse response function with a shock of 12 periods ahead. The graphs illustrating the results consider the response variable on the Y-axis and are in the annex.

Regarding the results, the function showed a positive impact on IPCA given the shock in the Exchange Rate. When we reverse the shock, a negative effect on the Exchange Rate was observed initially; however, the relationship reverses as the periods progress.

On the supply side, a response impulse in IPCA revealed a positive impact on prices, while the dynamics of the impulse in IPCA concerning supply showed a positive variation

and a gradual inversion of the impact to the negative field.

Demand, on the other hand, showed negative effects on prices, while the shock from IPCA to demand demonstrated a slightly positive effect in the early periods until the point where the dynamics reverse. In other words, a positive price shock generates negative influences on economic activity as time progresses. This behavior is also evidenced by impulses via the Exchange Rate.

## 3.9 Variance Decomposition

The variance decomposition of the prediction error is based on matrices of orthogonalized impulse response coefficients, allowing the analysis of the contribution of one variable to the forecast of another series. In this sense, one of the metrics for calculating pass-through is based on the variance decomposition of IPCA, according to Bueno (2011). Table 10 demonstrates the results from a shock of 12 periods ahead.

**Table 10.1: IPCA**

| est_ipca | est_cambio | est_petroleo | est_pim |
|---|---|---|---|
| 1.0000000 | 0.0000000 | 0.0000000 | 0.0000000 |
| 0.9528685 | 0.0000344 | 0.0456231 | 0.0014740 |
| 0.9384389 | 0.0010248 | 0.0565263 | 0.0040100 |
| 0.9358104 | 0.0020442 | 0.0573690 | 0.0047764 |
| 0.9352163 | 0.0024499 | 0.0573809 | 0.0049529 |
| 0.9350268 | 0.0025745 | 0.0573945 | 0.0050042 |
| 0.9349566 | 0.0026142 | 0.0574066 | 0.0050226 |
| 0.9349314 | 0.0026279 | 0.0574115 | 0.0050292 |
| 0.9349226 | 0.0026327 | 0.0574131 | 0.0050315 |
| 0.9349196 | 0.0026344 | 0.0574136 | 0.0050323 |
| 0.9349186 | 0.0026350 | 0.0574138 | 0.0050326 |
| 0.9349183 | 0.0026352 | 0.0574139 | 0.0050327 |

On the side of IPCA, we can assert that its variability is little explained by the other

variables and more by the variation in prices itself. However, over time, we see that the Exchange Rate comes to explain 0.26% of the index variation, representing the pass-through of the analyzed period. Additionally, it is worth noting that the contamination of prices is more evident over time, as already highlighted by the literature and verified in the table above.

**Table 10.2: Exchange Rate**

| est_cambio | est_ipca | est_petroleo | est_pim |
|---|---|---|---|
| 0.9957431 | 0.0042569 | 0.0000000 | 0.0000000 |
| 0.9541037 | 0.0042785 | 0.0363906 | 0.0052272 |
| 0.9426794 | 0.0042381 | 0.0476070 | 0.0054756 |
| 0.9423246 | 0.0043409 | 0.0477515 | 0.0055831 |
| 0.9422507 | 0.0043831 | 0.0477834 | 0.0055827 |
| 0.9422300 | 0.0043951 | 0.0477910 | 0.0055838 |
| 0.9422258 | 0.0043989 | 0.0477912 | 0.0055841 |
| 0.9422246 | 0.0044001 | 0.0477912 | 0.0055841 |
| 0.9422241 | 0.0044006 | 0.0477912 | 0.0055841 |
| 0.9422239 | 0.0044008 | 0.0477912 | 0.0055841 |
| 0.9422239 | 0.0044008 | 0.0477912 | 0.0055841 |
| 0.9422238 | 0.0044008 | 0.0477912 | 0.0055841 |

For the Exchange Rate, as with IPCA, the results demonstrate that its variability is more related to its own variation. However, variations in supply have the second-highest contribution, given the result of 4.7% at the end of the period, evidence that supply has, to some extent, driven the behavior of relative prices in the economy during this period.

