# Determinants of Real Exchange Rate: An analysis from macroeconomic internal factors in Latin American countries

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# Determinants of Real Exchange Rate:
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## Abstract

This paper study the macroeconomic factors than explain the real exchange real movements. We use a GMM Panel Vector Autoregressive for a period 1980-2016 for sixteen countries of America. We found that, the inflation, monetary mass, interest rate and the economic growth impact on real exchange rate positively. The public spend affect negatively but only significant on South American countries.

JEL classification: E52 E62 C33 C53
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1. Introduction:

The real exchange rate is a variable that has importance on the modern macroeconomic theory, it his definition is the relative price of tradable goods across countries and can serve as strength indicator of currencies from different countries.

The attempt to predict the real exchange rate has big relevance, Messe and Rogoff (1982) compare various structural and time series models for forecasting the real exchange rate, Messe and Rogoff (1982) study the predictability of real exchange rate from the real interest rate differentials. Mark (1995) attempt to predict the real exchange rate using a monetary model from fundamental values as money stock and domestic real income. Mcdonalds (1995) review the papers that modelling it in the long-run. Engel and West(2005) used the money supplies, outputs, inflation and interest rates for forecast the real exchange rate.

Some studies find that an overvaluation of real exchange rate has link with lower long-run economic growth, as Aguirre and Calderon (2006) and Edwards (1989). Krugman (1979) found that an overvaluation can be a warning indicator of currency crash. Instability of real exchange rate can affect to macroeconomic performance, see Hnatskova and Loayza (2004) and Aghion et al. (2006). Frankel and Rose (1996) estimate an event study analysis panel data for currencies from developing countries, they found that the reserves and domestic credit impact on the currencies and the current account or government budget deficits have not. Another researcher as Abuaf and Jorion(1990), Wei and Parselu(1995) and McDonals(1999) use weak and strong form of purchasing power parity for found long runs relations with the 'fundamentals' as term of trade, price of oil, real interest rate, inflation and etc. De Melo, J., & Edwards, S. (1991) and Soto and Elbadawi(2007) review the concept and measures of real exchange rate for developing countries.

The main question of this study is to examine the behavior of real exchange rate before shocks of o ur explicative variables that are only macroeconomic factors. This is because there is an interest in explaining how affects only the internal economy to real exchange rate. This question can to be relevant when the policymakers face currency crash, overvaluation or undervaluation of real exchange rate because using tools from his countries can decrease these impacts to the economy.

In this study, we determinate the macroeconomic factors that can affect to real exchange rate and how it reacts to shocks of them. We focus on Latin-American countries, and slice in north countries, central countries and South American countries for estimate if there are similar effects from these variables. We use annual data from 1980-2016 for all American countries, fourteen countries in total and we use consumer price index, gross domestic product, public spend, monetary mass, interest rate and net trade[1].

This paper contributes to the literature because, as will see on the literature review section, there is a lack of literature about determinants of real exchange rate. Our methodology propose is a panel data vector autoregressive using a general methods moments, proposed by Love and Zicchino (2006), that permit us estimate a Panel VAR for these variables using General Methods Moments methodology proposed by Arellano and Bond(1992), and we transform our variables with forward orthogonal deviations (FOD) dropping the serial correlation and unobserved heterogeneity, also we graphs his impulse-response functions to 20 periods before a shock of internal macroeconomics variables , and his variance decomposition that explain the real exchange rate movements.

The paper proceeds as follow: Section 2 discuss the literature about the link between the variables mentioned and the real exchange rate. Section 3 describe our data and methodology used. Section 4 present

[1] The source of these variables is World Bank's Data Bank.

the results by groups: American countries, Latin American countries, North American countries, Central American countries and South American countries. The section 5 provides the conclusions.

## 2. Literature Review:

The variables that we choice is respect to a neo Keynesian model framework, see Giordani(2004). We use all the variables in natural logarithm and annual terms. The historical data presented start in 1980 until to 2016, to exempt some countries that do not have all historical data and they are presented in the last row of our estimations.

### 2.1 Consumer Price Index:

There is an effect called pass-through that occur when the consumer changes the local currency for foreign change because variations of exchange rate. Liu(2015) find that negative link between real exchange rate and consumer price index for China case. Hüfner and Schröder (2002) estimate this effect for euro area using a Harmonized Index of Consumer Price(HICP), finding if occur a depreciation of 10%, the HICP will increase in 0.4%. Akinbobola(2012) find inverse effects of the exchange rate on inflationary pressures. Monfared and Akin(2017) find that a increase of real exchange rate makes the inflation increase too of Iran case. Edwards(2006) find that in countries that have inflation targeting, the pass-through effects experience declines.

### 2.2 Gross Domestic Product

The real exchange rate can have negative effects on gross domestic product, because an appreciation, a decrease of real exchange rate, the import is cheaper and the exports more expensive, these effects can reduce the gross domestic. In addition, suppose that occur a shock of demand, the gross domestic product arises, the money demand too, this increase the price and inflation, thus decrease the real exchange rate. Habib et al. (2016) find this negative relation only for developing countries. Razzaque et al. (2012) find that in short term, the real depreciations may result in decline in GDP. Inam and Umobong (2015) find that there is not causality between real exchange rate and economic growth in Nigeria. Gyimah and Gyapong (1993), Mwinlaaru and Ofori(2017) and Ndou, E. et al(2017) find positive causality between these variables.

### 2.3 Public spend:

Miyamoto et al. (2019) find that and increase in government purchase generate decrease real exchange rate. Bouakez and Equem(2011) find that a positive shock of government spend cause a depreciation on real exchange rate. Moreno and Segura-Ubiergo(2014) find that a fiscal discipline and increasing public investment can decrease the real exchange rate. Castro and Fernandez-Caballero(2011) find that fiscal shock can causes real appreciation for Spain case. Lambertini and Tavares(2003) find that fiscal adjustment can cause real depreciations. Chatterjee and Mursagulov(2012) , Galstyan and Lane(2008) and Benetrix and Lane(2013) find differential effects on real exchange rate depending of composition of public spend. Another papers that study this links are Sachs and Wyplosz(1984), Gazioglu(1993) and Di Giorgio et al.(2015),

### 2.4 Monetary Mass:

If occur an increase of monetary mass, the inflation arises, and the real exchange price will decrease (appreciation). Carvalho et al. (2019) support this.

2.5 Interest Rate:

Stavrakeva and Tang(2015) find that conventional monetary policy has low explaining power to real exchange rate. Cormun and De Leo(2017) find that a contractionary policy shock cause a depreciation of exchange rate. West(2003) A shock of monetary policy can decrease the volatility of real exchange rate. Eichenbaum and Evans(1993) find that the real exchange rate movements have not to significant response in interest rate. Sun and De(2018) find that real exchange rate changes not is explained by changes in the U.S monetary policy. Audzei and Brazdik(2015) find that real exchange rate have asymmetric response to changes in the monetary policy. Baxter(1992), Nakagawa(2002) and Kim(2007) using several methodologies find that there is a link between real exchange rate and real interest differentials at trend and business cycle. Another papers that study this links are Floyd(2009) and Clarida(2017)

2.6 Term of trade:

Mendoza(1995) find that a shock of term of trade cause real appreciations. Catao and Chang(2013) find that the term of trade and real exchange rate can have opposite movements. De Gregorio and Wolf (1994) find that an improvement in the terms of trade cause a real appreciation. Others papers that study this interrelations are Edwars(1988) and Choudhri and Schembri(2010).

3. Methodology and data:

We apply a Panel Vector Autoregressive (PVAR) for panel data, proposed for Love and Zicchino(2006). We chose endogenous variables in a system for all the countries called System-GMM proposed by Blundell and Blond (1998) that use lagged values of the endogenous variables as instruments for this system. These variables are: real exchange rate($q_{i,t}$), consumer price index($cpi_{i,t}$), gross domestic product($gdp_{i,t}$), public spend ($gov_{i,t}$), monetary mass ($m_{i,t}$), interest rate ($i_{i,t}$) and net trade($trade_{i,t}$).

Our empirical proposed is as follow:

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \eta_i + \epsilon_{i,t} \quad . \quad . \quad . \quad .(1)$$

Where I = 1, 2, . . . N and t = 1,2,3,…T. $Y_{i,t} = [q_{i,t}, cpi_{i,t}, gdp_{i,t}, gov_{i,t}, m_{i,t}, i_{i,t}, trade_{i,t}]$ is a vector that contain the endogenous variables in natural logarithm, $\alpha$ is the fixed effects for all the countries, $\eta_i$is the unobserved heterogeneity and $\epsilon_{i,t}$ is the error term. We can to use two techniques for drop the unobserved heterogeneity, the first one is the first difference and consist in, difference the endogenous variables with the lagged value, $\Delta Y_{i,t} = Y_{i,t} - Y_{i,t-1}$, getting the new form of this model:

$$\Delta Y_{i,t} = \beta_1 \Delta Y_{i,t-1} + \Delta\epsilon_{i,t} \quad . \quad . \quad . \quad .(2)$$

Where $\Delta$ is the operator of first difference but this estimation can suffer the serial correlation, due to that in the estimations for all the moments the lagged values ($Y_{i,t-1}$) can have correlation with lagged values of the error term, $\epsilon_{i,t-1}$. This generate a lack of orthogonality,$E\left(\Delta Y_{i,t-1}\Delta\epsilon_{i,t-1}\right) \neq 0$, that mean, biased estimations. For this reason, we include another technique available, following to Arellano and Bover(1995), who were propose a technique called Forward Orthogonal Deviations (FOD) that drop the unobserved heterogeneity and serial correlation constructing a new standardization of our variables subtracting the average of all future available observations, $\nabla Y_{i,t+1} = c_{i,t}(Y_{i,t} - \frac{\sum_{t=1}^{T} Y_{i,t+1}}{T_{i,t}})$, where $T_{i,t}$ is the number of observations for each country and $c_{i,t}$ is the scale factor equal to $\sqrt{\frac{T_{i,t}}{T_{i,t}+1}}$ . This permit that the variables gets an independent and identically distribution, and have the new form:

$$\nabla Y_{i,t+1} = \beta_1 \nabla Y_{i,t} + \nabla\epsilon_{i,t} \quad . \quad . \quad . \quad .(3)$$

Where $\nabla$ is the operator of forward orthogonal deviations (FOD). Thus, our PVAR model, that have a System-GMM structure and his endogenous variables have forward orthogonal transformation, get biases dropped. Our model proposed by us is presented in the next equation:

$$Y_t = \alpha + A_1 Y_{t-1} + \mu_t. \quad . \quad . \quad .(7)$$

Where $Y_t$ is the transformed series in vector form equal to $[q_{i,t}, cpi_{i,t}, gdp_{i,t}, gov_{i,t}, m_{i,t}, i_{i,t}, trade_{i,t}]$, $\alpha$ is the vector of intercepts, $A_1$ is the parameters matrix and $\mu_t$ is vector of term errors that is uncorrelated over time. Let assume that $N(0, \sum)$ distribution for the term errors, where $\sum$ is a matrix of covariance.

4. Empirical results and discussions:

This section gives the results of our estimations from System-GMM Panel VAR model, Granger Causality test, Orthogonalized Impulse-Reaction Function and variance decomposition.

4.1 Panel Data

4.1.1 Granger Causality tests:

First, we split all our countries by groups: First group called All countries, that contain all American countries. Second group called Latin American Countries, we exclude United States and Canada. Third group called North American Countries; we maintain United States, Canada and Mexico. Fourth group called, Central American Countries; we maintain Guatemala, Costa Rica, Dominican Republic, Saint Lucia, Guyana and Jamaica. Fifth group called South American, contain Bolivia, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay.

The Table 1 show the Granger Causality Test for each group and adding dummies. We found that when we add dummies for year and for exogenous variables as both oil and gold prices, for all the countries, there is a causality of gross domestic product, interest rate and net trade. For Latin American countries, we found that similar results but adding consumer price index. For North American Countries[2], we found significance only for consumer price index only when we add year dummies. For Central American Countries, we do not found causality for all the variables. For South American Countries, we found causality by consumer price index; gross domestic product and public spend.

[2] We work without gross domestic product and monetary base because as is a short panel data, for three countries, we cannot have more variables than observations in some because, for this reason, we drop these variables

# Table 1: Panel Var-Granger Causality Wald Test

| Variables | All-countries | | | Latin American countries | | | North American Countries | | | Central American Countries | | | South American Countries | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies |
| $cpi_{i,t}$ | 1.380 | 1.980 | 2.773 | 1.039 | 1.891 | 3.049* | 0.026 | 2.89* | 1.857 | 0.540 | 0.544 | 0.276 | 0.688 | 3.775** | 3.37** |
| | (0.24) | (0.16) | (0.10) | (0.31) | (0.17) | (0.08) | (0.87) | (0.09) | (0.17) | (0.46) | (0.46) | (0.60) | (0.41) | (0.05) | (0.07) |
| $gdp_{i,t}$ | 1.442 | 1.520 | 4.991** | 0.672 | 0.642 | 5.348** | 2.479 | | | 0.040 | 0.235 | 0.379 | 0.011 | 2.027 | 3.79** |
| | (0.23) | (0.22) | (0.03) | (0.41) | (0.42) | (0.02) | (0.12) | | | (0.84) | (0.63) | (0.54) | (0.92) | (0.16) | (0.05) |
| $gov_{i,t}$ | 0.050 | 0.340 | 0.110 | 0.002 | 0.190 | 0.040 | 0.158 | 0.200 | 0.091 | 1.000 | 0.632 | 0.080 | 2.563 | 2.539 | 3.92** |
| | (0.82) | (0.56) | (0.74) | (0.96) | (0.66) | (0.84) | (0.69) | (0.66) | (0.76) | (0.32) | (0.43) | (0.78) | (0.11) | (0.11) | (0.05) |
| $m_{i,t}$ | 0.141 | 0.270 | 0.834 | 0.294 | 0.416 | 1.518 | 0.059 | | | 0.090 | 0.028 | 0.156 | 1.653 | 0.203 | 1.060 |
| | (0.71) | (0.60) | (0.36) | (0.59) | (0.52) | (0.22) | (0.81) | | | (0.76) | (0.87) | (0.69) | (0.11) | (0.65) | (0.30) |
| $i_{i,t}$ | 0.811 | 0.780 | 6.107** | 0.379 | 0.271 | 4.361** | 0.106 | 2.036 | 2.409 | 0.040 | 0.298 | 0.115 | 2.601 | 0.083 | 0.270 |
| | (0.37) | (0.38) | (0.01) | (0.54) | (0.60) | (0.04) | (0.75) | (0.15) | (0.12) | (0.83) | (0.59) | (0.73) | (0.11) | (0.77) | (0.60) |
| $trade_{i,t}$ | 0.770 | 0.570 | 4.606** | 0.382 | 0.216 | 3.584* | 0.001 | 0.192 | 0.121 | 0.190 | 0.414 | 0.253 | 0.349 | 0.111 | 1.010 |
| | (0.38) | (0.45) | (0.03) | (0.54) | (0.64) | (0.06) | (0.97) | (0.66) | (0.73) | (0.66) | (0.52) | (0.62) | (0.55) | (0.74) | (0.31) |
| | 12.245*** | 10.64 | 14.468*** | 12.246* | 11.3* | 13.262** | 15.989** | 12.566** | 6.678 | 7.400 | 4.133 | 1.254 | 12.936** | 17.84*** | 8.570 |
| ALL | (0.06) | (0.10) | (0.025) | (0.06) | (0.08) | (0.04) | (0.01) | (0.01) | (0.15) | (0.29) | (0.66) | (0.97) | (0.04) | (0.01) | (0.20) |

Chi-square is the first row for each variable
P-values in parenthesis
* $p < 0.1$
** $p < 0.05$
*** $p < 0.01$
$H_0$ : Excluded variable does not Granger-cause Equation variable
$H_a$ : Excluded variable Granger-causes Equation variable

### 4.1.2 GMM Panel VAR

The table 2 show that for all the countries, the consumer price index, gross domestic product, interest rate and net trade have positive and significative impact on exchange rate, also as exogenous variable, the oil price have positive and significative impact on the exchange rate. For Latin American Countries, we found similar results with all the countries. For both North American Countries and Central American Countries, we do not found results of impacts on exchange rate, except for his lagged. For South American Countries, we found that the exchange rate is positive and significative impacted by his lagged value, consumer price index and gross domestic product but negative and significative by public spend. These results differ to the empirical literature,

# Table 2: GMM Panel VAR

| Variables | American Countries | | | Latin American countries | | | North American Countries | | | Central American Countries | | | South American Countries | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies | Only variables | With year dummies | With year dummies and prices dummies |
| $q_{i,t-1}$ | 0.942*** | 0.931*** | 0.939*** | 0.942*** | 0.927*** | 0.935*** | 0.614* | 0.763*** | 0.517 | 0.905*** | 0.906*** | 0.914*** | 0.884*** | 0.871* | 0.410* |
| | (2.73) | (24.79) | (27.59) | (17.6) | (22.13) | (26.88) | (1.93) | (4.52) | (1.54) | (13.18) | (13.49) | (14.34) | (9.30) | (8.50) | (1.83) |
| $cpi_{i,t-1}$ | 0.003 | 0.004 | 0.005* | 0.003 | 0.004 | 0.006* | -0.019 | 0.035* | 0.085 | 0.032 | 0.012 | 0.013 | 0.004 | 0.007 | 0.008* |
| | (1.17) | (1.41) | (1.67) | (1.02) | (1.38) | (1.75) | (-0.16) | (1.70) | (1.36) | (0.74) | (0.32) | (0.35) | (0.83) | (1.55) | (1.84) |
| $gdp_{i,t-1}$ | 0.080 | 0.058 | 0.061*** | 0.111 | 0.069 | 0.078*** | -0.264 | | | -0.018 | -0.016 | 0.048 | 0.006 | 0.019 | 0.152* |
| | (1.20) | (1.23) | (2.23) | (0.82) | (0.80) | (2.31) | (-1.57) | | | (-0.20) | (-0.13) | (0.57) | (0.10) | (0.36) | (1.95) |
| $gov_{i,t-1}$ | -0.02 | -0.038 | -0.015 | 0.007 | -0.040 | -0.010 | -1.687 | 0.152 | -0.088 | -0.040 | -0.058 | 0.009 | -0.304 | -0.377*** | -0.510** |
| | (0.220) | (-0.58) | (-0.33) | (-0.05) | (-0.44) | (-0.20) | (-0.40) | (0.45) | (-0.30) | (-1.00) | (-0.57) | (0.17) | (-1.60) | (-2.09) | (-1.98) |
| $m_{i,t-1}$ | -0.01 | -0.017 | -0.030 | 0.026 | -0.027 | -0.049 | -0.131 | | | 0.016 | -0.07 | 0.010 | 0.07 | 0.072 | 0.110 |
| | (0.380) | (-0.52) | (-0.91) | (-0.54) | (-0.65) | (-1.23) | (-0.24) | | | (0.31) | (-0.69) | (0.14) | (1.29) | (1.32) | (1.03) |
| $i_{i,t-1}$ | 0.03 | 0.022 | 0.042*** | 0.043 | 0.022 | 0.052*** | -0.208 | 0.067 | 0.207 | 0.008 | 0.010 | -0.018 | 0.029 | 0.029* | -0.020 |
| | (0.90) | (0.89) | (2.47) | (0.62) | (0.52) | (2.09) | (-0.33) | (1.43) | (1.55) | (0.22) | (0.14) | (-0.41) | (1.61) | (1.69) | (-0.52) |
| $trade_{i,t-1}$ | 0.130 | 0.084 | 0.148*** | 0.182 | 0.086 | 0.187** | 0.024 | 0.082 | 0.106 | -0.064 | -0.402 | -0.201 | 0.069 | 0.009 | -0.202 |
| | (0.88) | (0.76) | (2.15) | (0.62) | (0.46) | (1.89) | (0.04) | (0.44) | (0.35) | (-0.44) | (-0.52) | (-0.34) | (0.59) | (0.07) | (-1.01) |
| Year 2003 | | -0.039*** | -0.032*** | | -0.042*** | -0.026 | | -0.004 | 0.047 | | 0.026 | -0.038 | | -0.084*** | -0.140*** |
| | | (-2.68) | (-2.05) | | (-2.57) | (-1.28) | | (-0.14) | (0.49) | | (0.50) | (-1.14) | | (-2.29) | (-2.55) |
| Year 2006 | | 0.015 | 0.010 | | 0.016 | 0.015 | | 0.016 | -0.119 | | 0.072 | 0.009 | | 0.012 | -0.084 |
| | | (1.28) | (0.71) | | (1.21) | (0.85) | | (0.82) | (-0.92) | | (0.64) | (0.15) | | (0.40) | (-1.45) |
| Year 2009 | | 0.012 | 0.007 | | 0.014 | 0.007 | | -0.007 | -0.070 | | 0.048 | 0.034 | | -0.002 | -0.015 |
| | | (0.78) | (0.45) | | (0.83) | (0.44) | | (-0.20) | (-1.27) | | (1.02) | (1.04) | | (-0.06) | (-0.45) |
| Oil Price | | | 0.024** | | | 0.025** | | | 0.374 | | | -0.013 | | | 0.018 |
| | | | (1.91) | | | (1.85) | | | (1.51) | | | (-0.35) | | | (0.65) |
| Gold Price | | | -0.000 | | | 0.012 | | | -0.151 | | | -0.051 | | | -0.080 |
| | | | (-0.02) | | | (0.42) | | | (-0.63) | | | (-0.83) | | | (-1.55) |
| No. of Obs | 466 | 466 | 466 | 406 | 406 | 406 | 94 | 102 | 143 | 204 | 204 | 204 | 238 | 238 | 238 |
| No. of Panels | 16 | 16 | 16 | 14 | 14 | 14 | 3 | 3 | 3 | 6 | 6 | 6 | 7 | 7 | 7 |

Initial weight matrix: Identity
GMM weight matrix: Robust
Instruments :l(2).($q_{i,t-1} cpi_{i,t-1} gdp_{i,t-1} gov_{i,t-1} m_{i,t-1} i_{i,t-1} trade_{i,t-1}$) except for North American Countries
T-statistics in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

4.1.3 Variance decomposition and impulse-response graphs:

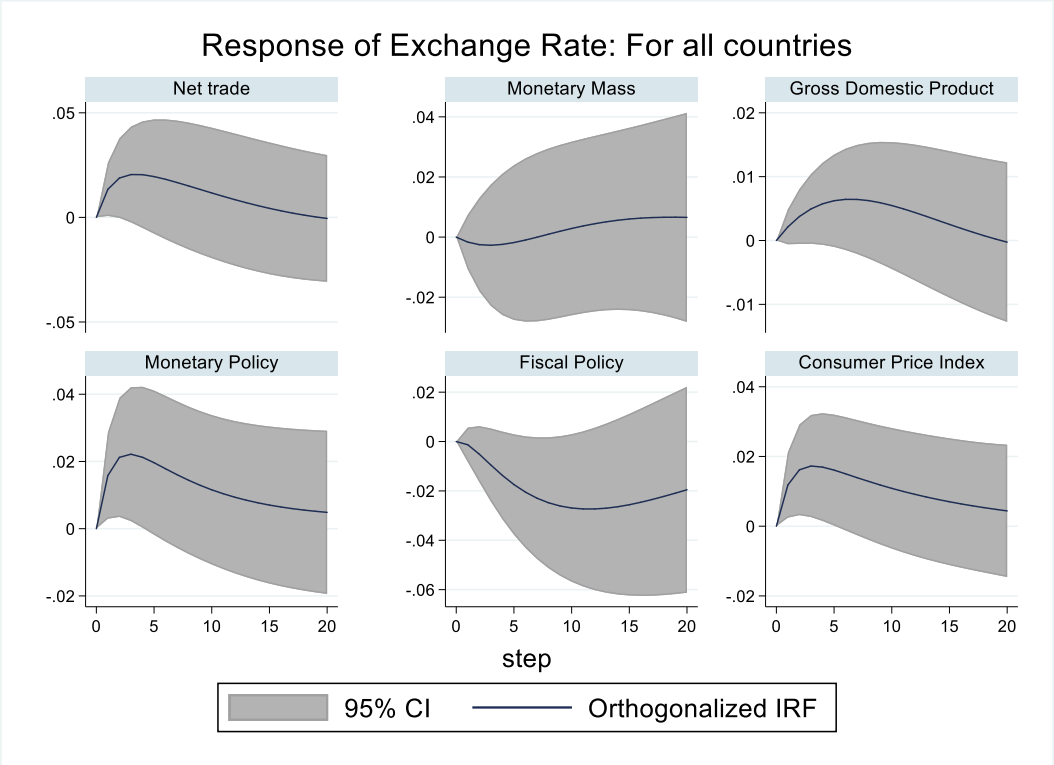
The following tables and graphs show the variance decomposition and the response to the impulse of the independent variables.