**Table 10.3: Brent Crude Oil Futures**

| est_petroleo | est_ipca | est_cambio | est_pim |
|---|---|---|---|
| 0.8629149 | 0.0028357 | 0.1342494 | 0.0000000 |

| est_petroleo | est_ipca | est_cambio | est_pim |
|---|---|---|---|
| 0.8537637 | 0.0036112 | 0.1281370 | 0.0144881 |
| 0.8521257 | 0.0041838 | 0.1290463 | 0.0146443 |
| 0.8520237 | 0.0042866 | 0.1290067 | 0.0146830 |
| 0.8519949 | 0.0043084 | 0.1290034 | 0.0146933 |
| 0.8519863 | 0.0043159 | 0.1290043 | 0.0146935 |
| 0.8519835 | 0.0043188 | 0.1290042 | 0.0146935 |
| 0.8519826 | 0.0043198 | 0.1290041 | 0.0146935 |
| 0.8519823 | 0.0043202 | 0.1290040 | 0.0146935 |
| 0.8519822 | 0.0043203 | 0.1290040 | 0.0146935 |
| 0.8519821 | 0.0043204 | 0.1290040 | 0.0146935 |
| 0.8519821 | 0.0043204 | 0.1290040 | 0.0146935 |

On the other hand, Brent Crude Oil Futures continued to show a variation more related to itself, but the second-highest contribution to its variability came from the Exchange Rate, in line with the Granger Causality Test. Thus, at the end of the period, the exchange rate explains 12.9% of the fluctuation in the supply variable, given the dependence of the series on the relative prices of the economy.

**Table 10.4: PIM**

| est_pim | est_ipca | est_cambio | est_petroleo |
|---|---|---|---|
| 0.9836452 | 0.0002945 | 0.0106369 | 0.0054234 |
| 0.7322272 | 0.0010443 | 0.0480708 | 0.2186577 |
| 0.7303637 | 0.0030995 | 0.0478324 | 0.2187044 |
| 0.7287791 | 0.0038379 | 0.0479706 | 0.2194124 |
| 0.7285151 | 0.0040306 | 0.0479518 | 0.2195026 |
| 0.7284656 | 0.0040895 | 0.0479536 | 0.2194913 |
| 0.7284488 | 0.0041103 | 0.0479543 | 0.2194865 |
| 0.7284428 | 0.0041178 | 0.0479543 | 0.2194851 |

| est_pim | est_ipca | est_cambio | est_petroleo |
|---|---|---|---|
| 0.7284407 | 0.0041204 | 0.0479542 | 0.2194846 |
| 0.7284400 | 0.0041213 | 0.0479542 | 0.2194845 |
| 0.7284397 | 0.0041216 | 0.0479542 | 0.2194844 |
| 0.7284396 | 0.0041217 | 0.0479542 | 0.2194844 |

Finally, the demand variable showed that its variation is mostly explained by itself, but supply explains 21.9% of its variability at the end of the period.

# 4 Conclusion

From the above, it is evident that the analyzed period shows a low exchange rate pass-through to inflation, given the value of 0.26% presented in the variance decomposition. The results align with the discussed literature. Table 9 presented the scenario of controlled inflation, while Table 11 provided data on the economy's spare capacity combined with the low growth of the time. Table 11 considers the real variation of Brazil's GDP, the unemployment rate, and a proxy for spare capacity given by the Capacity Utilization Level of the industry (NUCI), which shows the percentage of how much of the industrial park is being used. Furthermore, we can assert that NUCI indicates there is spare capacity, as the utilization of installed capacity is below its historical average of 80% in the reference years. Regarding the degree of trade openness, Brazil's low degree not only limits the pass-through but also its own economic growth when compared to countries that have an influential external sector in their economies, according to (Bacha, 2016).

In summary, we can affirm that the period presents some obstacles to price contamination when analyzed in the aggregate. However, some studies that open up price categories demonstrate that exchange rate pass-through occurs differently among the segments of the economy and among items in the consumption basket, as in the case of Maciel (2016) and Couto & Fraga (2014). Another evidence, in line with Taylor (2000) regarding firms' pricing power, the works of Maciel (2016) and Couto & Fraga (2014) also demonstrate that wholesale prices are more sensitive to Exchange Rate movements, corroborating the idea

that the mentioned factors end up limiting the pass-through, and when we look at prices in the aggregate, we notice such behavior.

**Table 11: Economy Growth and Idleness**

| Year | GDP (%) | Unemployment (%) | NUCI (%) |
|---|---|---|---|
| 2012 | 1,9 | 7,1 | 80.7 |
| 2013 | 3,0 | 6,9 | 79.8 |
| 2014 | 0,5 | 6,6 | 78.7 |
| 2015 | -3,5 | 8,4 | 75.6 |
| 2016 | -3,2 | 11,6 | 74.9 |
| 2017 | 1,3 | 12,8 | 75.7 |
| 2018 | 1,7 | 12,3 | 75.2 |
| 2019 | 1,2 | 11,9 | 75.6 |
| 2020 | -3,8 | 13,6 | 78.6 |
| 2021 | 4,6 | 14,4 | 77.9 |

Source: IBGE and IPEADATA

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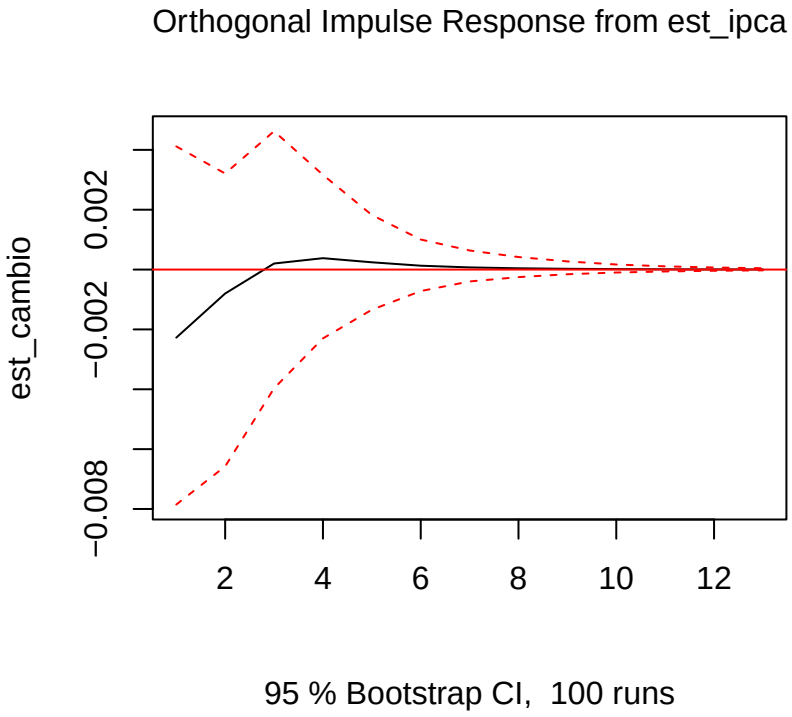
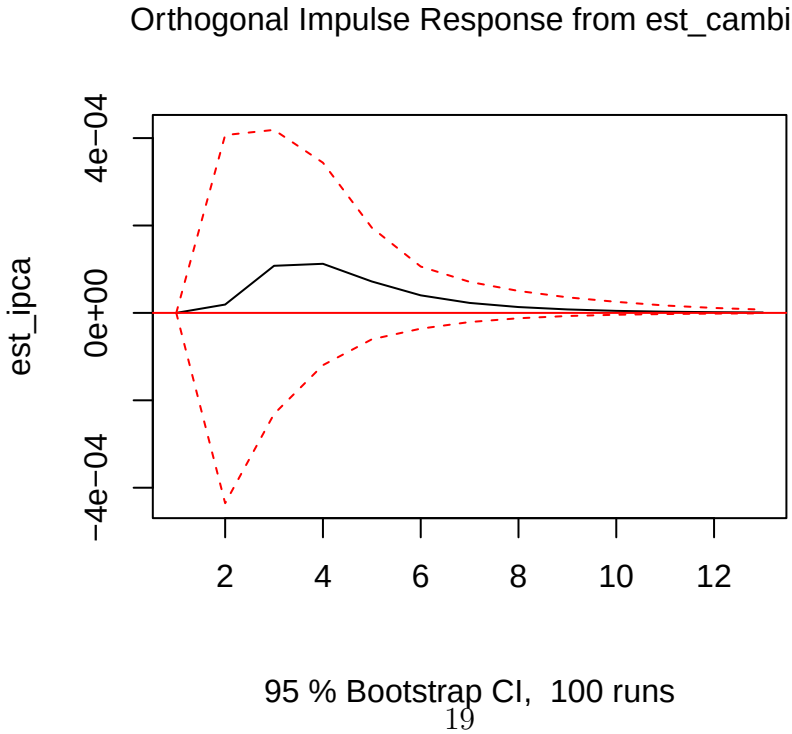
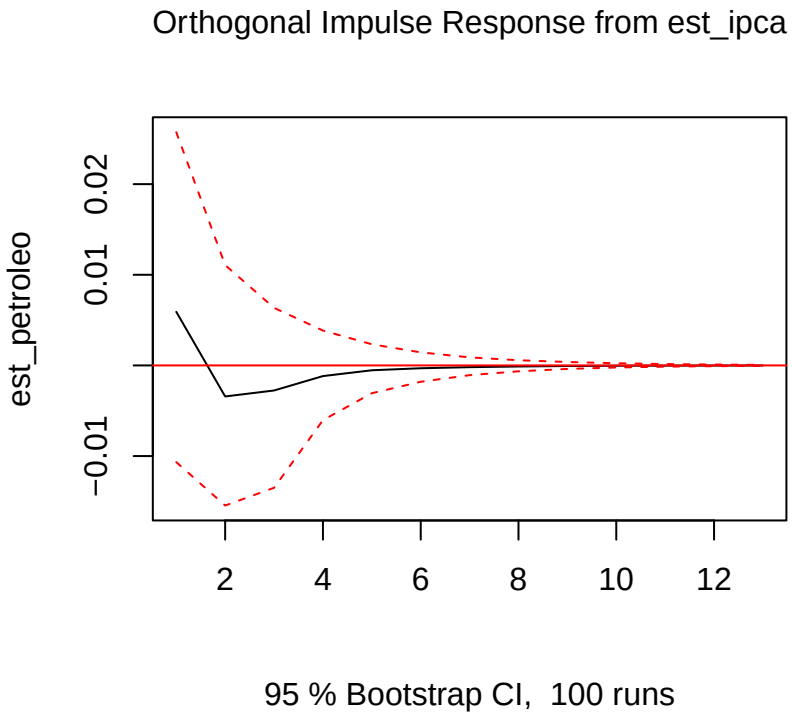
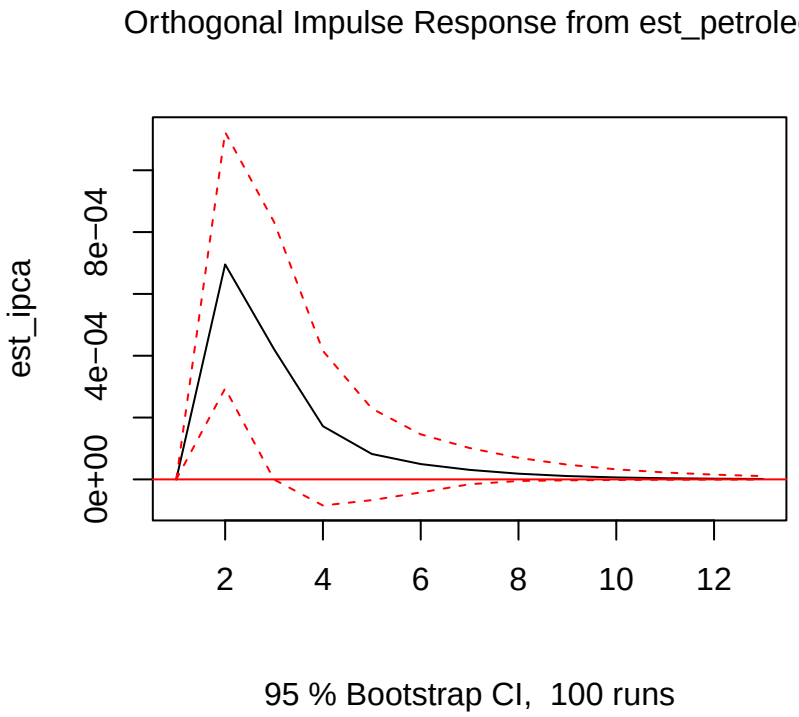
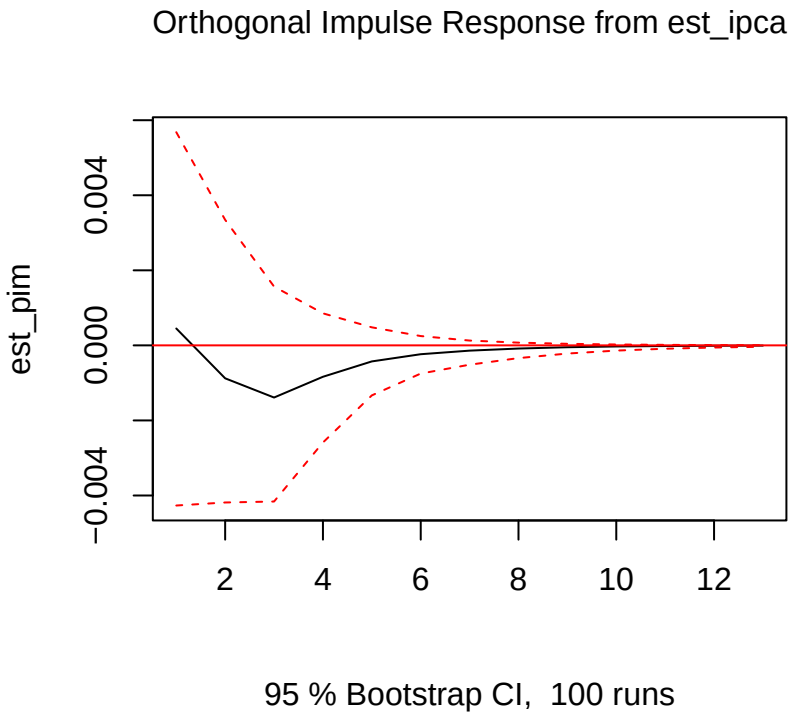
# 6 Appendix