Table 3: Forecast-error variance decomposition:
For All the countries

| $q_{i,t}$ | $cpi_{i,t}$ | $gdp_{i,t}$ | $gov_{i,t}$ | $m_{i,t}$ | $i_{i,t}$ | $trade_{i,t}$ |
|---|---|---|---|---|---|---|
| 0 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 2 | 0.94% | 0.03% | 0.01% | 0.02% | 1.68% | 1.21% |
| 3 | 1.89% | 0.09% | 0.13% | 0.04% | 3.29% | 2.51% |
| 4 | 2.60% | 0.16% | 0.44% | 0.06% | 4.43% | 3.54% |
| 5 | 3.10% | 0.24% | 0.96% | 0.07% | 5.16% | 4.31% |
| 6 | 3.45% | 0.32% | 1.69% | 0.07% | 5.62% | 4.85% |
| 7 | 3.70% | 0.39% | 2.58% | 0.07% | 5.90% | 5.23% |
| 8 | 3.87% | 0.46% | 3.61% | 0.06% | 6.05% | 5.49% |
| 9 | 3.99% | 0.52% | 4.73% | 0.06% | 6.14% | 5.65% |
| 10 | 4.08% | 0.56% | 5.90% | 0.06% | 6.17% | 5.73% |

For all countries, these macroeconomic variables can explain until 22% of the real exchange rate movements and the interest rate has the higher percentage of share.

Figure 1



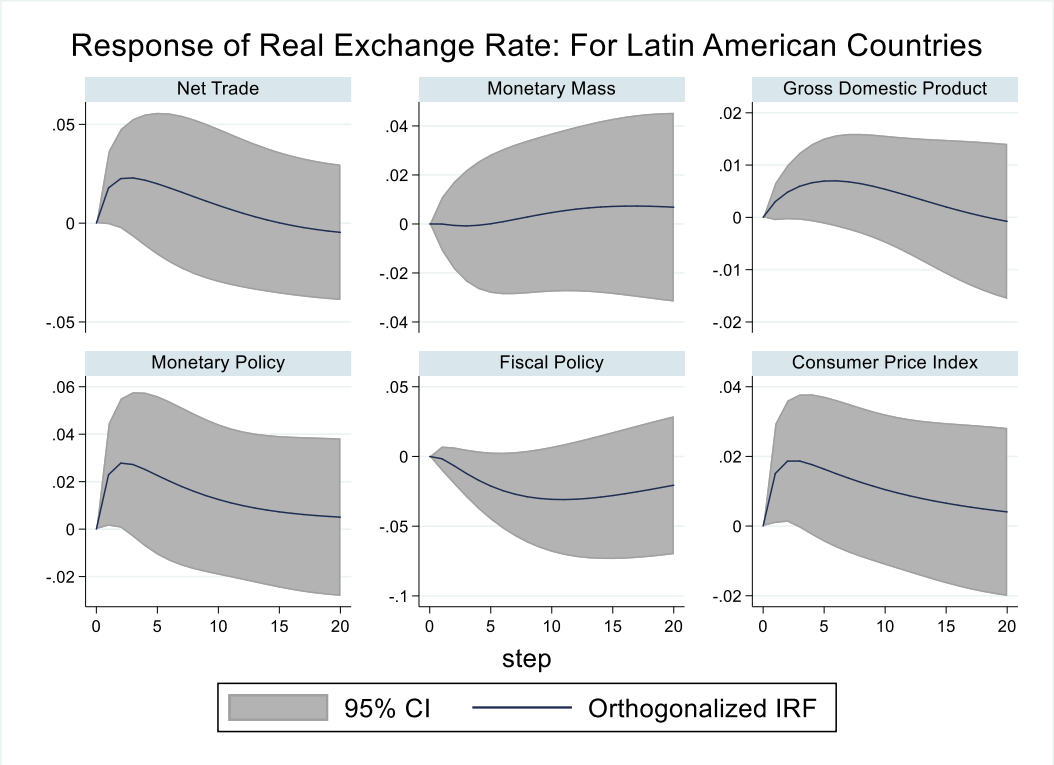

The impulse-response graph show that the fiscal policy and the monetary mass have negative impact on the real exchange rate but the first slightly while the fiscal policy is higher.

Table 4: Forecast-error variance decomposition:
For Latin American countries

| $q_{i,t}$ | $cpi_{i,t}$ | $gdp_{i,t}$ | $gov_{i,t}$ | $m_{i,t}$ | $i_{i,t}$ | $trade_{i,t}$ |
|---|---|---|---|---|---|---|
| 0 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 2 | 1.36% | 0.05% | 0.02% | 0.00% | 3.13% | 1.90% |
| 3 | 2.40% | 0.13% | 0.20% | 0.00% | 5.41% | 3.44% |
| 4 | 3.05% | 0.22% | 0.64% | 0.00% | 6.73% | 4.45% |
| 5 | 3.45% | 0.31% | 1.36% | 0.00% | 7.47% | 5.09% |
| 6 | 3.71% | 0.40% | 2.31% | 0.00% | 7.87% | 5.48% |
| 7 | 3.88% | 0.47% | 3.45% | 0.00% | 8.07% | 5.70% |
| 8 | 3.99% | 0.53% | 4.72% | 0.01% | 8.14% | 5.79% |
| 9 | 4.06% | 0.58% | 6.07% | 0.03% | 8.14% | 5.79% |
| 10 | 4.10% | 0.62% | 7.44% | 0.05% | 8.10% | 5.73% |

For Latin American countries, these variables can explain until 26% of real exchange rate movements and the interest rate has the higher percentage of share.

Figure 2



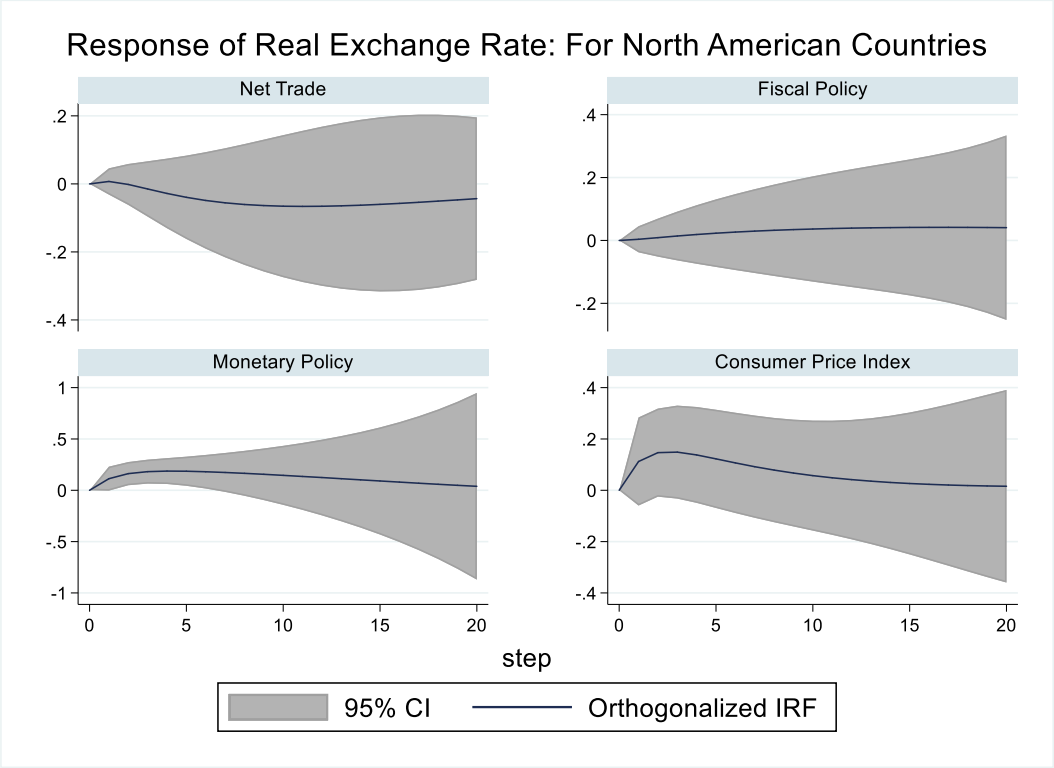

The impulse-response graph show that the fiscal policy and the monetary mass have negative impact on the real exchange rate but comparing to the all countries, the impact is slightly lower.

Table 5: Forecast-error variance decomposition:
For North American Countries

| $q_{i,t}$ | $cpi_{i,t}$ | $gov_{i,t}$ | $i_{i,t}$ | $trade_{i,t}$ |
|---|---|---|---|---|
| 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% |
| 2 | 2.0% | 0.0% | 2.1% | 0.0% |
| 3 | 4.2% | 0.0% | 4.8% | 0.0% |
| 4 | 5.8% | 0.0% | 7.5% | 0.0% |
| 5 | 6.9% | 0.1% | 9.8% | 0.1% |
| 6 | 7.6% | 0.1% | 11.9% | 0.2% |
| 7 | 8.0% | 0.1% | 13.7% | 0.4% |
| 8 | 8.2% | 0.2% | 15.2% | 0.6% |
| 9 | 8.3% | 0.3% | 16.5% | 0.8% |
| 10 | 8.3% | 0.3% | 17.6% | 1.1% |

For North American Countries, we found that these variables can explain until 26% of the real exchange movements, the interest rate has the higher percentage of sharing.

Figure 3:




The impulse-response graph show that these variables generate a raise of the real exchange rate but then tend to decrease, except the fiscal policy that seem increase but slightly.

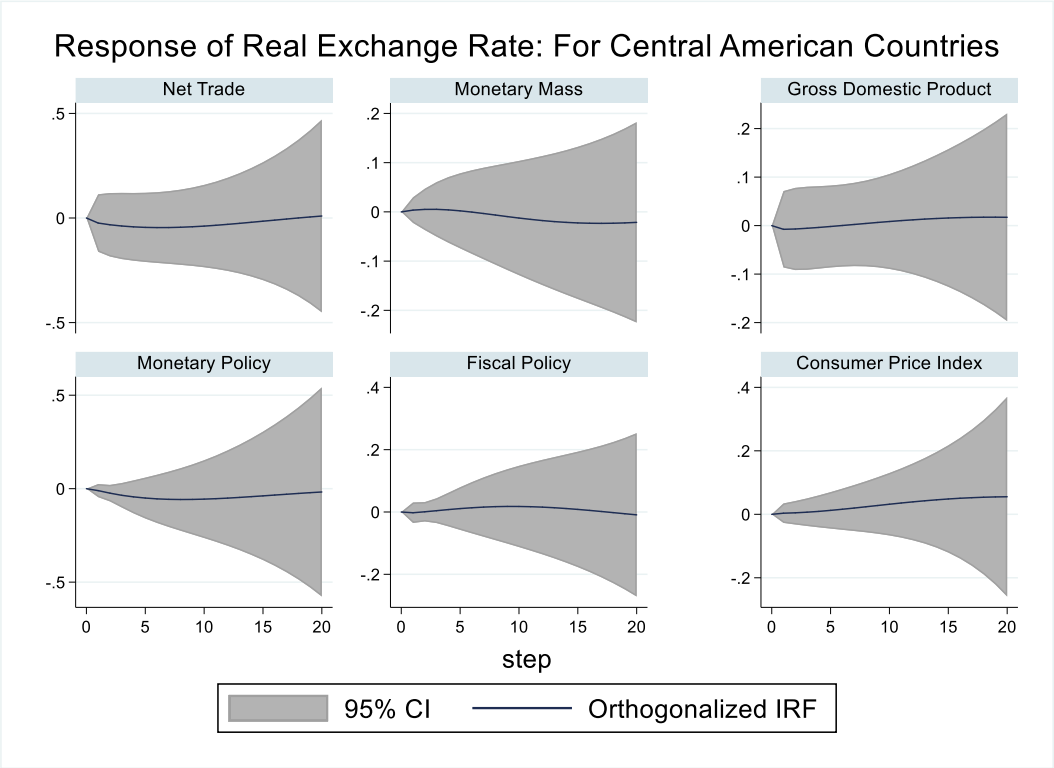
Table 6: Forecast-error variance decomposition:
For Central American Countries

| $q_{i,t}$ | $cpi_{i,t}$ | $gdp_{i,t}$ | $gov_{i,t}$ | $m_{i,t}$ | $i_{i,t}$ | $trade_{i,t}$ |
|---|---|---|---|---|---|---|
| 0 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 2 | 0.01% | 0.06% | 0.01% | 0.01% | 0.11% | 0.58% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 0.03% | 0.08% | 0.00% | 0.03% | 0.50% | 1.18% |
| 4 | 0.05% | 0.08% | 0.01% | 0.04% | 1.13% | 1.80% |
| 5 | 0.08% | 0.08% | 0.04% | 0.04% | 1.93% | 2.43% |
| 6 | 0.14% | 0.07% | 0.09% | 0.04% | 2.84% | 3.05% |
| 7 | 0.23% | 0.06% | 0.16% | 0.04% | 3.79% | 3.63% |
| 8 | 0.36% | 0.06% | 0.24% | 0.04% | 4.75% | 4.16% |
| 9 | 0.54% | 0.06% | 0.33% | 0.05% | 5.67% | 4.62% |
| 10 | 0.78% | 0.08% | 0.43% | 0.08% | 6.53% | 4.99% |

The table show that this variable only can explain until 12% of the real exchange movements, the interest rate and net trade have the more participation on this movement.

Figure 4:




The impulse-response graph shows slight changes before of shocks from these variables of the real exchange rate.

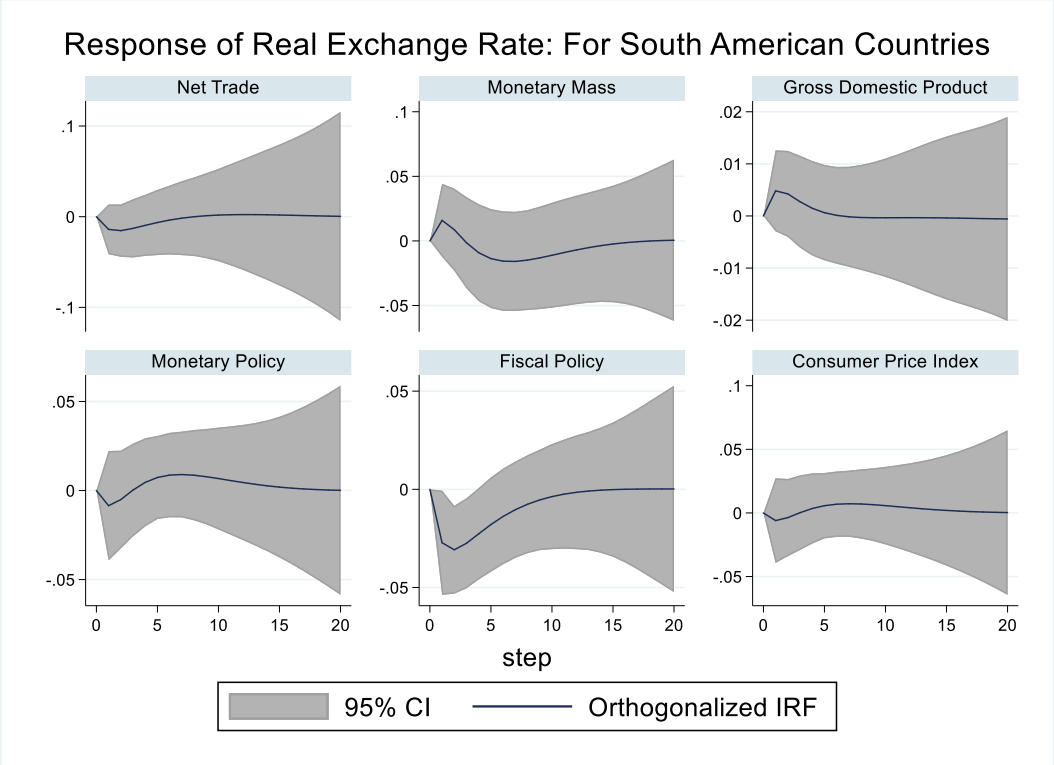
Table 8: Forecast-error variance decomposition:
For South American Countries

| $q_{i,t}$ | $cpi_{i,t}$ | $gdp_{i,t}$ | $gov_{i,t}$ | $m_{i,t}$ | $i_{i,t}$ | $trade_{i,t}$ |
|---|---|---|---|---|---|---|
| 0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2 | 0.3% | 0.2% | 5.5% | 1.9% | 0.5% | 1.4% |
| 3 | 0.3% | 0.3% | 11.2% | 2.2% | 0.7% | 2.9% |
| 4 | 0.3% | 0.3% | 15.2% | 2.1% | 0.6% | 3.7% |
| 5 | 0.4% | 0.3% | 17.6% | 2.5% | 0.7% | 4.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | 0.5% | 0.3% | 18.8% | 3.5% | 1.0% | 4.2% |
| 7 | 0.8% | 0.3% | 19.3% | 4.7% | 1.4% | 4.1% |
| 8 | 1.0% | 0.3% | 19.4% | 5.9% | 1.8% | 4.0% |
| 9 | 1.3% | 0.3% | 19.2% | 7.0% | 2.1% | 3.9% |
| 10 | 1.5% | 0.3% | 19.1% | 7.8% | 2.4% | 3.9% |

For South American Countries, these variables can explain until 35% of real exchange rate movements but with the difference that the public spend has the higher participation of these movements.

Figure 5:




The impulse-response graphs show that only the fiscal policy has negative impacts on the real exchange rate. For last, in the appendix, we check the stability condition of our estimations.

4.2 For each country:

4.2.1 Granger Causality Tests:

The table 9 show that the consumer price index and the gross domestic product are macroeconomic factor that Granger cause real exchange rate, for all countries except Brazil and Paraguay, in consumer price index case, and Paraguay and Peru for gross domestic product case. The public spend Granger cause real exchange rate for Bolivia, the monetary mass Granger cause real exchange rate for Brazil and Uruguay. The interest rate Granger cause real exchange rate for Peru and Uruguay. And for last, the term of trade Granger cause the real exchange rate for Paraguay.