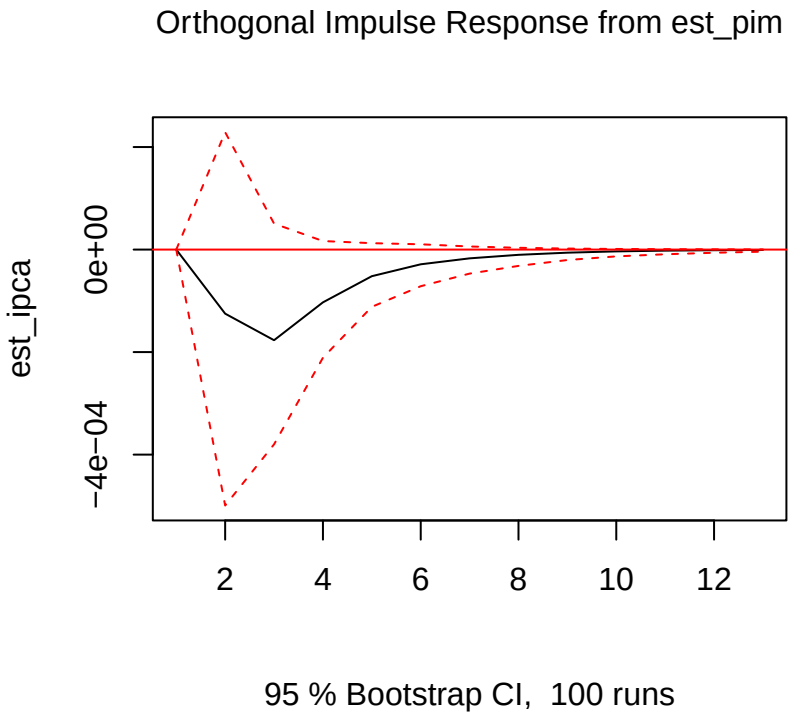

Orthogonal Impulse Response from est_ipca
est_cambio
0.002
−0.002
−0.008
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

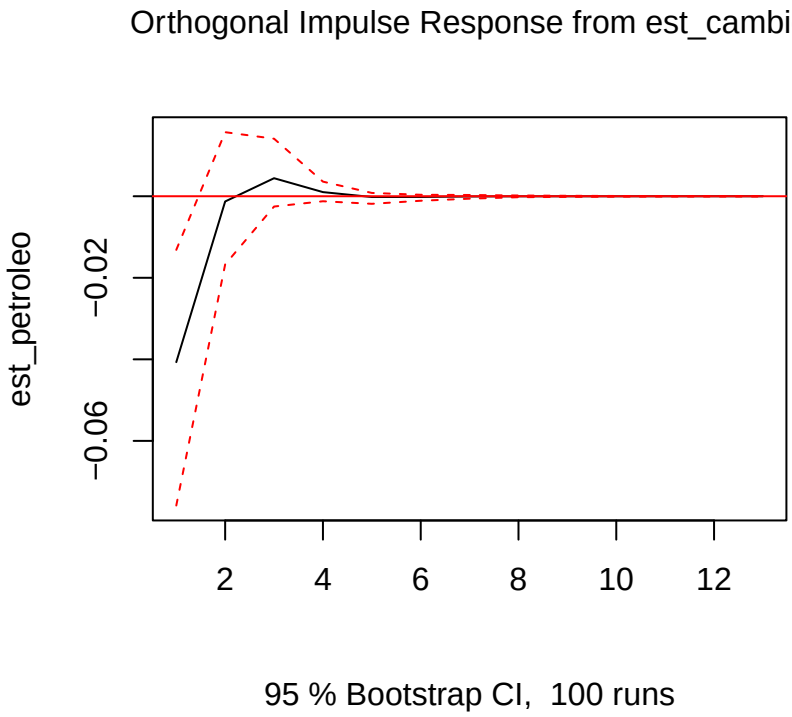

Orthogonal Impulse Response from est_cambio
est_ipca
4e−04
0e+00
−4e−04
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

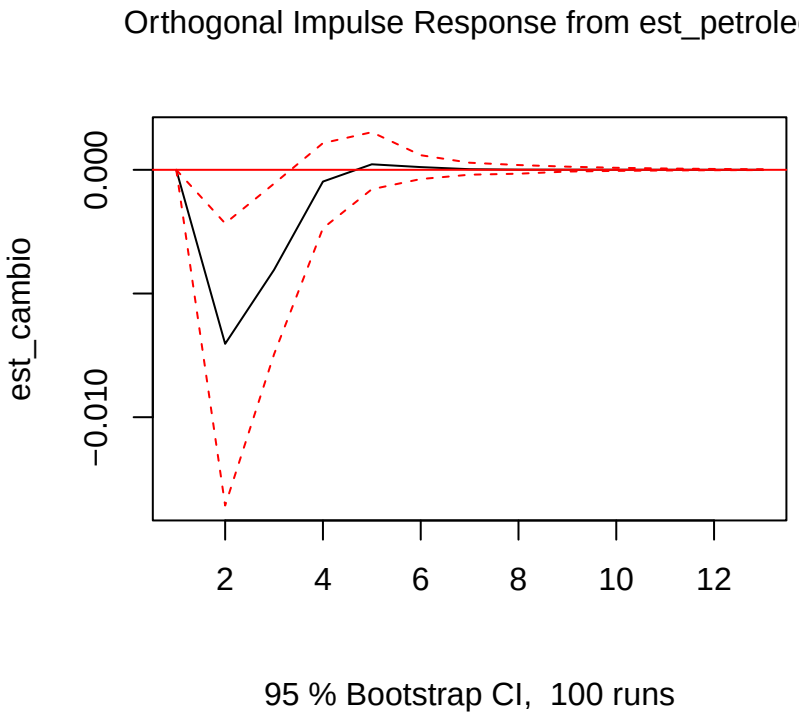

Orthogonal Impulse Response from est_ipca
est_petroleo
0.02
0.01
−0.01
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