Table 9: Granger causality Wald tests:
South American Countries

| Variables | South American Countries | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bolivia | Brazil | Chile | Colombia | Paraguay | Peru | Uruguay |
| $cpi_{i,t-1}$ | 3.298* | 1.528 | 9.610*** | 3.3146* | 0.926 | 4.187** | 7.959*** |
| | (0.07) | 0.22) | 0.00) | (0.07) | (0.34) | (0.04) | (0.01) |
| $gdp_{i,t-1}$ | 14.329* | 4.280*** | 6.286*** | 5.061** | 0.263 | 1.443 | 12.723*** |
| | (0.00) | 0.04) | 0.01) | (0.02) | (0.61) | (0.23) | (0.00) |
| $gov_{i,t-1}$ | 11.602* | 0.618 | 0.220 | 0.018 | 1.344 | 0.199 | 0.001 |
| | (0.00) | 0.43) | 0.64) | (0.89) | (0.25) | (0.66) | (0.97) |
| $m_{i,t-1}$ | 0.004 | 7.308*** | 0.277 | 0.000 | 0.578 | 0.233 | 19.553*** |
| | (0.95) | 0.01) | 0.60) | (1.00) | (0.45) | (0.63) | (0.00) |
| $i_{i,t-1}$ | 1.646 | 0.864 | 1.952 | 0.850 | 0.880 | 3.865** | 3.1794* |
| | (0.20) | 0.35) | 0.16) | (0.36) | (0.35) | (0.05) | (0.08) |
| $trade_{i,t-1}$ | 1.646 | 0.736 | 0.465 | 0.231 | 5.2005** | 0.013 | 1.566 |
| | (0.20) | 0.39) | 0.50) | (0.63) | (0.02) | (0.91) | (0.21) |

H0: endogenous variables do not Granger cause the dependent variable
P-values in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

The table 10 show that all variables except term of trade Granger cause real exchange rate for Dominican Republic. The consumer price index, gross domestic product and monetary mass Granger cause the real exchange rate for St. Lucia. Only the monetary mass Granger cause the real exchange rate for Guatemala and no variable causes the real exchange rate in Costa Rica, Guyana and Jamaica.

Table 10: Granger causality Wald tests:
Central American Countries

| Variables | Central American Countries | | | | | |
|---|---|---|---|---|---|---|
| | Costa Rica | Dominican Republic | Guatemala | Guyana | Jamaica | St Lucia |
| $cpi_{i,t-1}$ | 2.484 | 5.686** | 0.288 | 0.000 | 0.126 | 6.766*** |
| | (0.12) | (0.02) | (0.59) | (0.99) | (0.72) | (0.01) |
| $gdp_{i,t-1}$ | 1.752 | 2.8881* | 0.612 | 1.640 | 0.438 | 3.329* |
| | (0.19) | (0.09) | (0.43) | (0.20) | (0.51) | (0.07) |
| $gov_{i,t-1}$ | 0.442 | 7.254*** | 0.322 | 0.052 | 0.767 | 0.378 |
| | (0.51) | (0.01) | (0.57) | (0.82) | (0.38) | (0.54) |
| $m_{i,t-1}$ | 2.565 | 14.247*** | 3.151*** | 0.005 | 1.760 | 7.008*** |
| | (0.11) | (0.00) | (0.08) | (0.95) | (0.19) | (0.01) |
| $i_{i,t-1}$ | 0.063 | 6.2937*** | 0.748 | 2.028 | 0.036 | 0.194 |
| | (0.80) | (0.01) | (0.39) | (0.15) | (0.85) | (0.66) |
| $trade_{i,t-1}$ | 0.003 | 1.727 | 0.563 | 0.032 | 0.410 | 0.000 |
| | (0.85) | (0.19) | (0.45) | (0.86) | (0.52) | (0.98) |

H0: endogenous variables do not Granger cause the dependent variable
P-values in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

The table 11 show that the consumer price index does not Granger cause the real exchange rate. The gross domestic product does Granger cause the real exchange rate for Mexico and United States. The public spend

and term of trade do Granger cause the real exchange rate for Canada and United States. The interest rate does Granger cause the real exchange rate for United States.

Table 11: Granger causality Wald tests:
North American Countries

| Variables | North American Countries | | |
|---|---|---|---|
| | Mexico | Canada | United States |
| $cpi_{i,t-1}$ | 2.205 | 0.708 | 1.806 |
| | (0.14) | (0.40) | (0.18) |
| $gdp_{i,t-1}$ | 7.689*** | 0.008 | 6.827*** |
| | (0.01) | (0.93) | (0.01) |
| $gov_{i,t-1}$ | 1.848 | 6.253*** | 3.384* |
| | (0.17) | (0.01) | (0.07) |
| $m_{i,t-1}$ | 3.111* | 0.020 | 1.170 |
| | (0.08) | (0.89) | (0.28) |
| $i_{i,t-1}$ | 2.426 | 1.426 | 4.025** |
| | (0.12) | (0.23) | (0.05) |
| $trade_{i,t-1}$ | 1.369 | 28.214*** | 7.873*** |
| | (0.24) | (0.00) | (0.01) |

H0: endogenous variables do not Granger cause the dependent variable
P-values in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

4.2.2 Vector Autoregressive for each country:

The table 12 show the results of the estimations; we found that the lagged value of real exchange rate has positive impact on the current value for all the countries except for Bolivia. The consumer price index has negative impact on real exchange rate for Bolivia, Peru and Uruguay but positive impact for Chile and Colombia. The gross domestic product has positive impact on real exchange rate for Bolivia and Uruguay but negative impact for Brazil, Chile and Colombia. The public spend has negative impact on real exchange rate only for Bolivia. The monetary mass has positive impact on real exchange rate for Brazil and negative impact for Uruguay. The interest rate has negative impact on real exchange for Peru but positive impact for Uruguay. In addition, the term of trade has positive impact on real exchange rate for Paraguay.

Table 12: Vector Autoregressive:
South American Countries

| Variables | South American Countries | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bolivia | Brazil | Chile | Colombia | Paraguay | Peru | Uruguay |
| $q_{i,t-1}$ | 0.223 | 0.593*** | 0.758*** | 0.711*** | 0.573*** | 0.757*** | 0.475*** |
| | (1.04) | (3.23) | (8.18) | (3.68) | (2.46) | (4.05) | (2.86) |
| $cpi_{i,t-1}$ | -0.400* | 0.013 | 0.302*** | 0.263* | -0.099 | -0.200*** | -0.042*** |
| | (-1.82) | (1.24) | (3.10) | (1.82) | (-0.96) | (-2.05) | (-2.82) |
| $gdp_{i,t-1}$ | 1.357*** | -0.966*** | -0.440*** | -1.013*** | 0.214 | -0.311 | 0.843*** |
| | (3.79) | (-2.07) | (-2.51) | (-2.25) | (0.51) | (-1.20) | (3.57) |
| $gov_{i,t-1}$ | -0.719*** | -0.222 | 0.077 | -0.047 | 0.178 | 0.136 | 0.012 |
| | (-3.41) | (-0.79) | (0.47) | (-0.13) | (1.16) | (0.45) | (0.04) |
| | 0.011 | 0.200*** | -0.035 | -0.000 | -0.099 | 0.069 | -0.593*** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $m_{i,t-1}$ | (0.07) | (2.70) | (-0.53) | (0.00) | (-0.76) | (0.48) | (-4.42) |
| $i_{i,t-1}$ | 0.012 | -0.021 | -0.025 | 0.087 | -0.027 | -0.087** | 0.067* |
| | (0.27) | (-0.93) | (-1.40) | (0.92) | (-0.94) | (-1.97) | (1.78) |
| $trade_{i,t-1}$ | -0.276 | -0.208 | 0.104 | 0.239 | 0.271*** | 0.020 | 0.222 |
| | (-1.28) | (-0.86) | (0.68) | (0.48) | (2.28) | (0.11) | (1.25) |
| year2003 | -0.021 | -0.113 | -0.094*** | -0.055 | -0.043 | -0.014 | -0.002 |
| | (-0.70) | (-1.21) | (-3.45) | (-0.58) | (-0.86) | (-0.34) | (-0.04) |
| year2006 | -0.056 | 0.072 | 0.018 | 0.046 | -0.091* | -0.030 | 0.034 |
| | (-1.22) | (0.84) | (0.64) | (0.61) | (-1.80) | (-0.56) | (0.45) |
| year2009 | -0.020 | 0.048 | -0.024 | -0.066 | -0.045 | 0.018 | 0.012 |
| | (-0.56) | (0.54) | (-0.87) | (-0.83) | (-0.69) | (0.37) | (0.20) |
| Oil price | -0.121*** | 0.067 | -0.019 | -0.084 | 0.073 | 0.025 | 0.067 |
| | (-2.69) | (0.79) | (-0.64) | (-1.03) | (1.04) | (0.51) | (1.32) |
| Gold price | -0.056 | 0.168 | 0.054 | 0.343*** | 0.016 | 0.125 | -0.187 |
| | (-0.86) | (1.11) | (1.46) | (2.07) | (0.16) | (1.17) | (-2.35) |
| cons | 4.640*** | 5.872*** | 0.922 | 1.40 | -0.383 | 1.886 | 1.151 |
| | (2.81) | (2.36) | (0.77) | (0.48) | (-0.32) | (1.21) | (0.76) |
| Sample | 1988-2016 | 1981-2016 | 1986-2016 | 1987-2016 | 1990-2016 | 1991-2016 | 1981-2016 |
| Obs | 29.0 | 36.0 | 31.0 | 30.0 | 27.0 | 26.0 | 36.0 |

t-statistics in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

The table 13 show that the lagged value of real exchange rate for Costa Rica has positive impact. The monetary mass has negative impact on real exchange rate for Dominican Republic, Guatemala and St. Lucia. The interest rate has negative impact on real exchange rate for Dominican Republic. In addition, the term of trade does not have impact on real exchange rate for all countries.

Table 13: Vector Autoregressive:
Central American Countries

| Variables | Central American Countries | | | | | |
|---|---|---|---|---|---|---|
| | Costa Rica | Dominican Republic | Guatemala | Guyana | Jamaica | St Lucia |
| $q_{i,t-1}$ | 0.560*** | 0.195 | 0.619 | -0.103 | 0.590 | 0.124 |
| | (2.37) | (0.92) | (1.21) | (-0.32) | (1.15) | (0.51) |
| $cpi_{i,t-1}$ | -0.205 | -1.592*** | -0.318 | -0.002 | 0.184 | 0.398*** |
| | (-1.58) | (-2.38) | (-0.54) | (-0.01) | (0.36) | (2.60) |
| $gdp_{i,t-1}$ | 0.593 | 1.123* | 0.653 | 0.415 | 0.788 | -0.188* |
| | (1.32) | (1.70) | (0.78) | (1.28) | (0.66) | (-1.82) |
| $gov_{i,t-1}$ | -0.086 | 0.196*** | 0.143 | -0.033 | -0.535 | 0.030 |
| | (-0.66) | (2.69) | (0.57) | (-0.23) | (-0.88) | (0.61) |
| $m_{i,t-1}$ | -0.072 | -0.514*** | -0.306* | -0.015 | 0.292 | -0.290*** |
| | (-1.60) | (-3.77) | (-1.78) | (-0.07) | (1.33) | (-2.65) |
| $i_{i,t-1}$ | 0.016 | -0.385*** | -0.107 | 0.068 | 0.037 | 0.016 |
| | (0.25) | (-2.51) | (-0.87) | (1.42) | (0.19) | (0.44) |
| $trade_{i,t-1}$ | -0.010 | 0.149 | 0.141 | -0.021 | -0.231 | -0.002 |
| | (-0.06) | (1.31) | (0.75) | (-0.18) | (-0.64) | (-0.02) |
| | 0.026 | -0.019 | -0.007 | 0.011 | -0.025 | 0.046* |

| | | | | | | |
|---|---|---|---|---|---|---|
| year2003 | | | | | | |
| | (0.67) | (-0.29) | (-0.12) | (0.34) | (-0.18) | (1.86) |
| year2006 | -0.024 | 0.013 | 0.015 | 0.047 | -0.185 | -0.002 |
| | (-0.58) | (0.21) | (0.35) | (1.38) | (-1.32) | (-0.07) |
| year2009 | 0.014 | -0.044 | 0.069 | 0.028 | 0.078 | 0.027 |
| | (0.32) | (-0.61) | (1.64) | (0.69) | (0.41) | (1.27) |
| Oil price | 0.032 | 0.103* | 0.019 | -0.061 | 0.147 | 0.005 |
| | (0.87) | (1.95) | (0.29) | (-1.12) | (0.95) | (0.28) |
| Gold price | 0.041 | -0.088 | | 0.062 | -0.080 | -0.040 |
| | (0.65) | (-1.28) | | (1.37) | (-0.44) | (-1.41) |
| cons | 0.528 | 8.579*** | 0.693 | 2.994* | -0.619 | 4.422*** |
| | (0.22) | (3.88) | (0.45) | (1.69) | (-0.08) | (2.89) |
| Sample | 1983-2016 | 1981-2016 | 1998-2016 | 1995-2016 | 1981-2016 | 1981-2016 |
| Obs | 34 | 36 | 19 | 22 | 36 | 36 |

t-statistics in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

The table 14 show that the lagged value of real exchange rate has positive impact on current value of real exchange rate for Mexico and United States. The gross domestic product has negative impact on real exchange rate for Mexico and United States. The public spend and interest rate have negative impact on real exchange state for United States. The monetary mass has positive impact on real exchange rate for Mexico. And the term of trade has positive impact for Canada but negative impact for United States.

Table 14: Vector Autoregressive:
North American Countries

| Variables | North American Countries | | |
|---|---|---|---|
| | Mexico | Canada | United States |
| $q_{i,t-1}$ | 0.606** | -0.051 | 0.898*** |
| | (1.90) | (-0.30) | (6.53) |
| $cpi_{i,t-1}$ | 0.050 | 0.150 | 0.372 |
| | (1.48) | (0.84) | (1.34) |
| $gdp_{i,t-1}$ | -1.454*** | 0.022 | -0.730*** |
| | (-2.77) | (0.09) | (-2.61) |
| $gov_{i,t-1}$ | -0.728 | -1.162 | -2.245* |
| | (-1.36) | (-2.50) | (-1.84) |
| $m_{i,t-1}$ | 0.264* | 0.007 | 0.191 |
| | (1.76) | (0.14) | (1.08) |
| $i_{i,t-1}$ | -0.137 | 0.041 | -0.094*** |
| | (-1.56) | (1.19) | (-2.01) |
| $trade_{i,t-1}$ | 0.337 | -0.804*** | 0.667*** |
| | (1.17) | (-5.31) | (2.81) |
| year2003 | 0.084 | -0.038 | 0.033 |
| | (1.03) | (-1.48) | (0.79) |
| | -0.045 | 0.040 | 0.031 |

| | | | |
|---|---|---|---|
| year2006 | (-0.60) | (1.44) | (0.87) |
| year2009 | 0.035 | 0.059 | 0.046 |
| | (0.41) | (2.10) | (1.15) |
| Oil price | 0.209*** | -0.036 | 0.035 |
| | (2.74) | (-0.90) | (0.98) |
| Gold price | -0.146 | | -0.105* |
| | (-1.18) | | (-1.89) |
| cons | 9.68*** | 12.809*** | 9.510 |
| | (2.19) | (4.35) | (1.52) |
| Sample | 1981-2016 | 1981-2008 | 1981-2016 |
| Obs | 36 | 28 | 36 |

t-statistics in parenthesis
* p < 0.1
** p < 0.05
*** p < 0.01

5. Conclusions:

The results show that the variables of South American countries can explain a big percentage of changes in the real exchange rate, especially the public spend, and whose shock has a negative effect on the real exchange rate. For Central American countries, apparently, neither variable have not impact on real exchange rate and only can explain 12% of his movements. For north American countries, we work only with consumer price, public spend, interest rate and net trade, these variables can explain 26% but we don't work with the remain variables because occur that we will have more variables than observations and could not calculate the estimations. Also, we found that only the consumer price index has positive impact on the exchange rate when don't include both oil and gold price. When we exclude Canada and United States, and we work with fourteen countries, it says, Latin American countries, we found significance in all variables except public spend and monetary mass. In addition, all variables have positive impact on the exchange rate, these variables can explain until 26% of the real exchange movements, the interest rate has the higher participation, the oil price, as exogenous variable, has positive impact. For all the countries, we found similar results that Latin-American countries, and these variables can explain 22% of the real exchange movements.

In addition, for each countries, we found heterogeneous impact on real exchange rate; the consumer price index has positive impact for Chile, Colombia and St Lucia and negative impact for Bolivia, Peru, Uruguay and Dominican Republic. The gross domestic product has negative impact for Brazil, Chile, Colombia, St Lucia, Mexico and United States but positive impact for Bolivia, Uruguay, and Dominican Republic. The public Spend have negative impact for Bolivia, Canada and United State but positive impact for Dominican Republic. The monetary mass has positive impact for Brazil and Uruguay but negative impact for Uruguay, Dominican Republic and St Lucia. The interest rate has negative impact for Dominican Republic, Peru and United States. The term of trades has positive impact for Paraguay and United States and negative impact for Canada. These results show that the impacts differ for each country but can find an only impact on a global view.

6. Discussion:

This research is important due to the relevance of study the positive effects could to have undervaluations of real exchange rate on the economics, especially in developing countries, Rodrik(2008) for institutions weaks and market failures. We found positive effects of GDP, term of trade and interest rate on real

exchange rate and negative effects of public spend. When occur a currency crash or another monetary crisis, the policymakers could to try smooth the volatility via public spend or monetary policy.

**Declarations:**
Consent for publication.

**List of abbreviations:**
PVAR: Panel Vector Autoregressive
FOD: Forward Orthogonal Deviations
$q_{i,t-1}$: Real exchange rate in logarithm terms
$cpi_{i,t-1}$: Consumer Price Index in logarithm terms
$gdp_{i,t-1}$: Gross Domestic Product in logarithm terms
$m_{i,t-1}$ ; Monetary Mass in logarithm terms
$gov_{i,t-1}$; Public Spend in logarithm terms
$i_{i,t-1}$ : Interest rate in logarithm terms

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**Authors' contributions**
The papers was entirely write for me. I did the econometric part, tables and figures, and I did write each part of this paper.

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**Availability of data and materials**
The data that support the findings of this study can to be obtained from the authors upon request.

**Ethics approval and consent to participate**
Ethical approval and consent to participate are not applicable for this study.

**Competing interests**
The authors declare that they have no competing interests.

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Appendix:

In this section, we show the impulse-response graphs for each country and the stability condition graphs by group.

Figure 6:

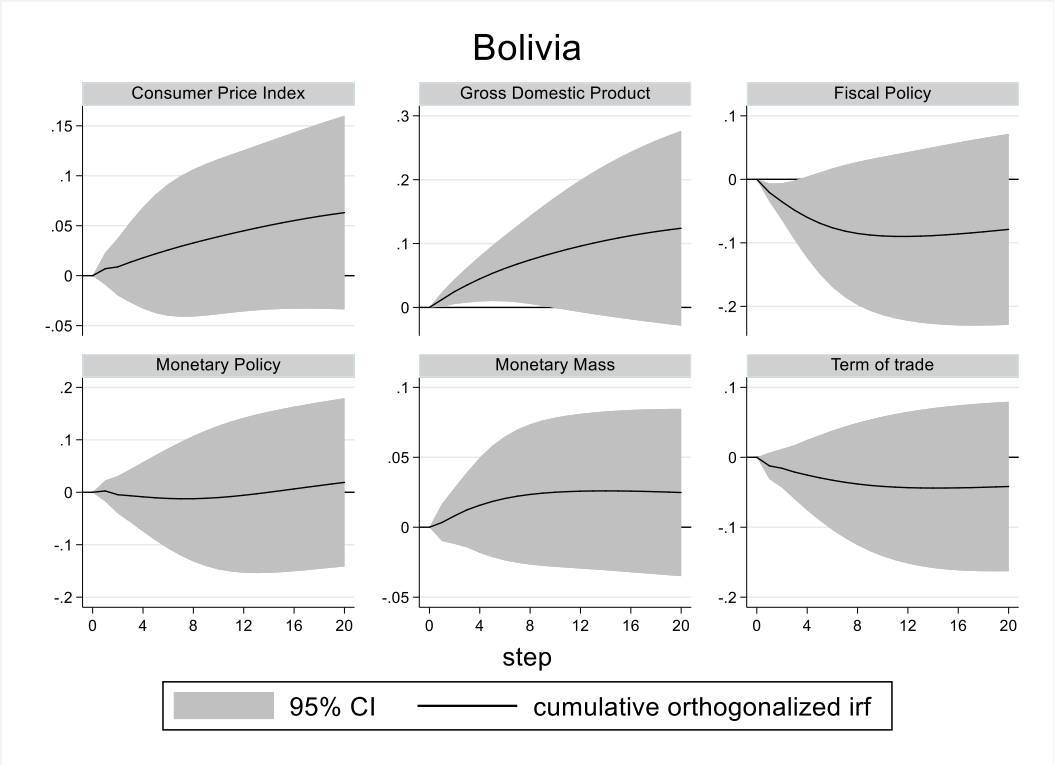



Figure 7:

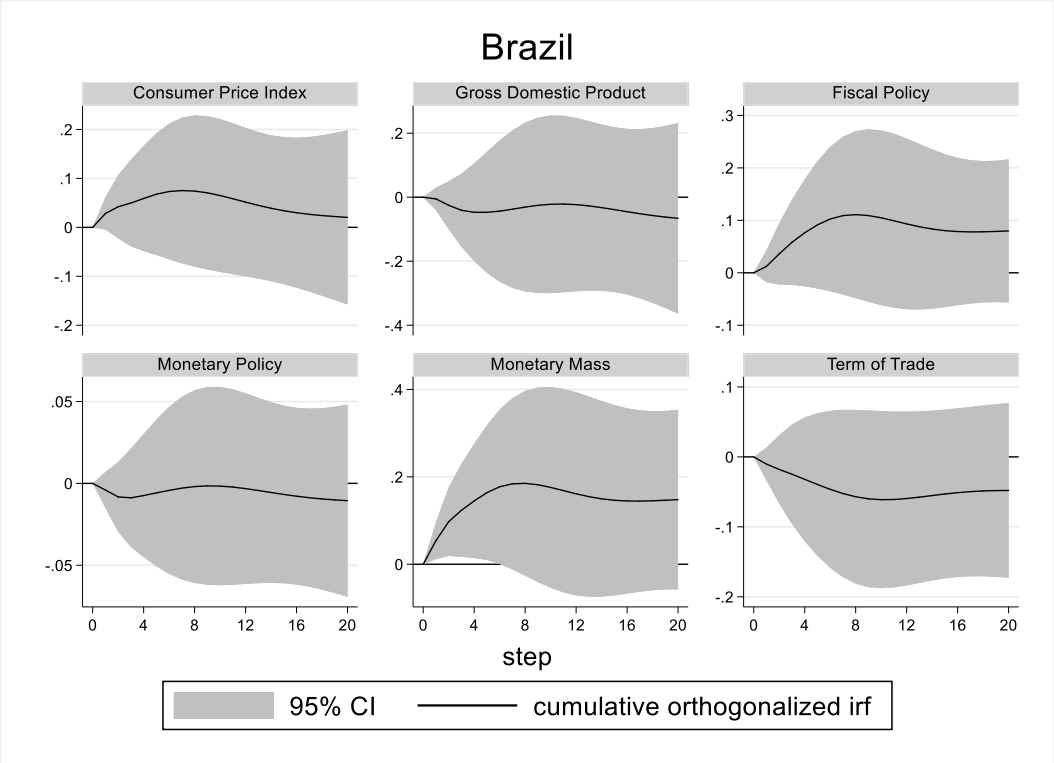



Figure 8:

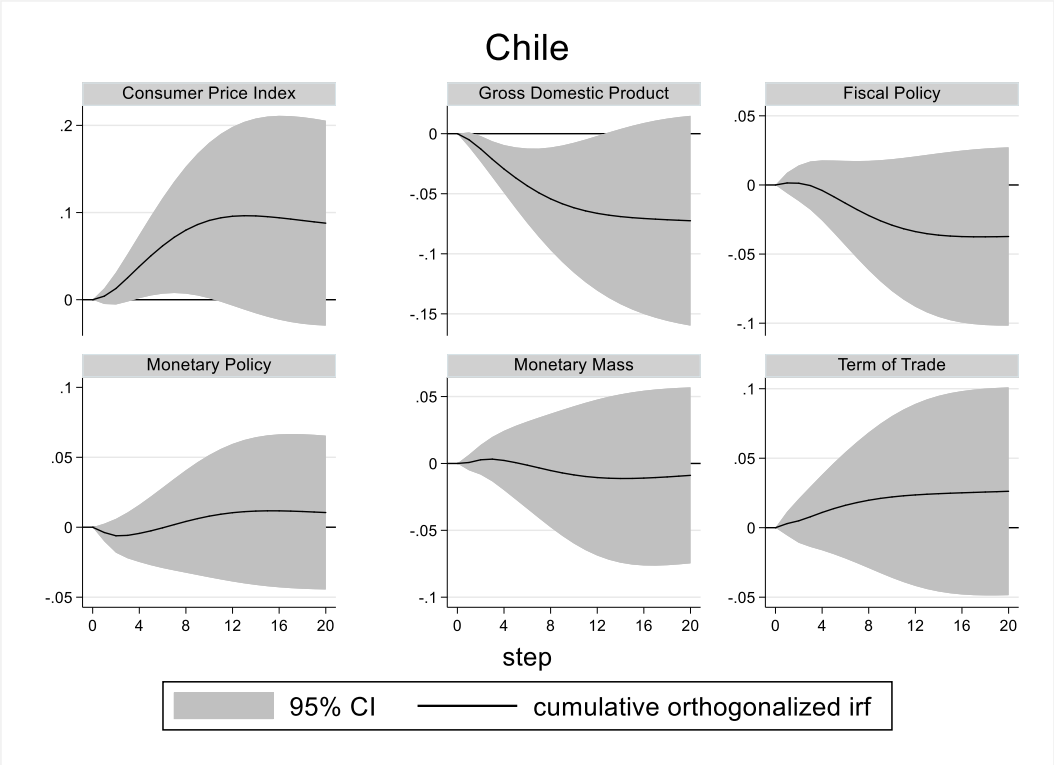

Chile
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 9:

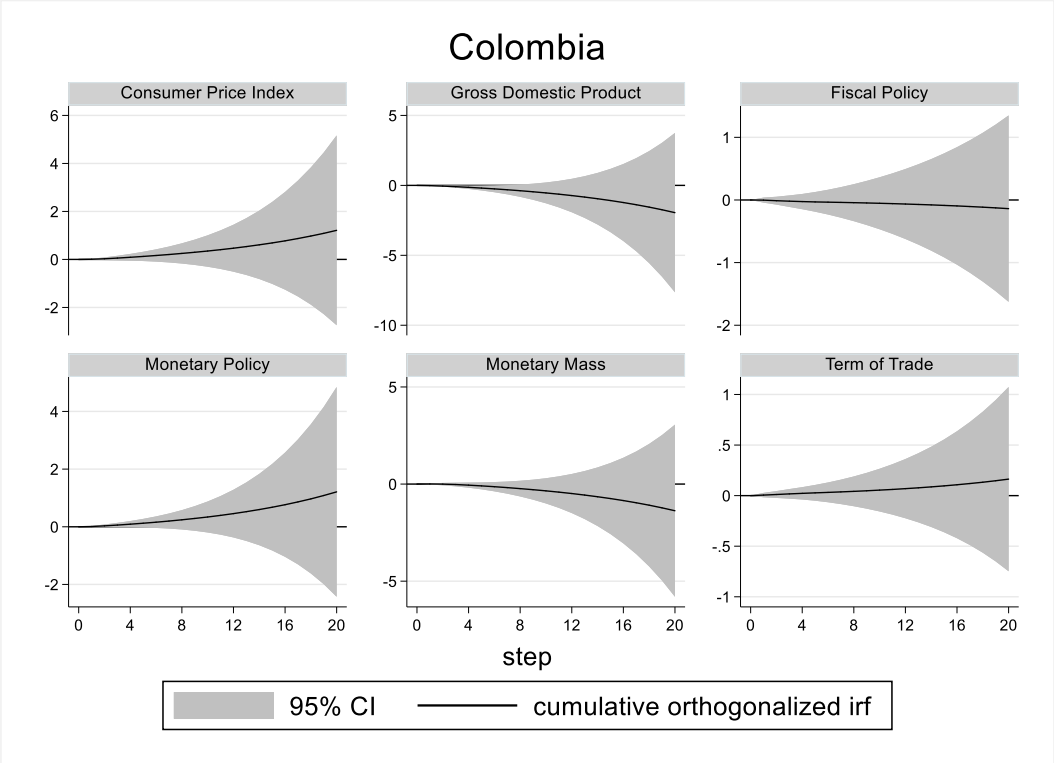

Colombia
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 10.

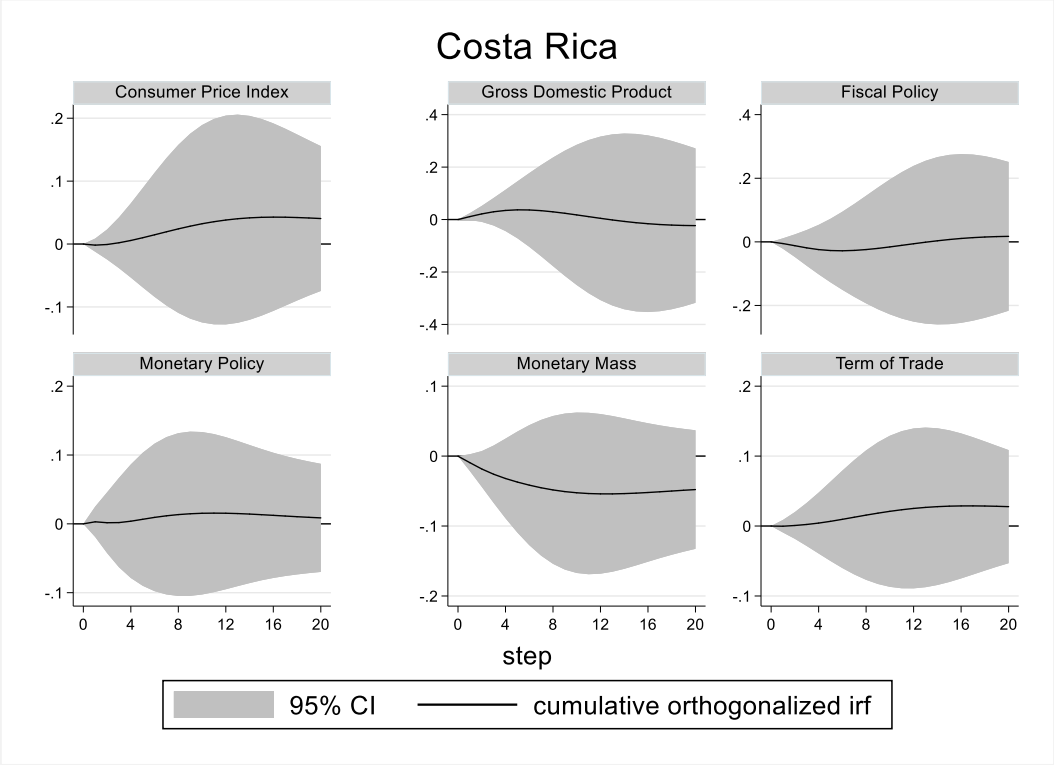



Figure 11:

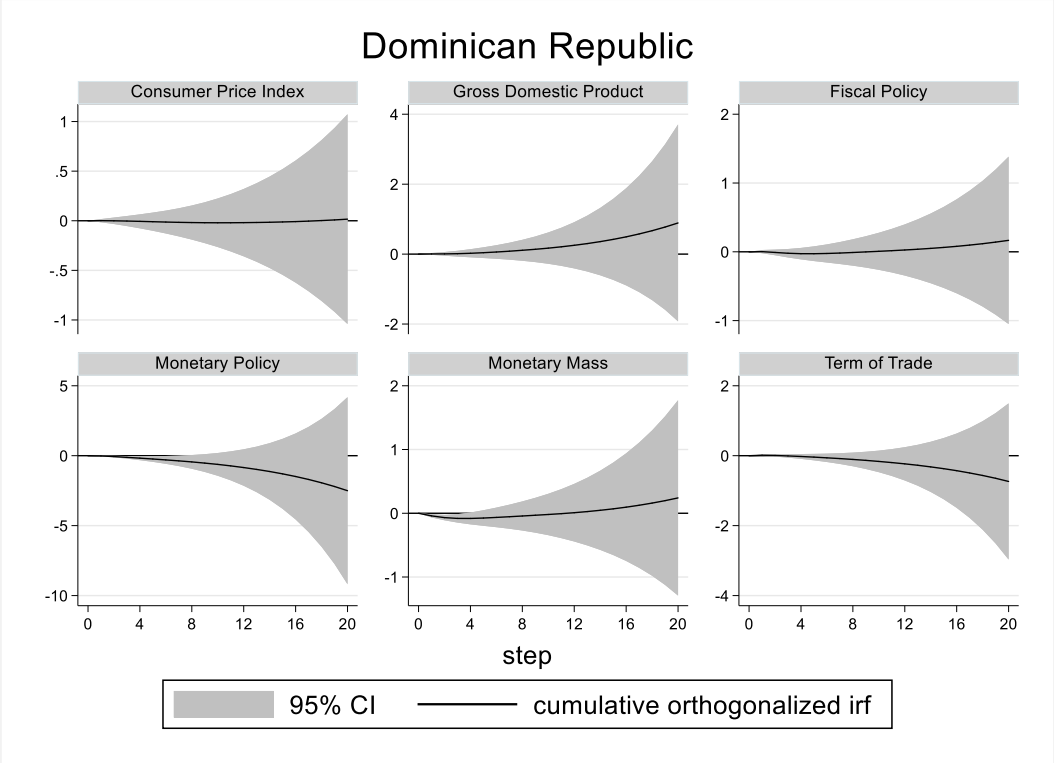



Figure 12:

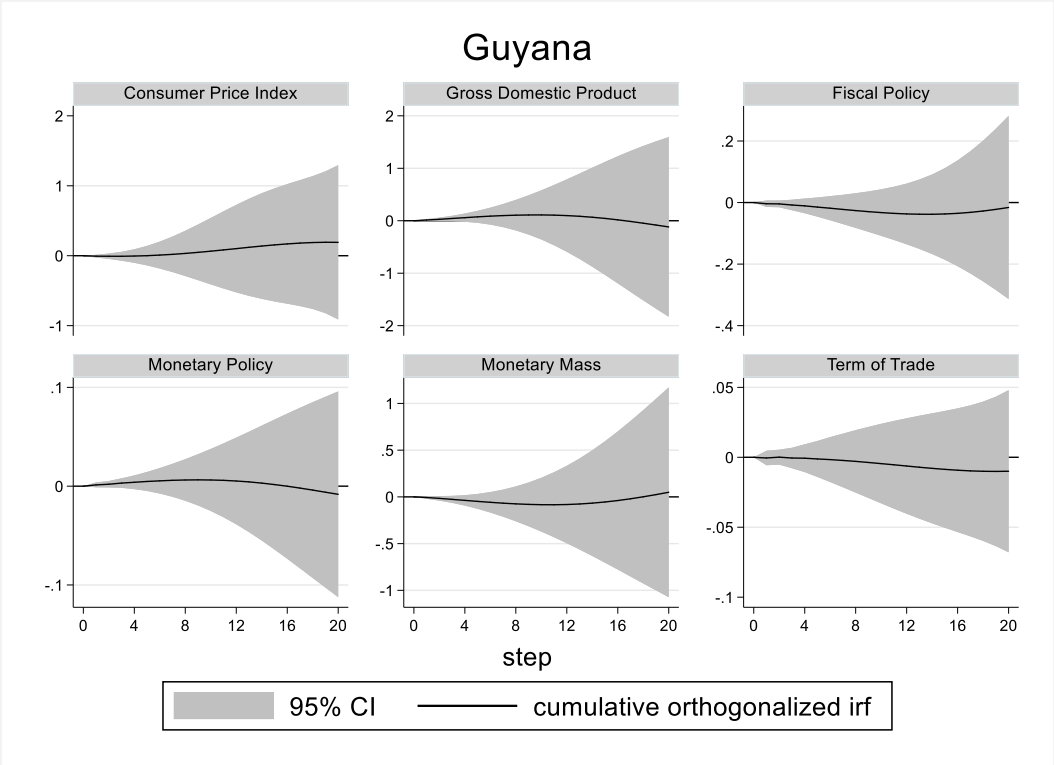

Guyana
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 13:

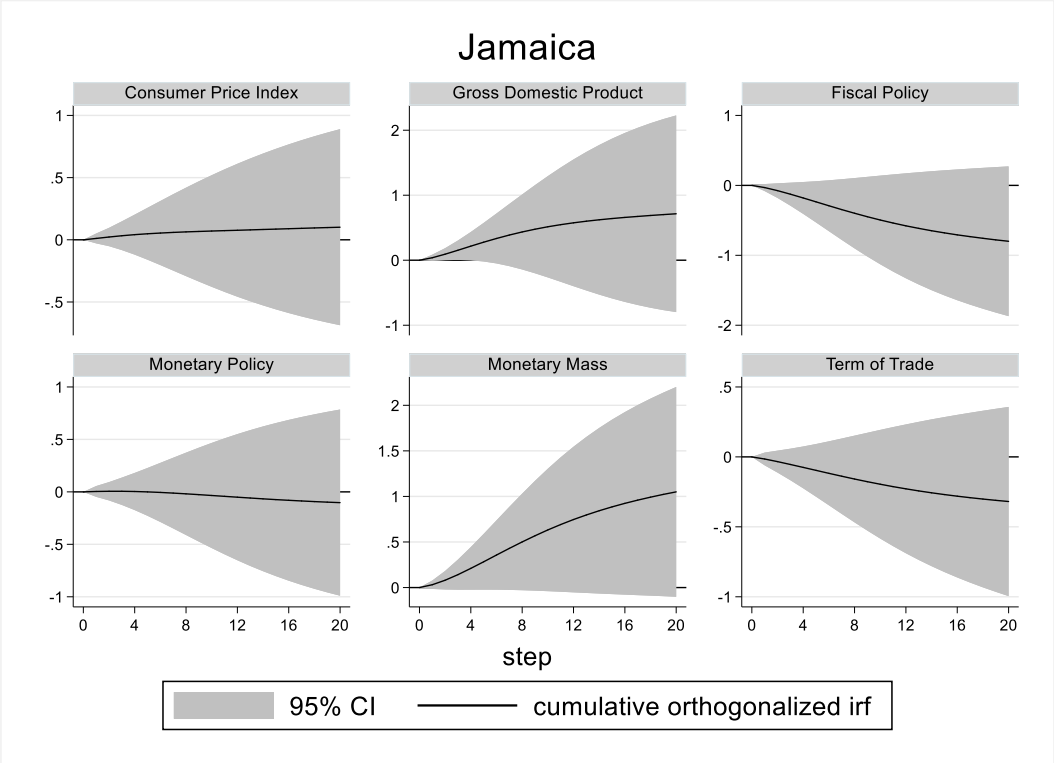

Jamaica
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 14:

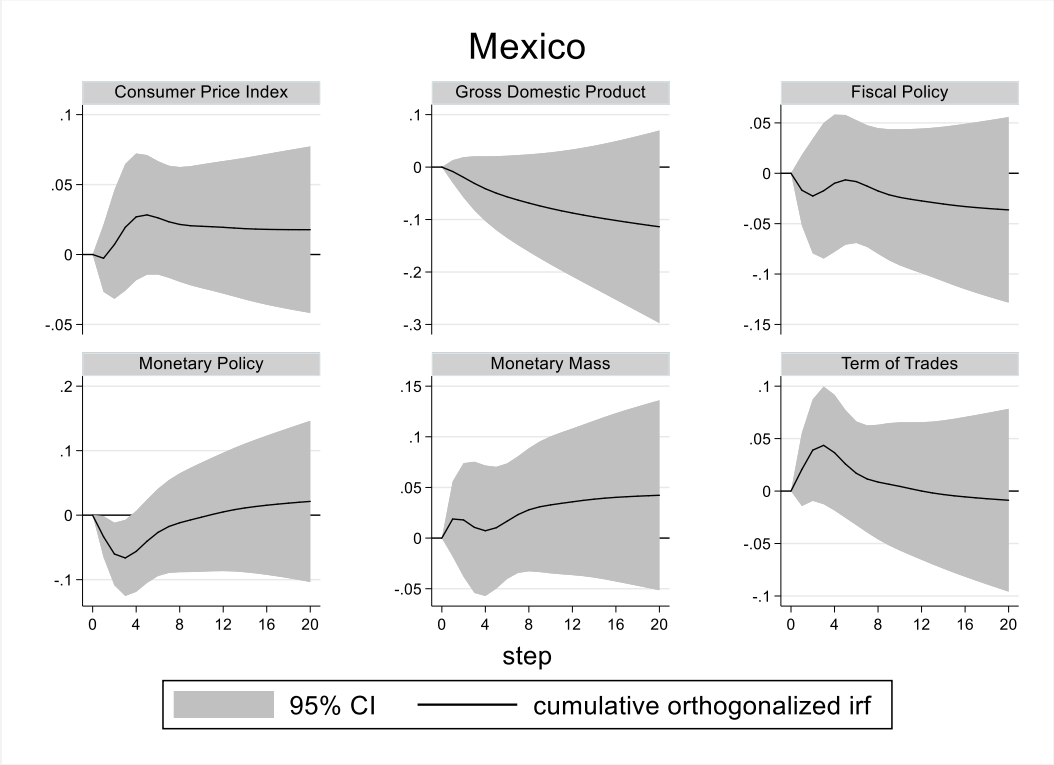



Figure 15:

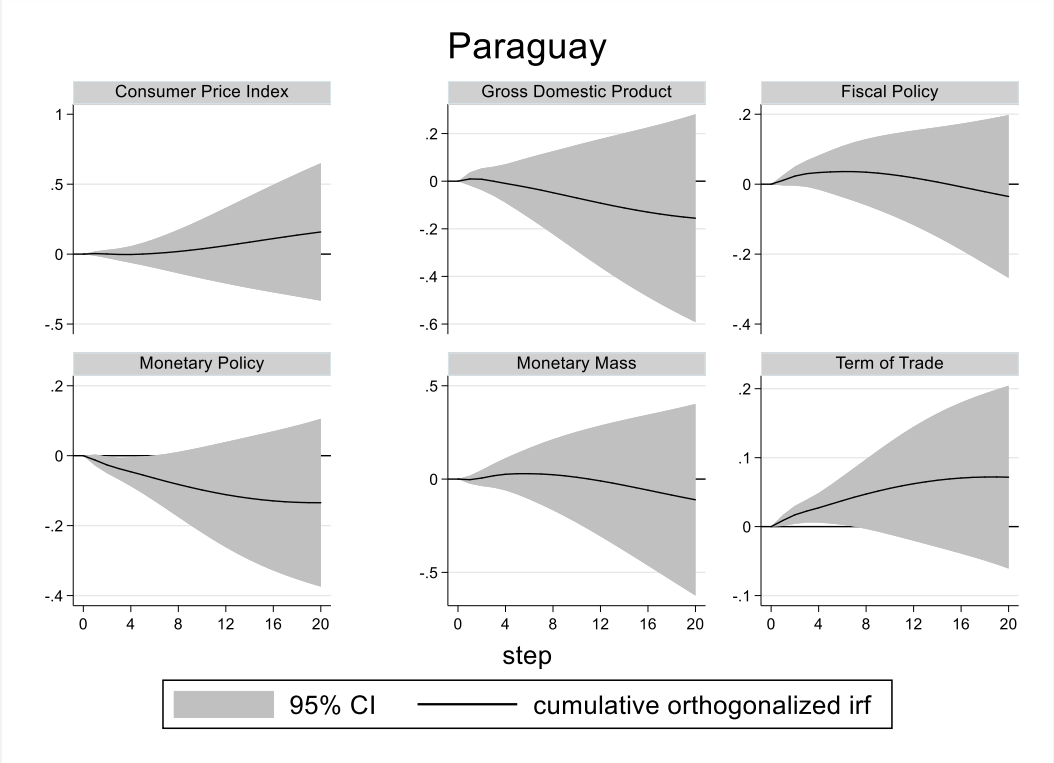



Figure 16:

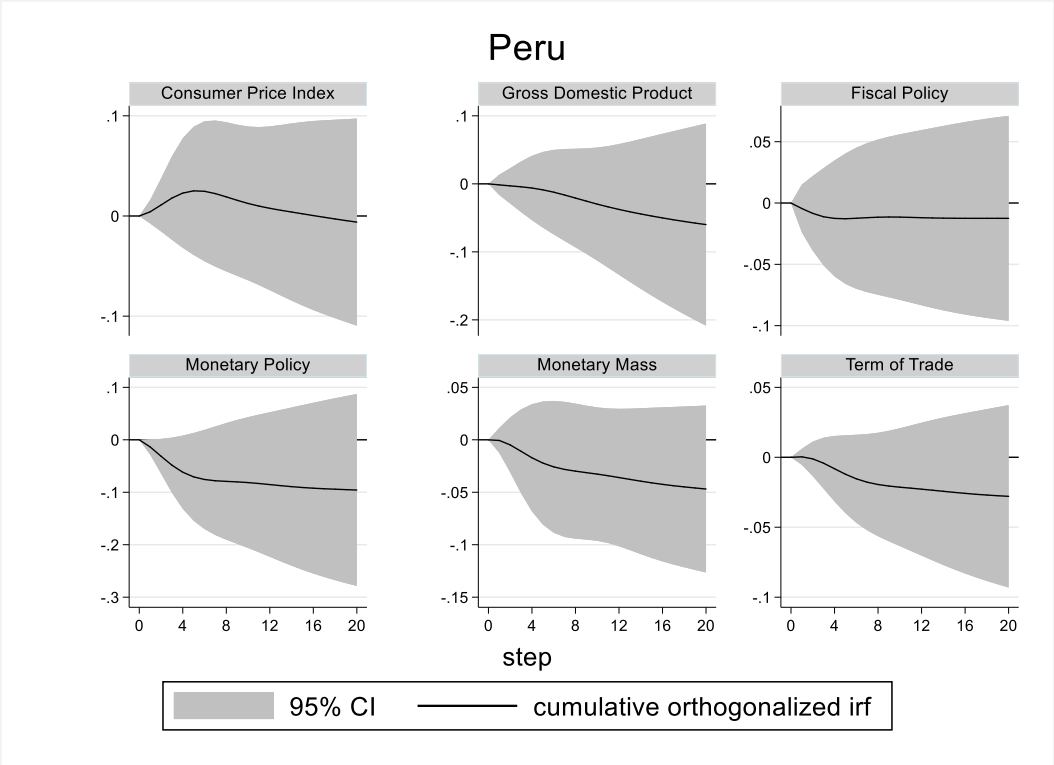



Figure 17:

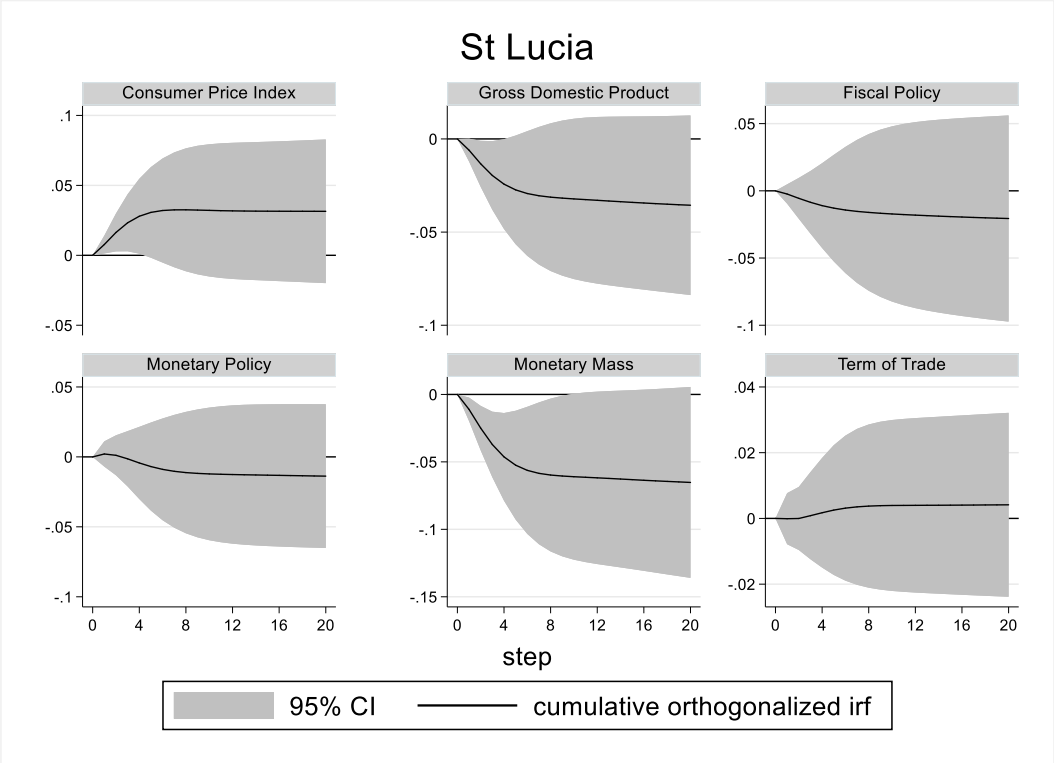



Figure 18:

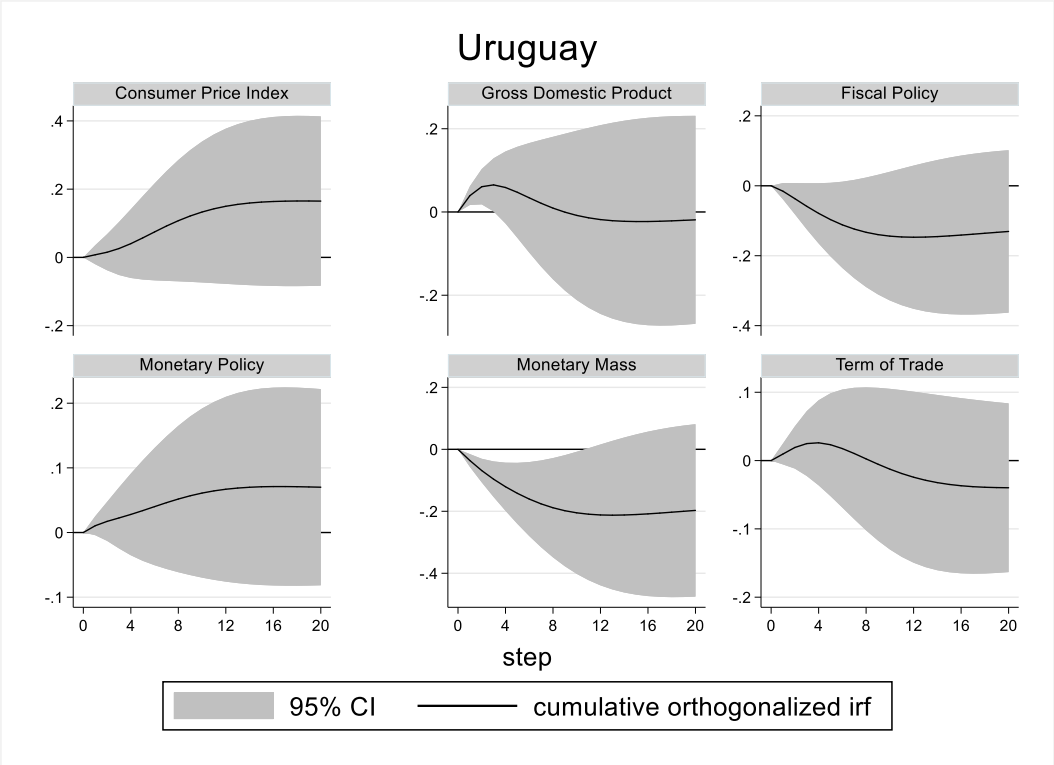



Figure 19:

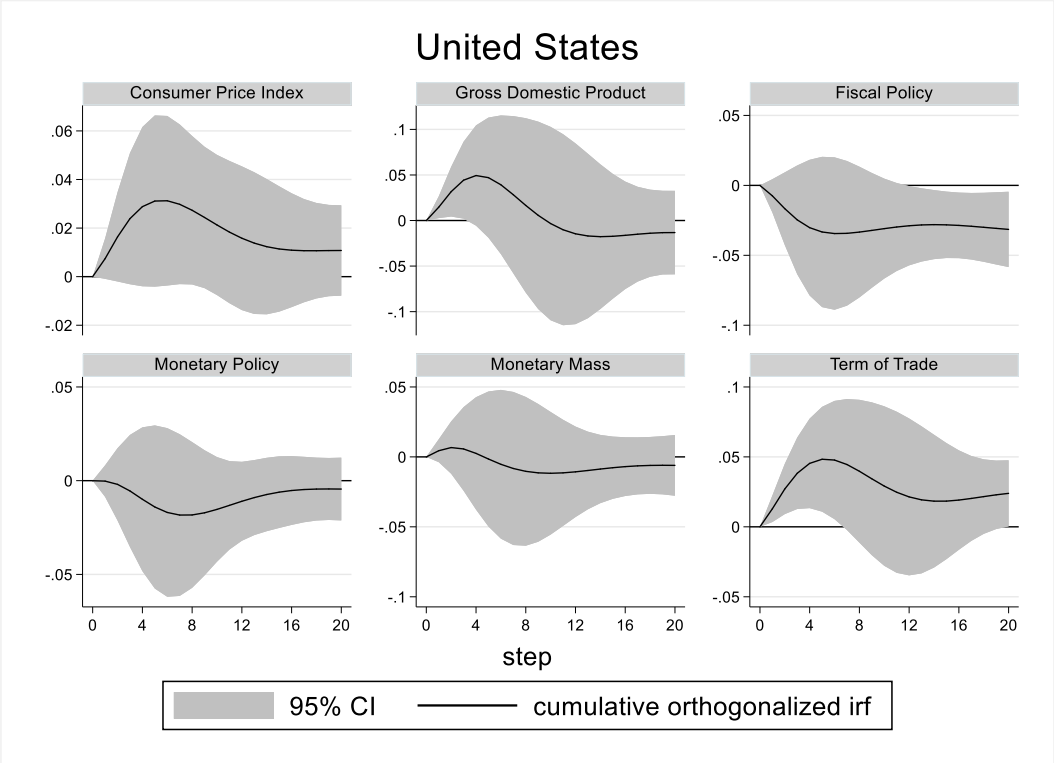



Figure 20:

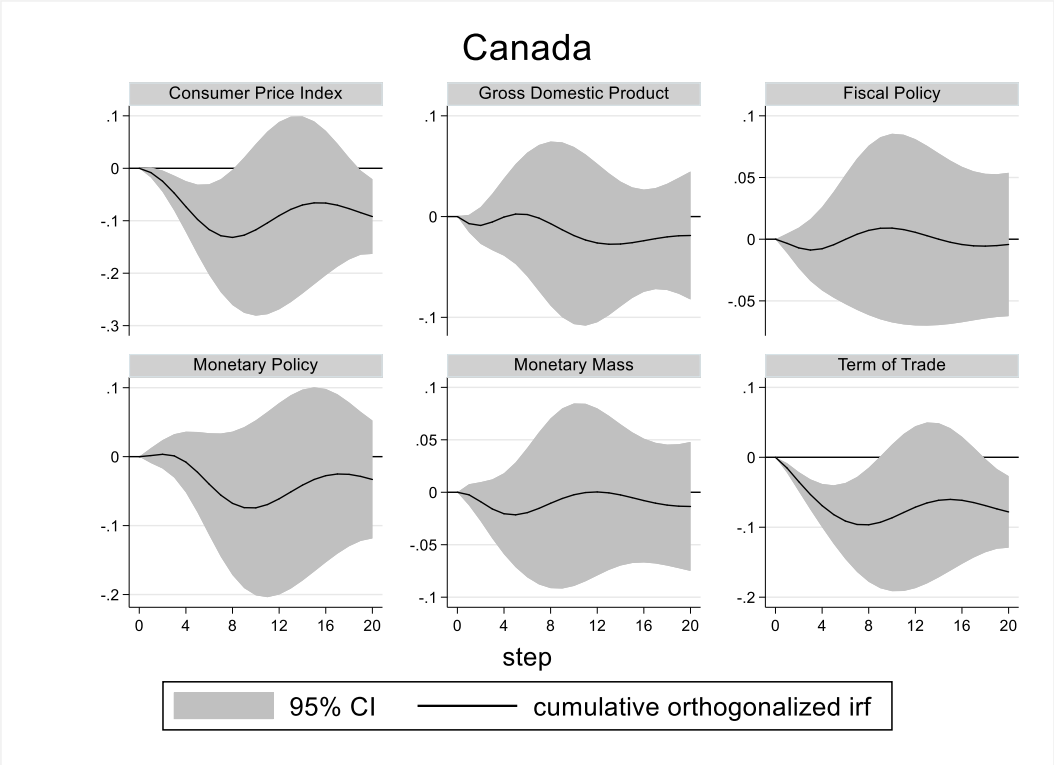



Table 15: For all the countries

| Eigenvalue stability condition | | |
|---|---|---|
| Eigenvalue | | |
| Real | Imaginary | Modulus |
| 0.952439 | 0 | 0.952439 |
| 0.919055 | -0.088795 | 0.92333 |
| 0.919055 | 0.088795 | 0.923335 |
| 0.905879 | 0.0284595 | 0.906326 |
| 0.905879 | -0.02846 | 0.906326 |
| 0.800938 | 0 | 0.800938 |
| 0.438728 | 0 | 0.438728 |

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.

Figure 21:

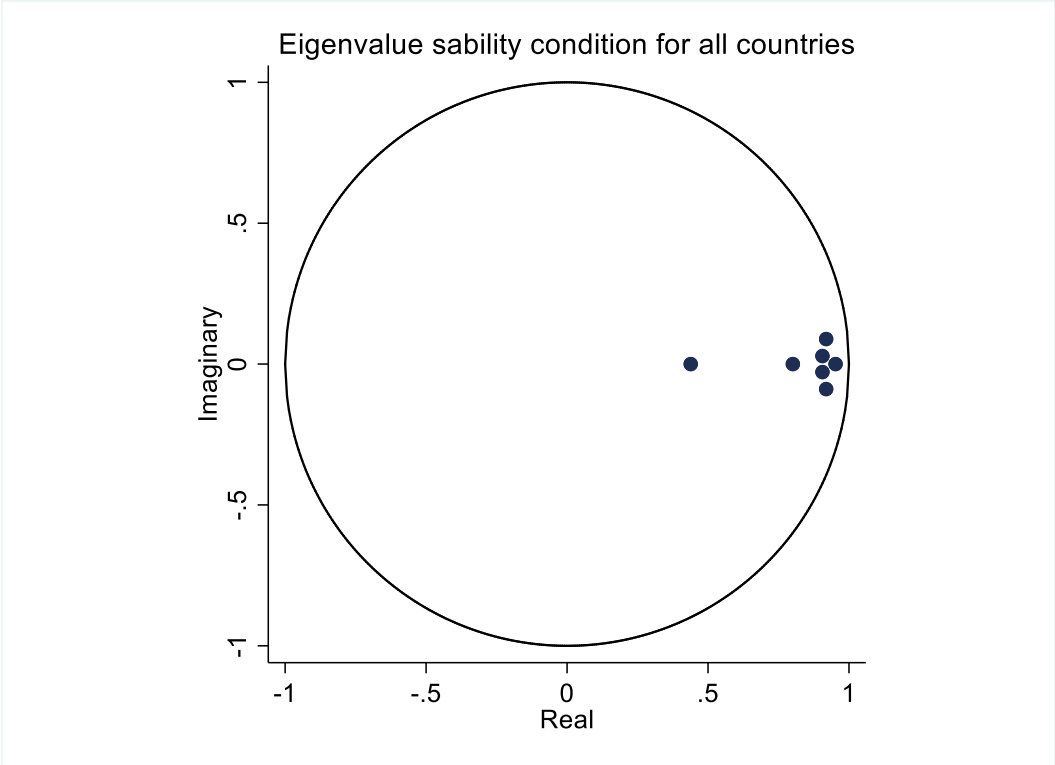



Table 16: For Latin American countries

Eigenvalue stability condition

| Eigenvalue | | |
|---|---|---|
| Real | Imaginary | Modulus |
| 0.949992 | 0 | 0.949992 |
| 0.913057 | 0.092743 | 0.917755 |
| 0.913057 | -0.09274 | 0.917755 |
| 0.907941 | -0.02981 | 0.90843 |
| 0.907941 | 0.02981 | 0.90843 |
| 0.780479 | 0 | 0.780479 |
| 0.303172 | 0 | 0.303172 |

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.

Figure 22:

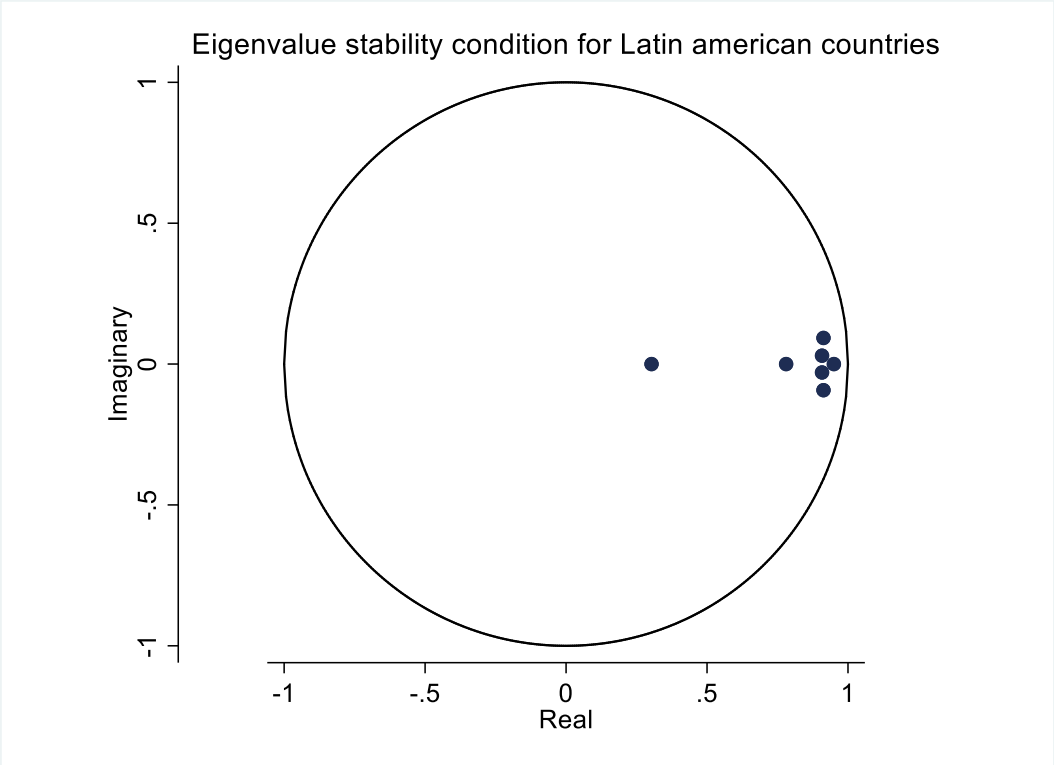



Table 17: For North American Countries

| Eigenvalue stability condition | | |
|---|---|---|
| Eigenvalue | | |
| Real | Imaginary | Modulus |
| 0.948862 | 0.08163 | 0.952367 |
| 0.948862 | -0.08163 | 0.952367 |
| 0.908575 | 0 | 0.908575 |
| 0.800055 | 0 | 0.800055 |
| 0.44957 | 0 | 0.44957 |

All the eigenvalues lie inside the unit circle.

pVAR satisfies stability condition.

Figure 23:

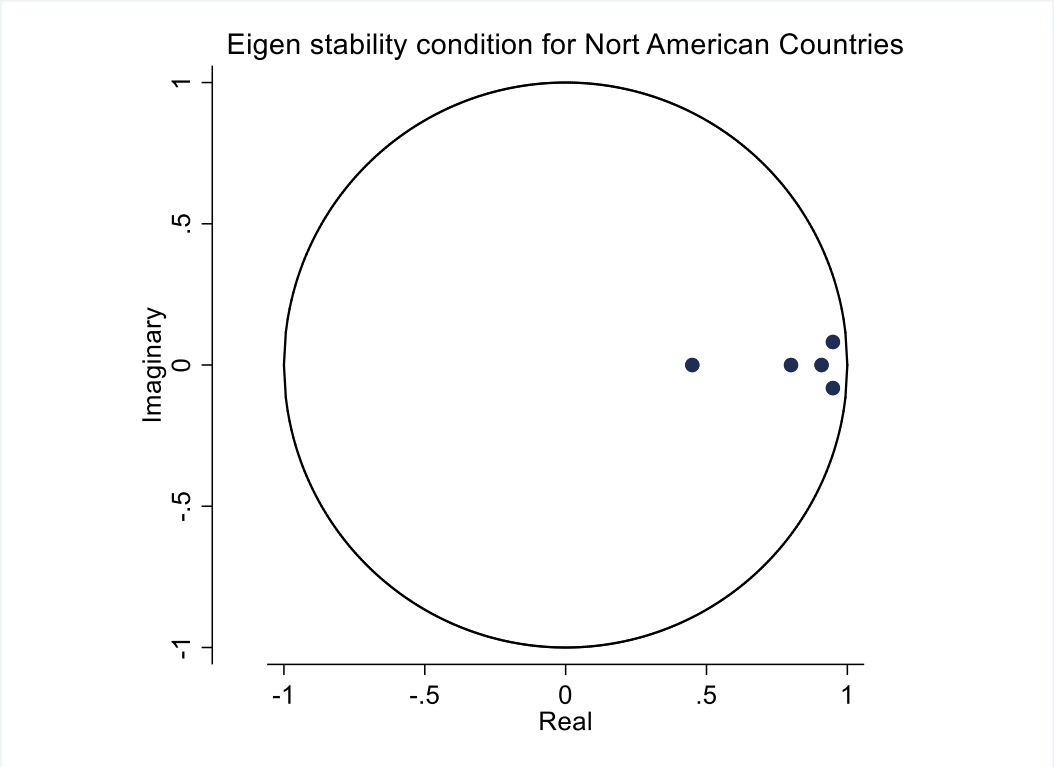



Table 18: For Central American Countries

Eigenvalue stability condition

| Eigenvalue | | |
|---|---|---|
| Real | Imaginary | Modulus |
| 0.954932 | 0 | 0.954932 |
| 0.942387 | -0.10814 | 0.948571 |
| 0.942387 | 0.108136 | 0.948571 |
| 0.920749 | 0 | 0.920749 |
| 0.882336 | -0.05298 | 0.883925 |
| 0.882336 | 0.052976 | 0.883925 |
| 0.063107 | 0 | 0.063107 |

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.