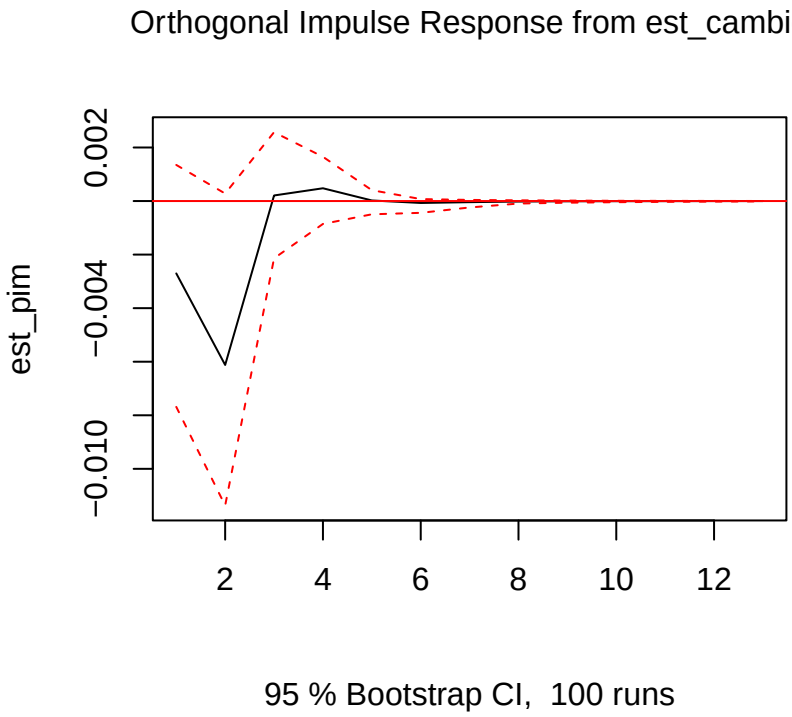

Orthogonal Impulse Response from est_petroleo
est_ipca
0e+00
4e−04
8e−04
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

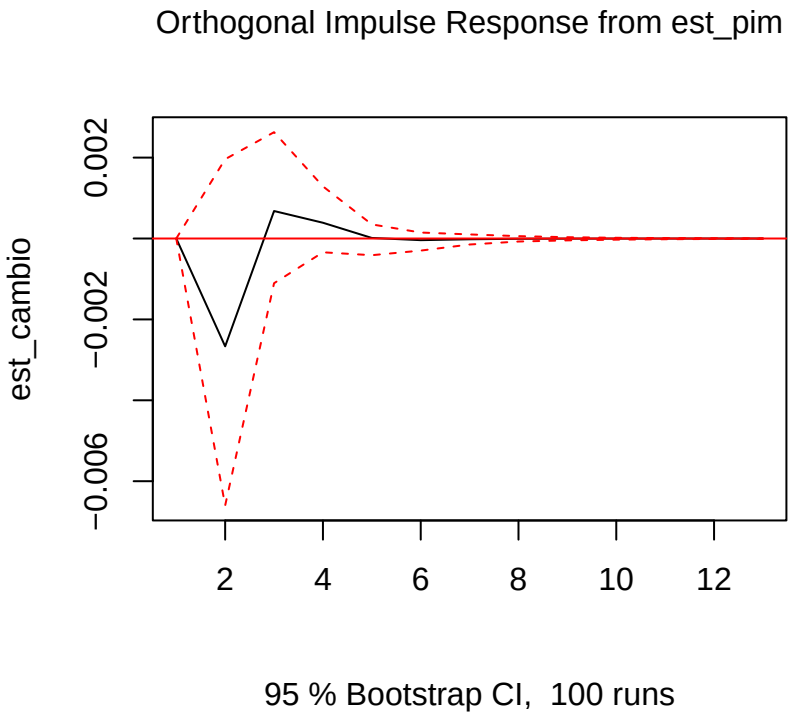

Orthogonal Impulse Response from est_ipca
est_pim
0.004
0.000
−0.004
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

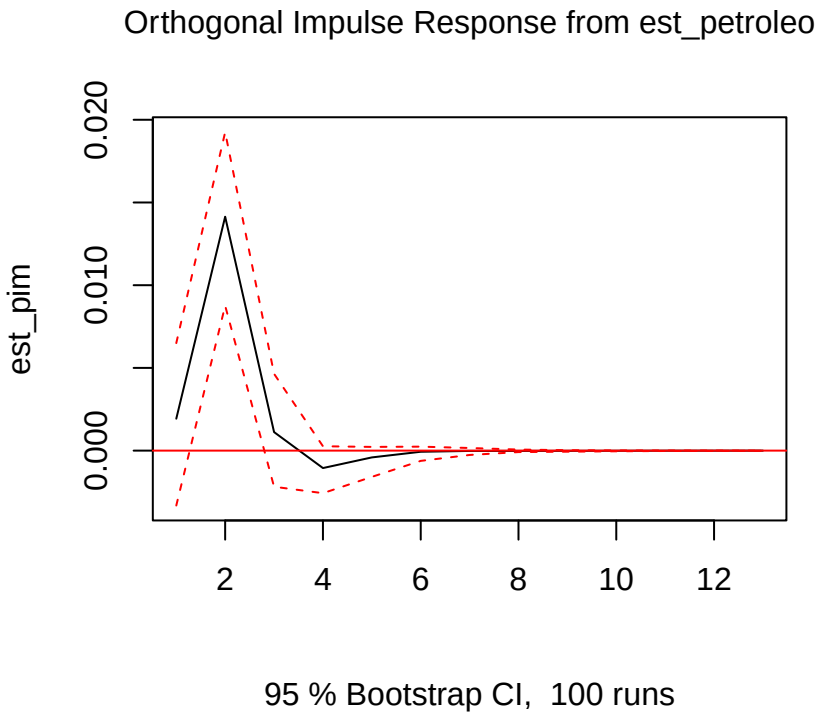

Orthogonal Impulse Response from est_pim
est_ipca
0e+00
−4e−04
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs

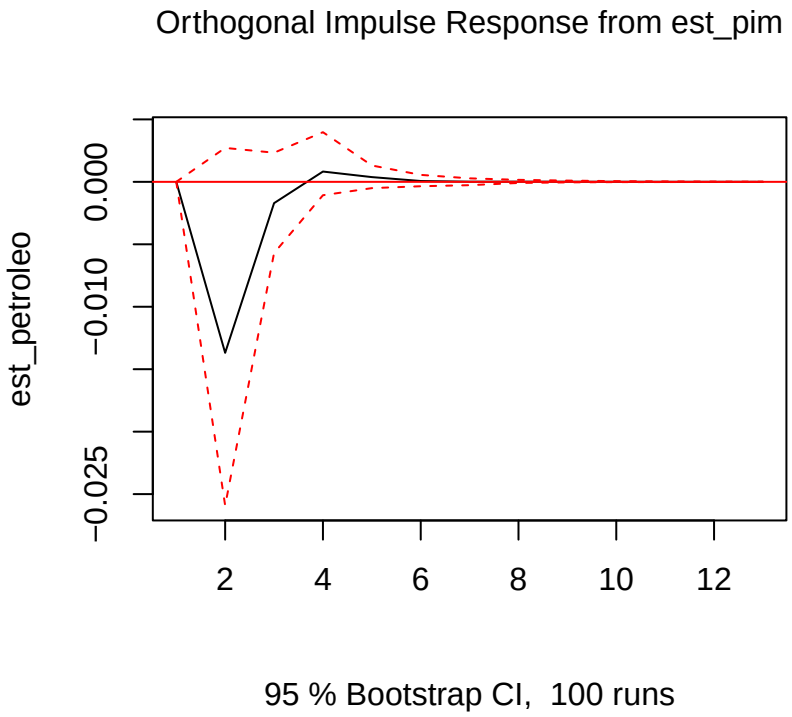

Orthogonal Impulse Response from est_cambio
est_petroleo
−0.06
−0.02
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from est_petroleo
est_cambio
0.000
−0.010
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from est_cambio
est_pim
0.002
−0.004
−0.010
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from est_pim
est_cambio
0.002
−0.002
−0.006
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from est_petroleo
est_pim
0.000
0.010
0.020
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from est_pim
est_petroleo
−0.025
−0.010
0.000
2
4
6
8
10
12
95 % Bootstrap CI, 100 runs