Figure 24:

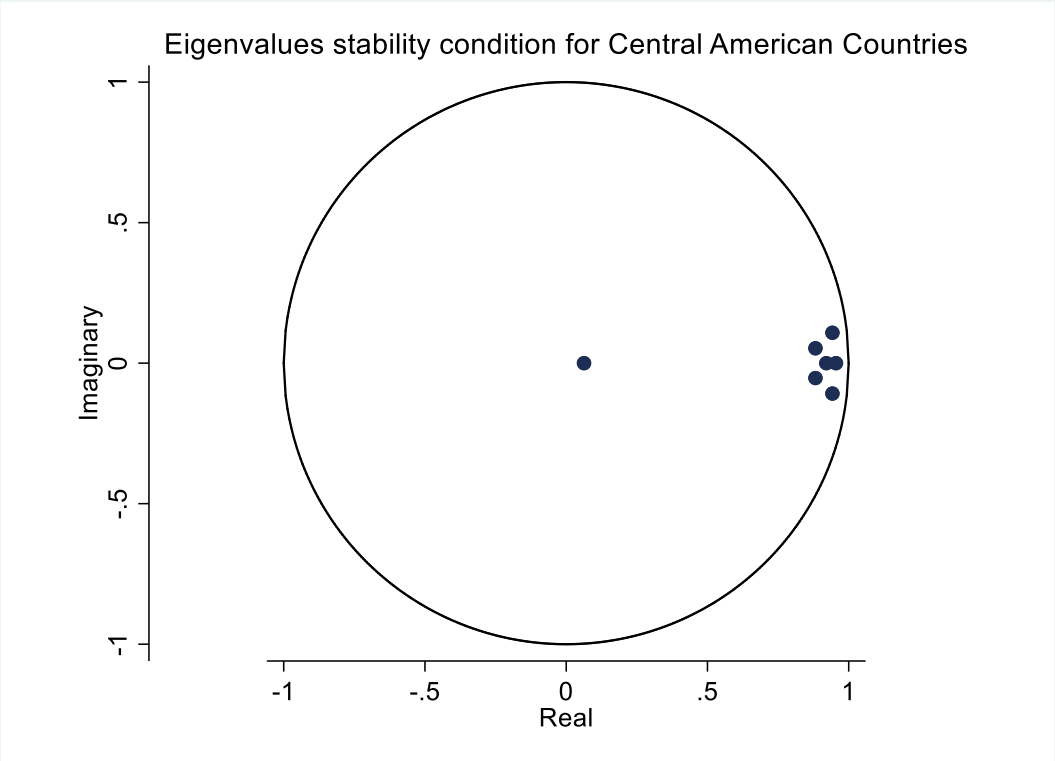


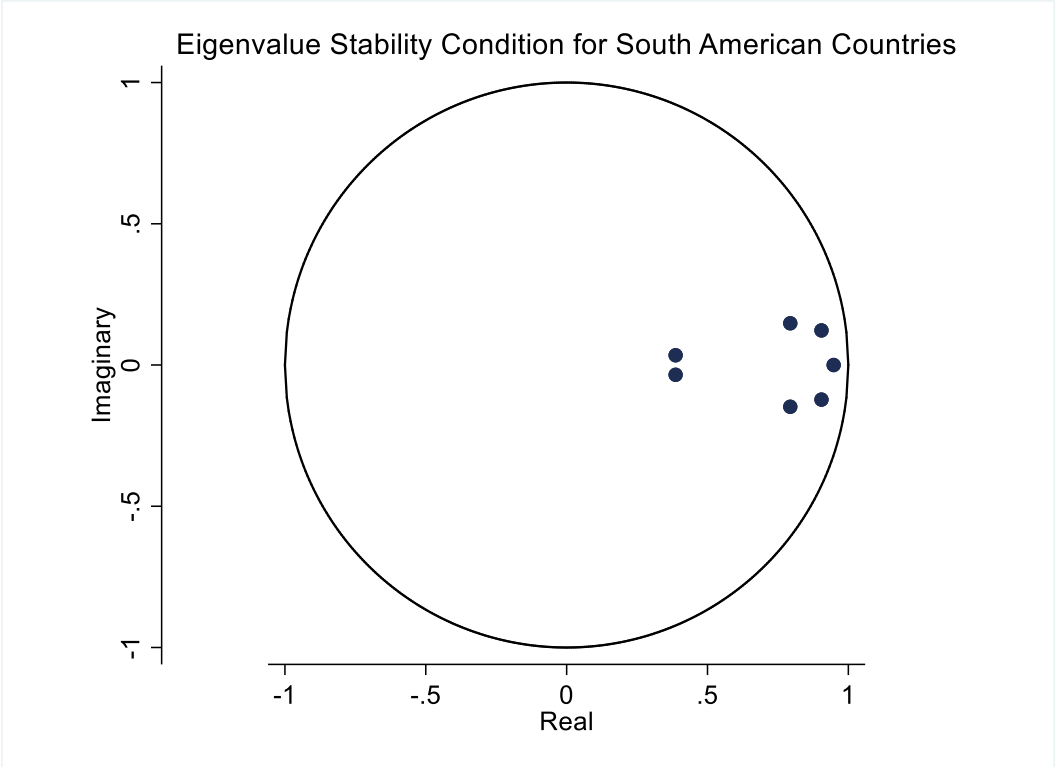

Table 19: For South American Countries

Eigenvalue stability condition

| Eigenvalue | | |
|---|---|---|
| Real | Imaginary | Modulus |
| 0.947934 | 0 | 0.947934 |
| 0.904645 | 0.122467 | 0.912897 |
| 0.904645 | -0.12247 | 0.912897 |
| 0.793863 | -0.14774 | 0.807494 |
| 0.793863 | 0.147742 | 0.807494 |
| 0.38688 | -0.03458 | 0.388422 |
| 0.38688 | 0.034579 | 0.388422 |

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.

Figure 25:


Eigenvalue Stability Condition for South American Countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

# Figures

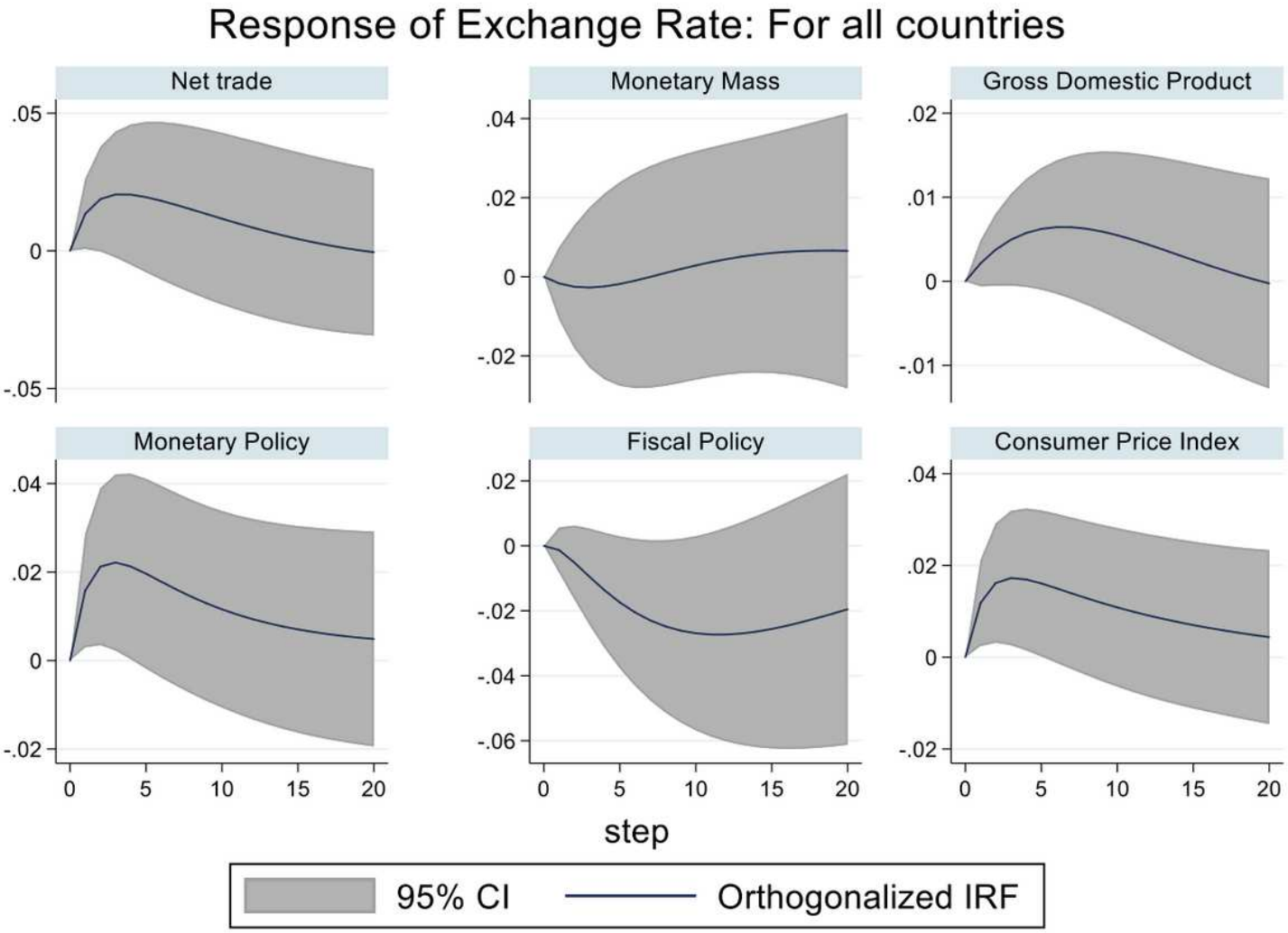



Figure 1

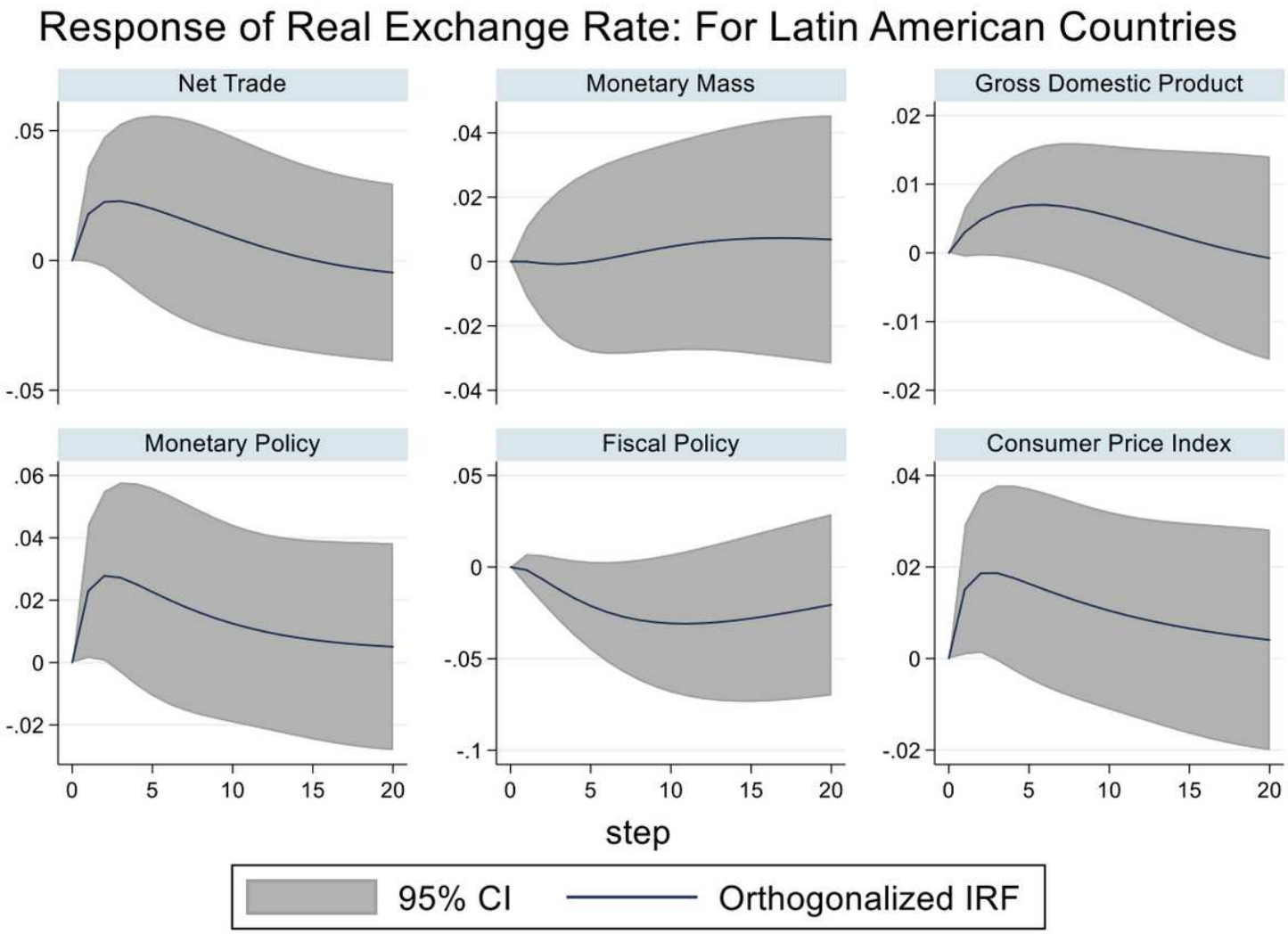

Response of Real Exchange Rate: For Latin American Countries
Net Trade
Monetary Mass
Gross Domestic Product
Monetary Policy
Fiscal Policy
Consumer Price Index
step
95% CI
Orthogonalized IRF

Figure 2

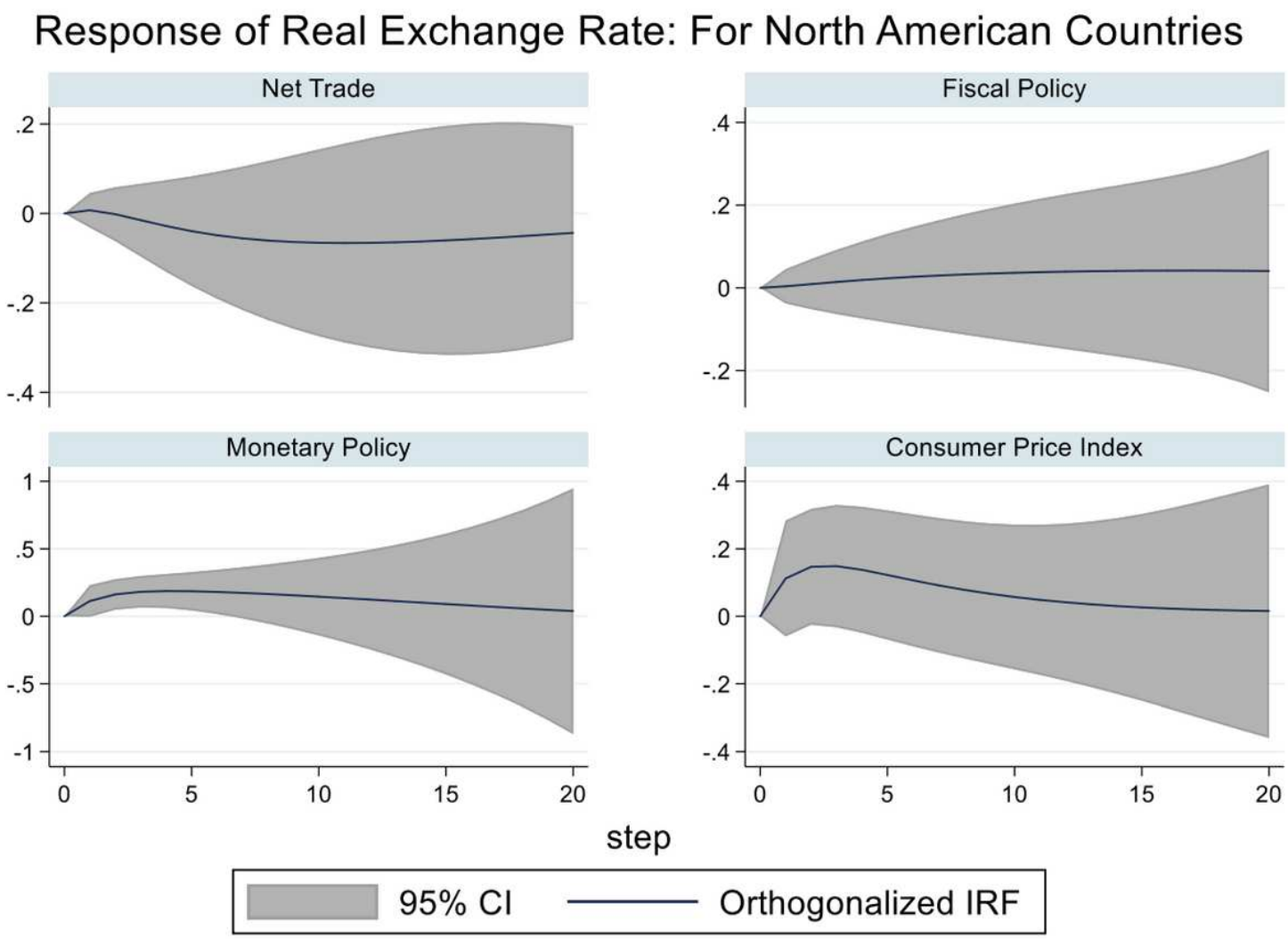

Response of Real Exchange Rate: For North American Countries
Net Trade
Fiscal Policy
Monetary Policy
Consumer Price Index
step
95% CI
Orthogonalized IRF

Figure 3

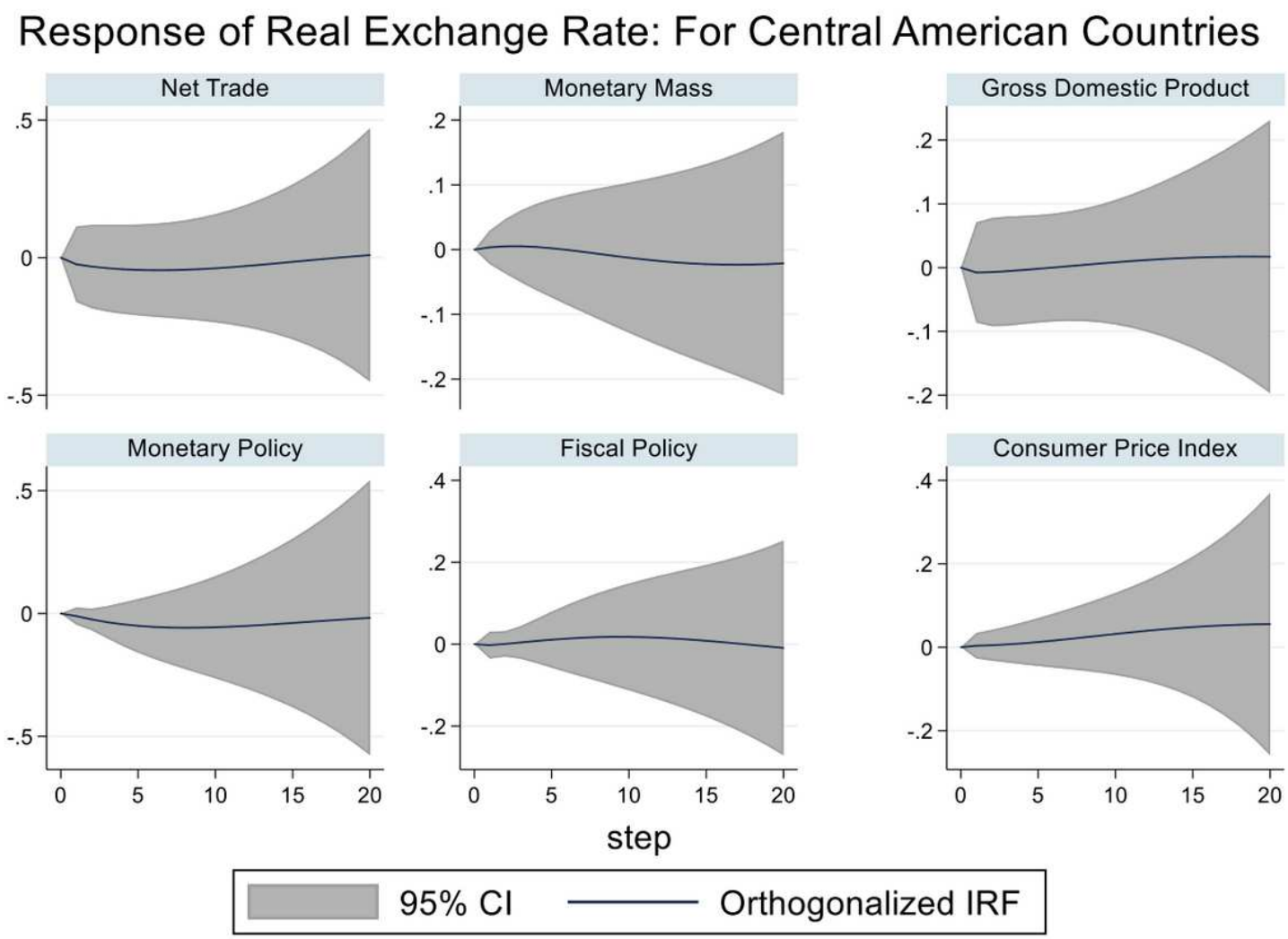

Response of Real Exchange Rate: For Central American Countries
Net Trade
Monetary Mass
Gross Domestic Product
Monetary Policy
Fiscal Policy
Consumer Price Index
step
95% CI
Orthogonalized IRF

Figure 4

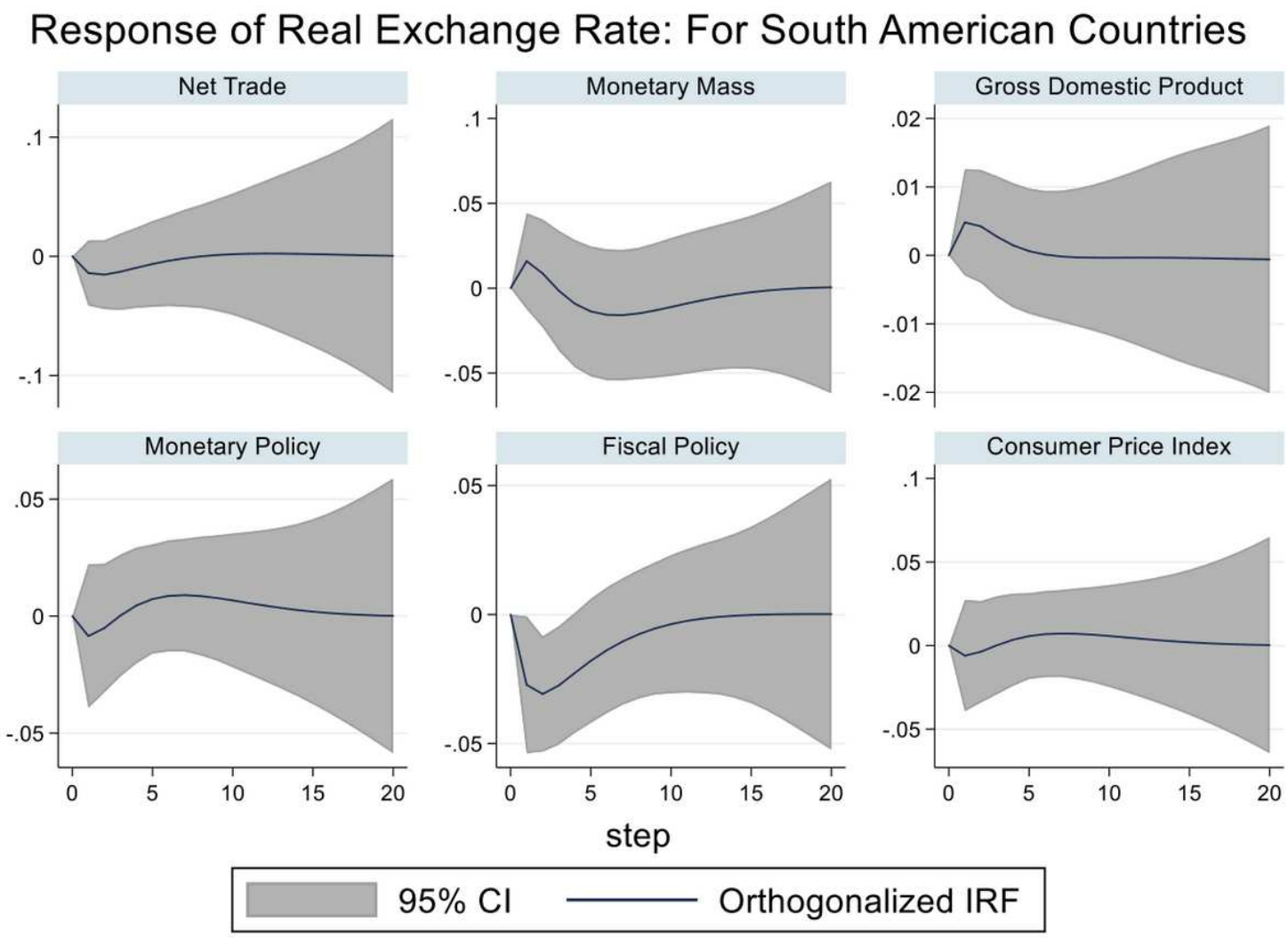

Response of Real Exchange Rate: For South American Countries
Net Trade
Monetary Mass
Gross Domestic Product
Monetary Policy
Fiscal Policy
Consumer Price Index
step
95% CI
Orthogonalized IRF

Figure 5

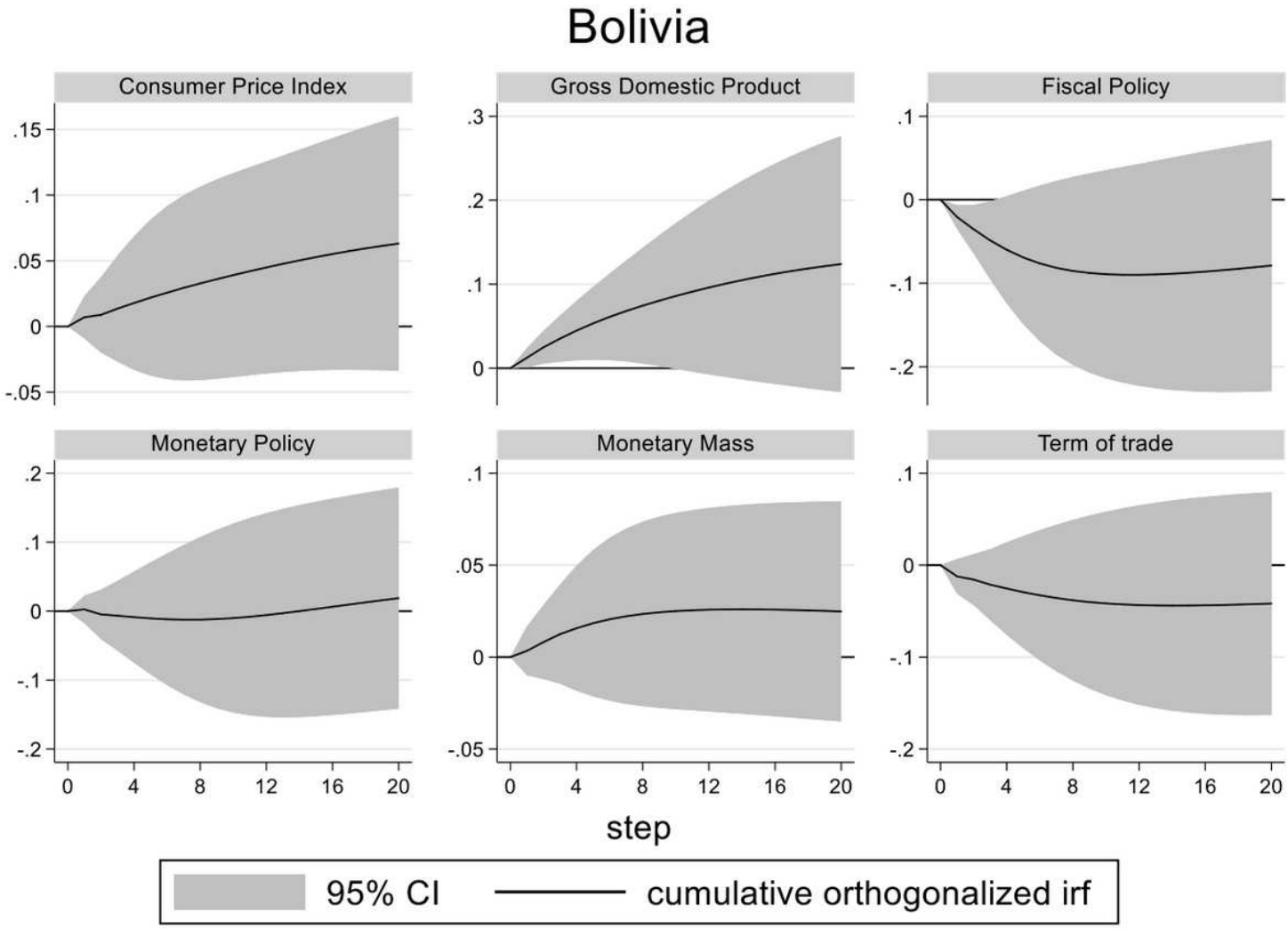

Bolivia
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of trade
step
95% CI
cumulative orthogonalized irf

Figure 6

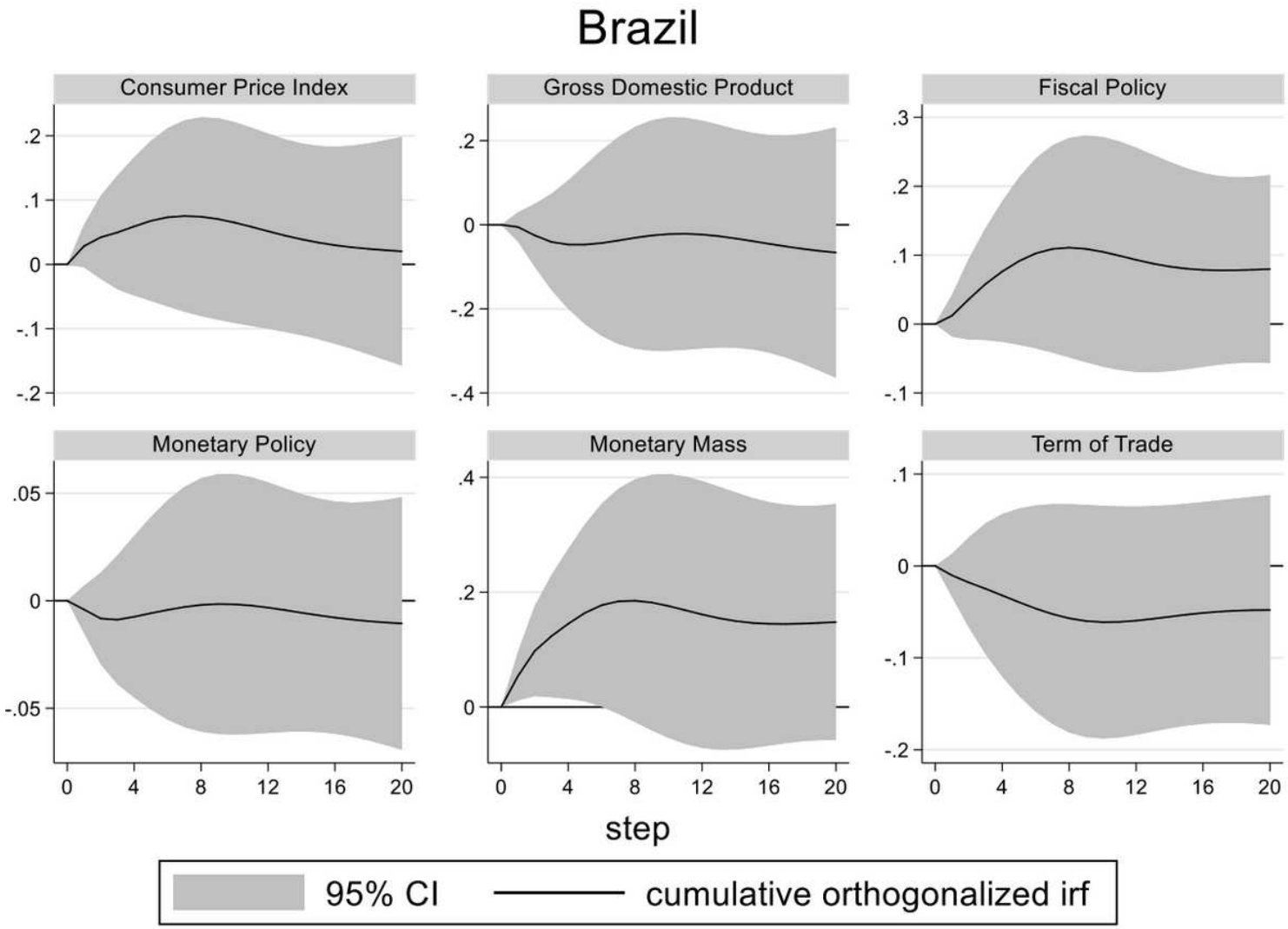

Brazil
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 7

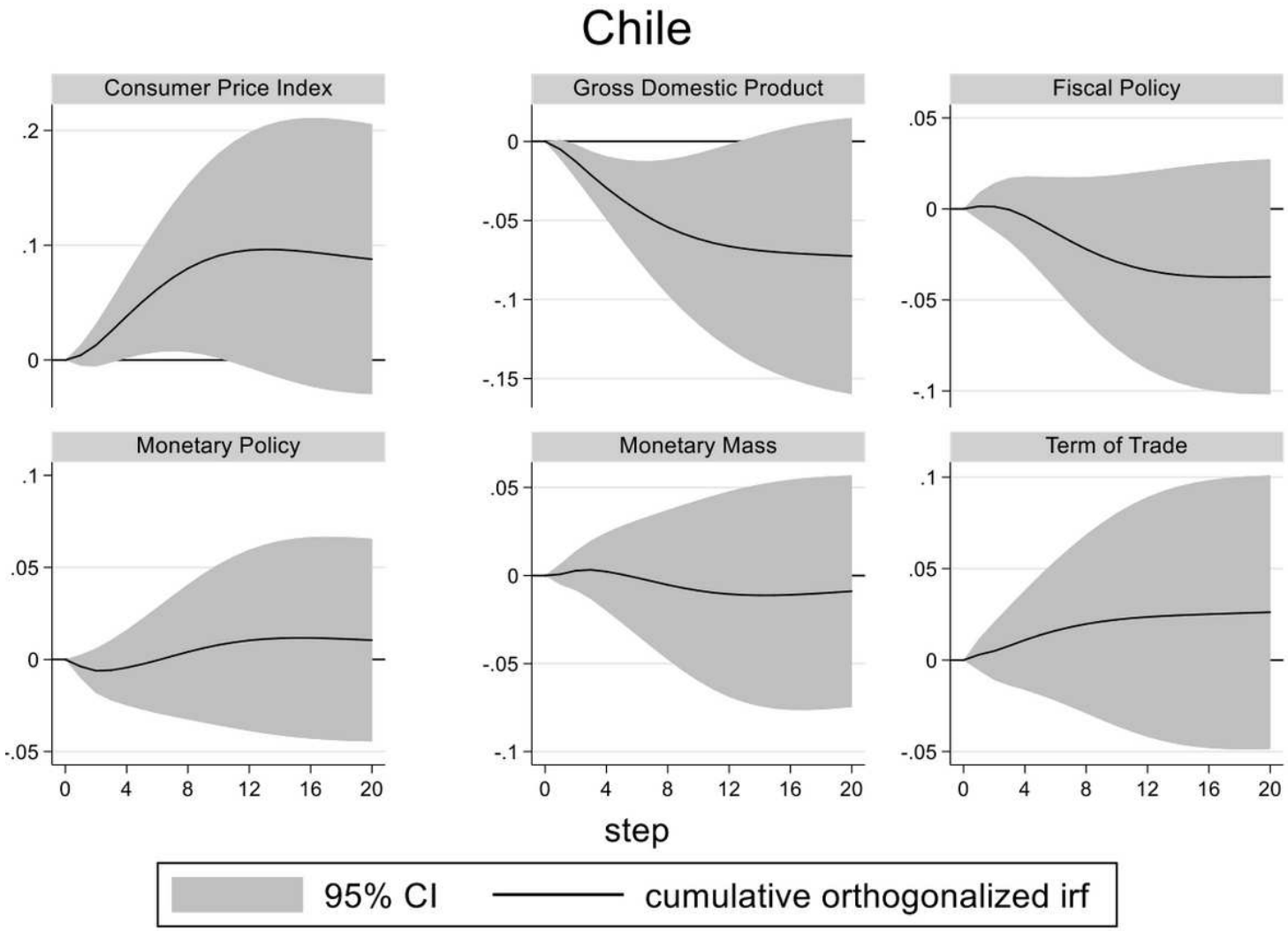

Chile
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 8

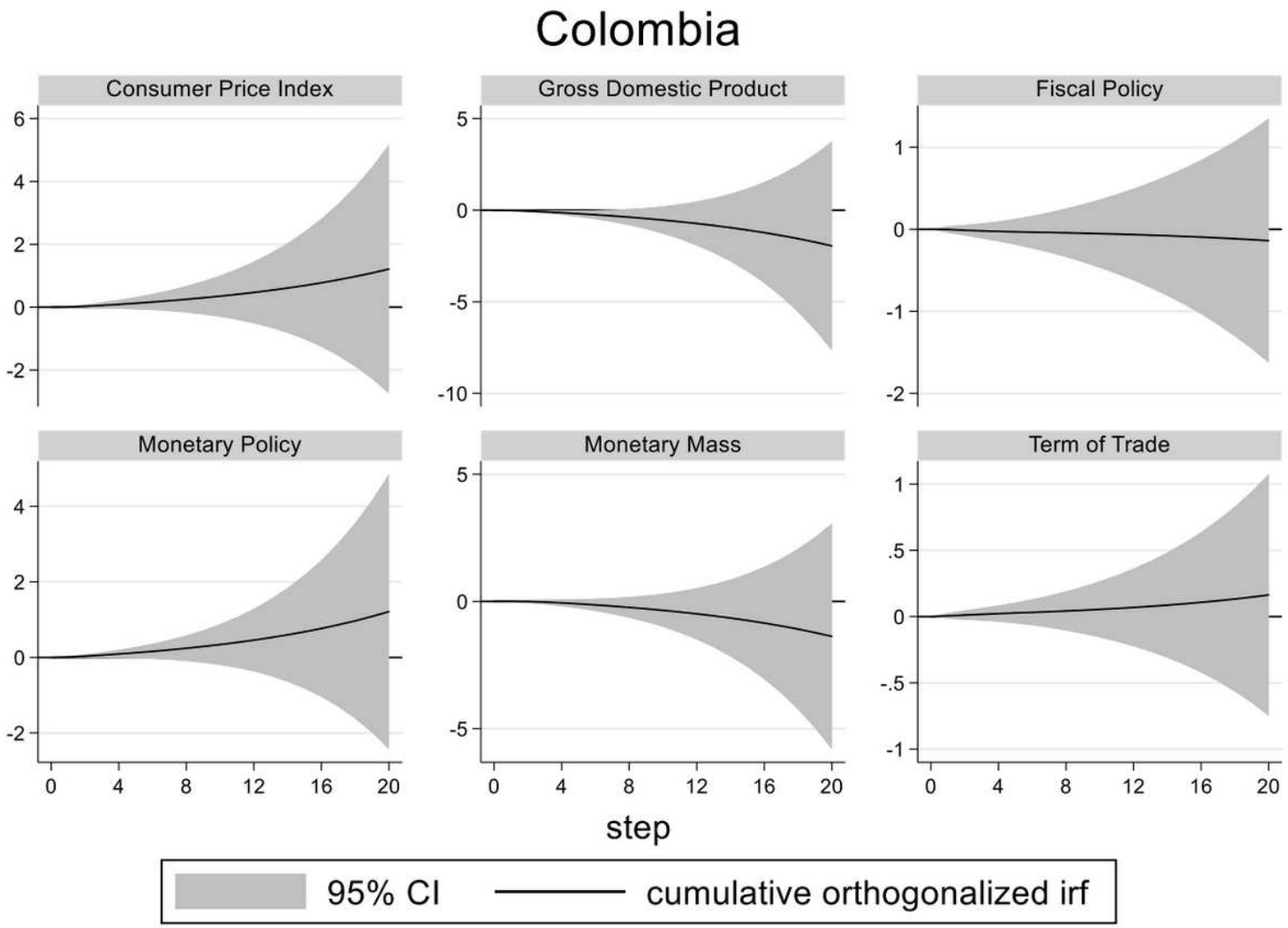

Colombia
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 9

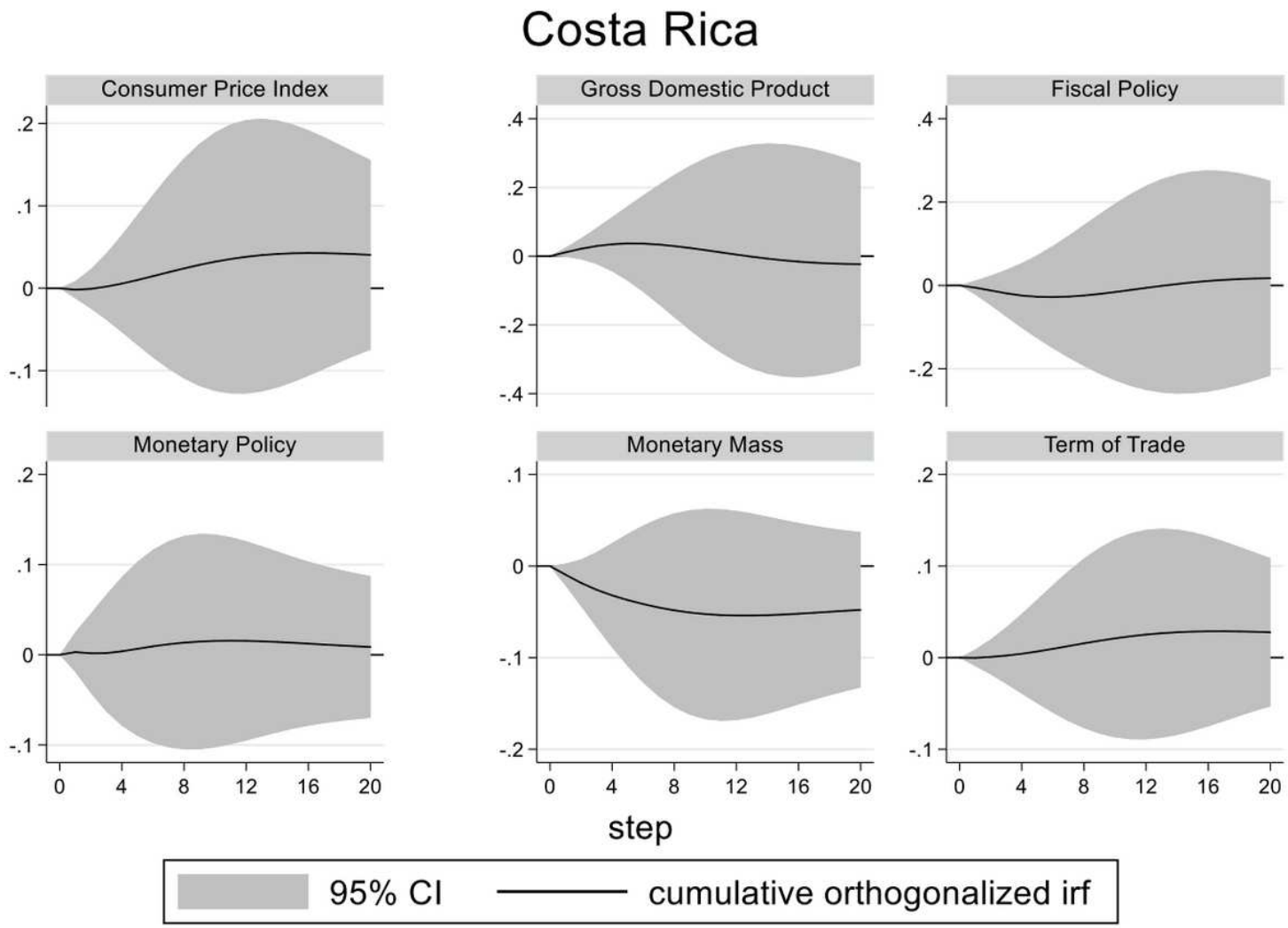

Costa Rica
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 10

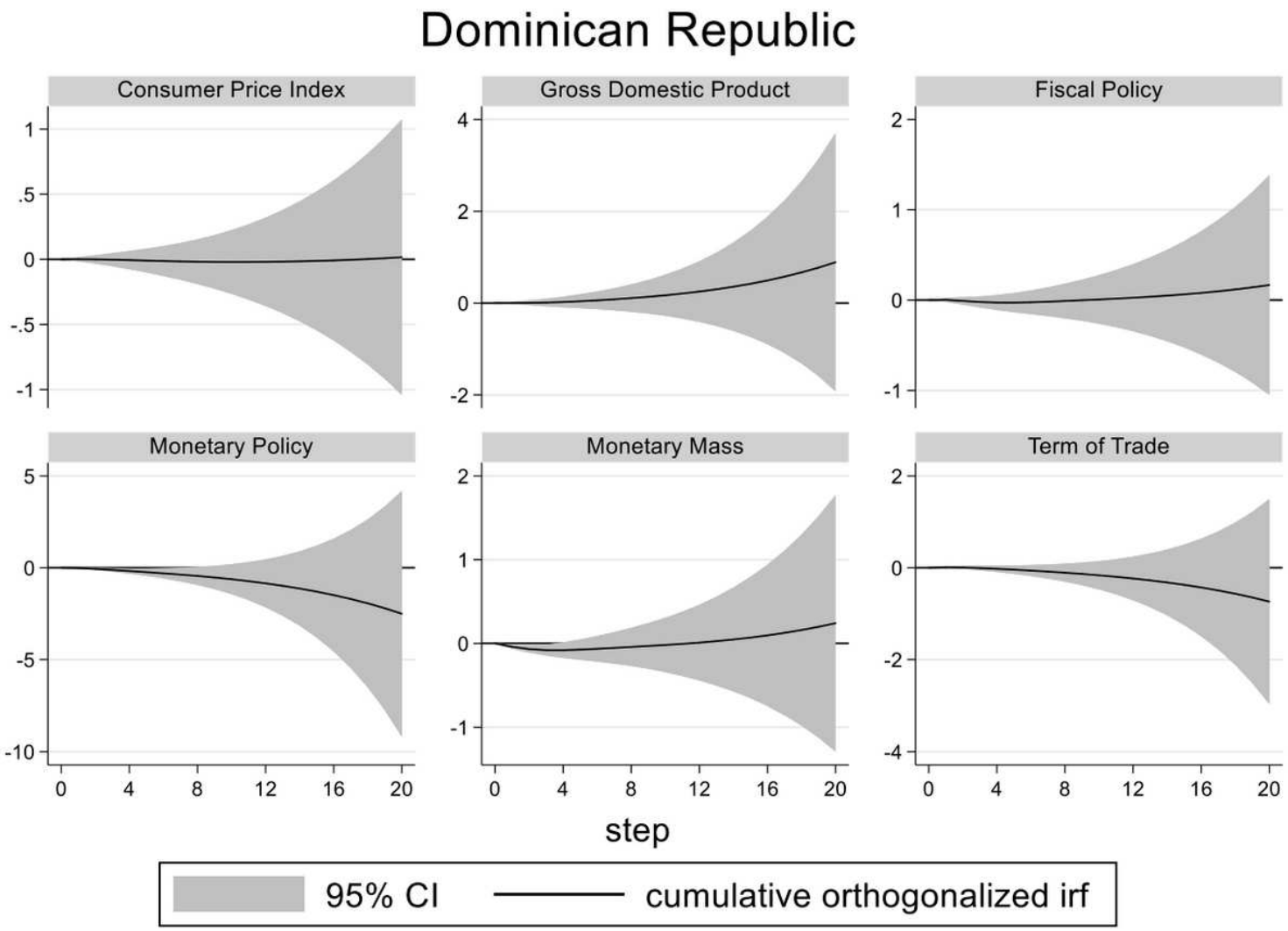

Dominican Republic
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 11

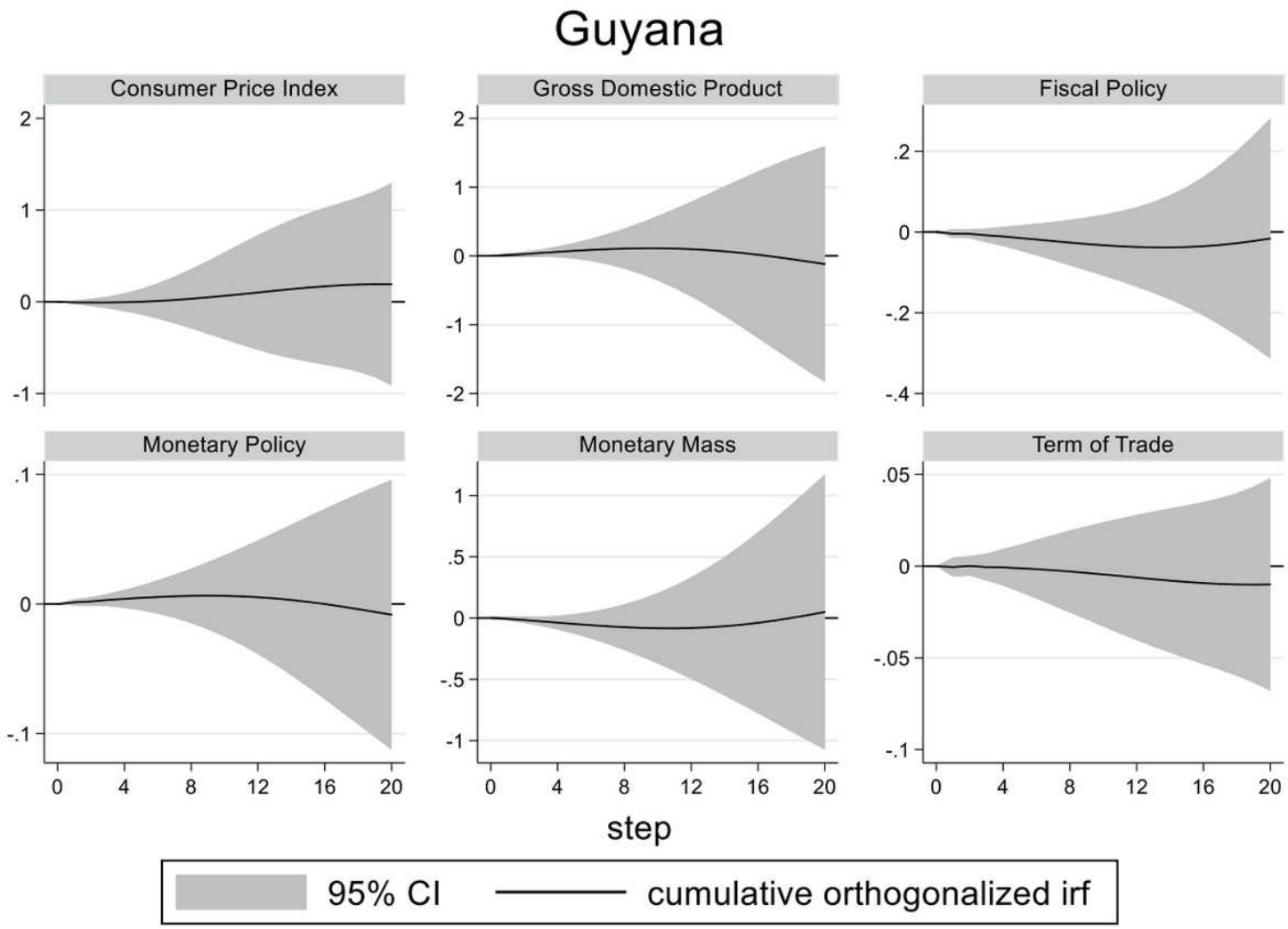

Guyana
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 12

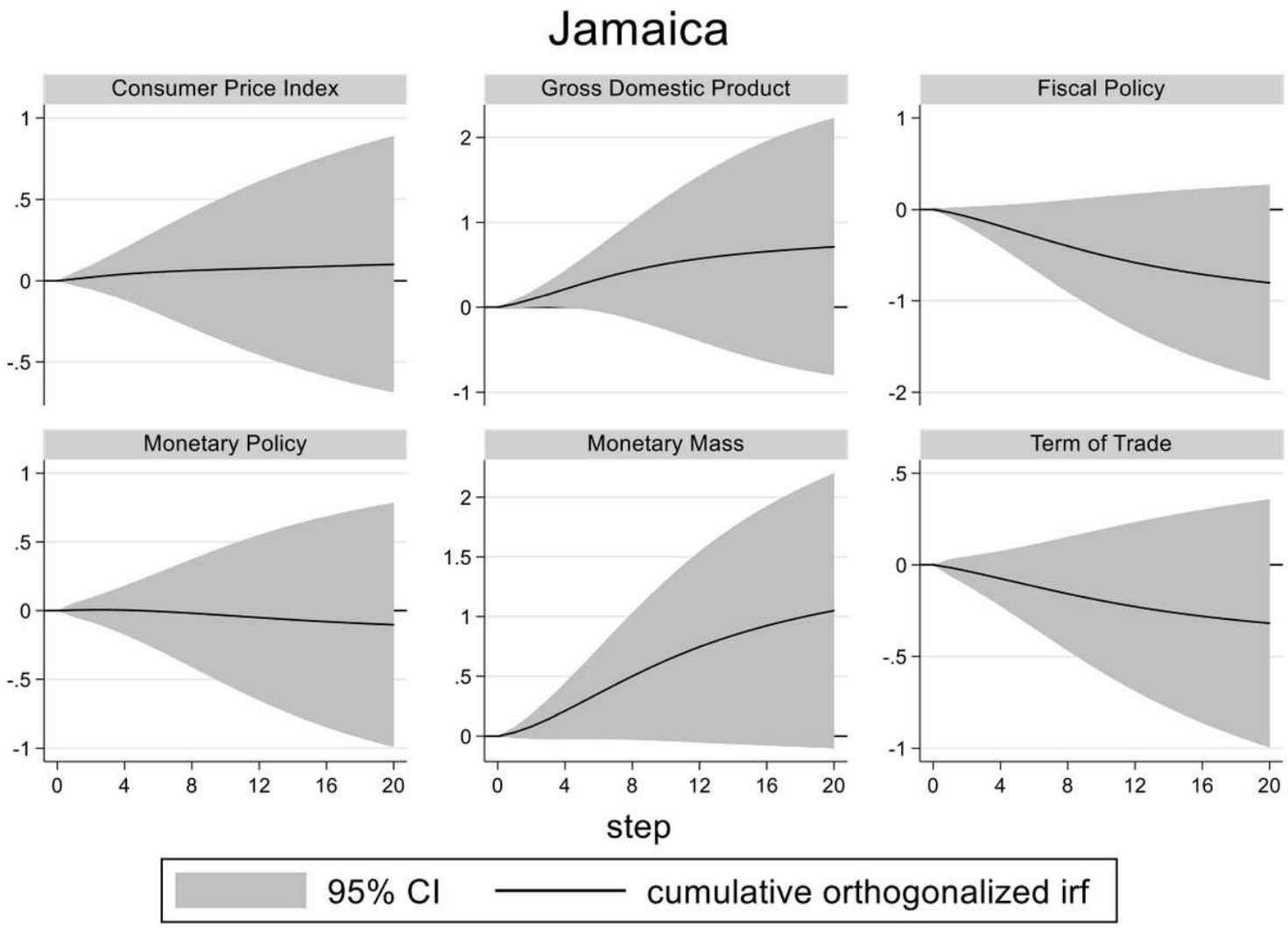

Jamaica
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 13

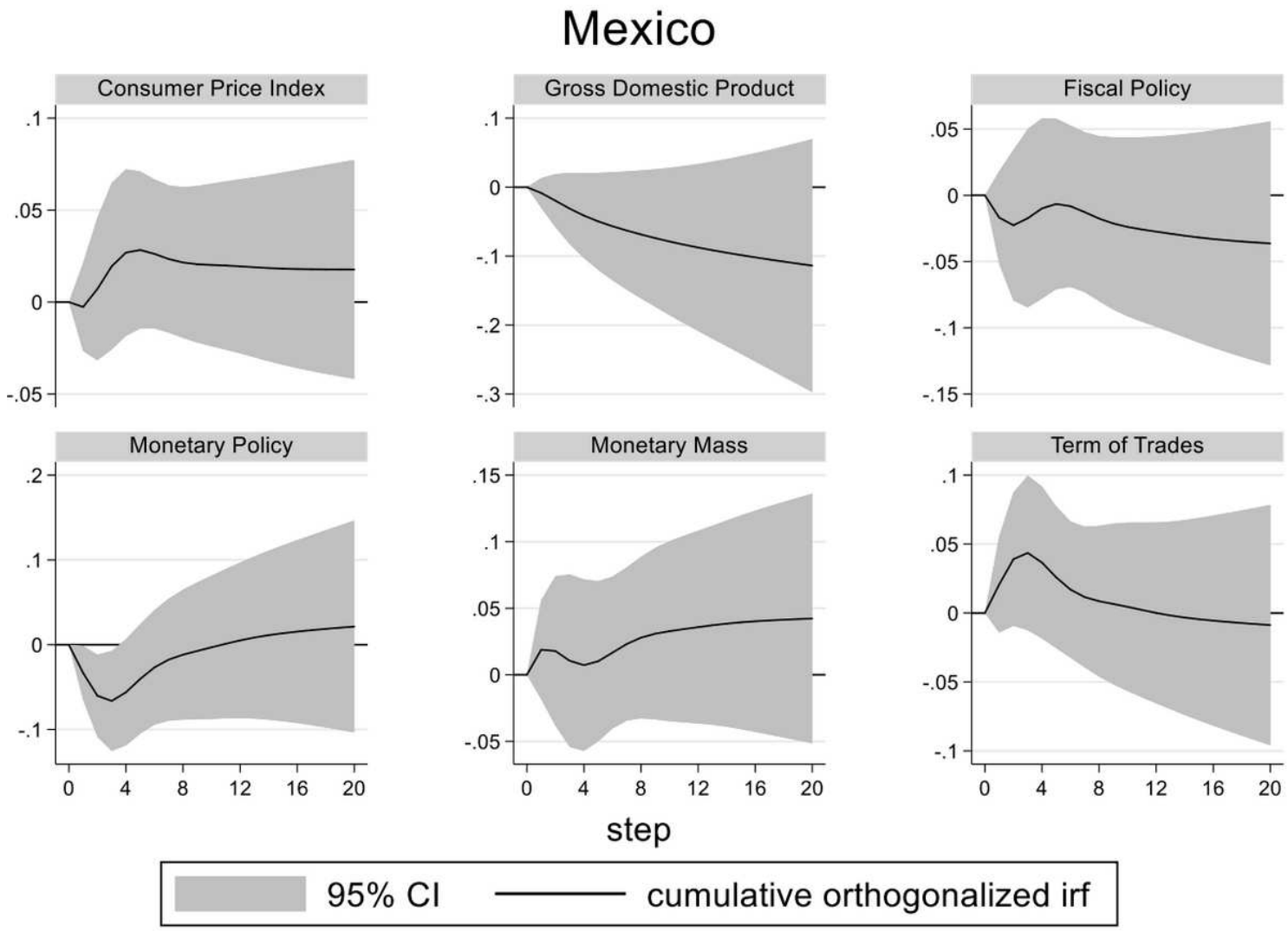

Mexico
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trades
step
95% CI
cumulative orthogonalized irf

Figure 14

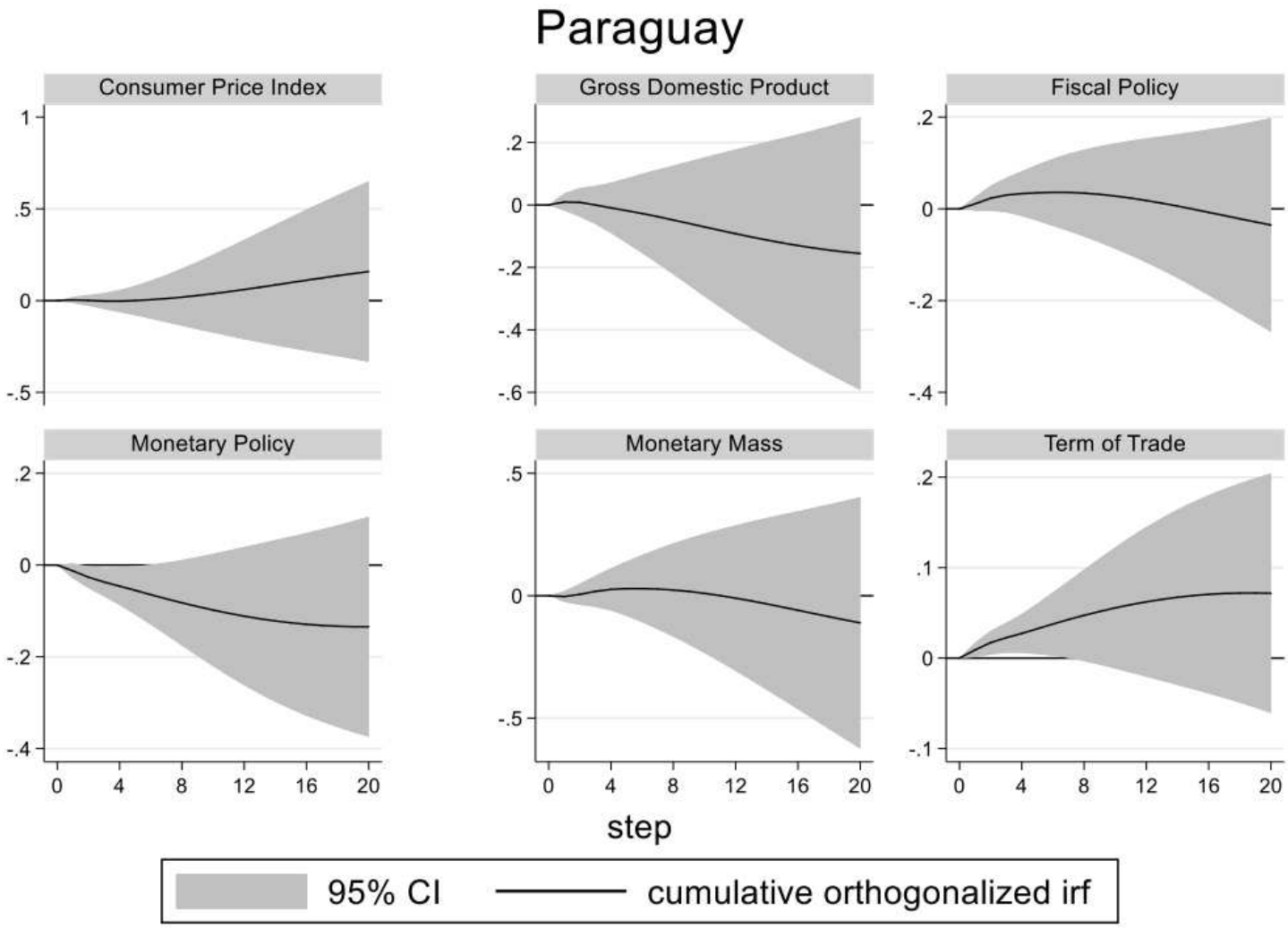

Paraguay
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 15

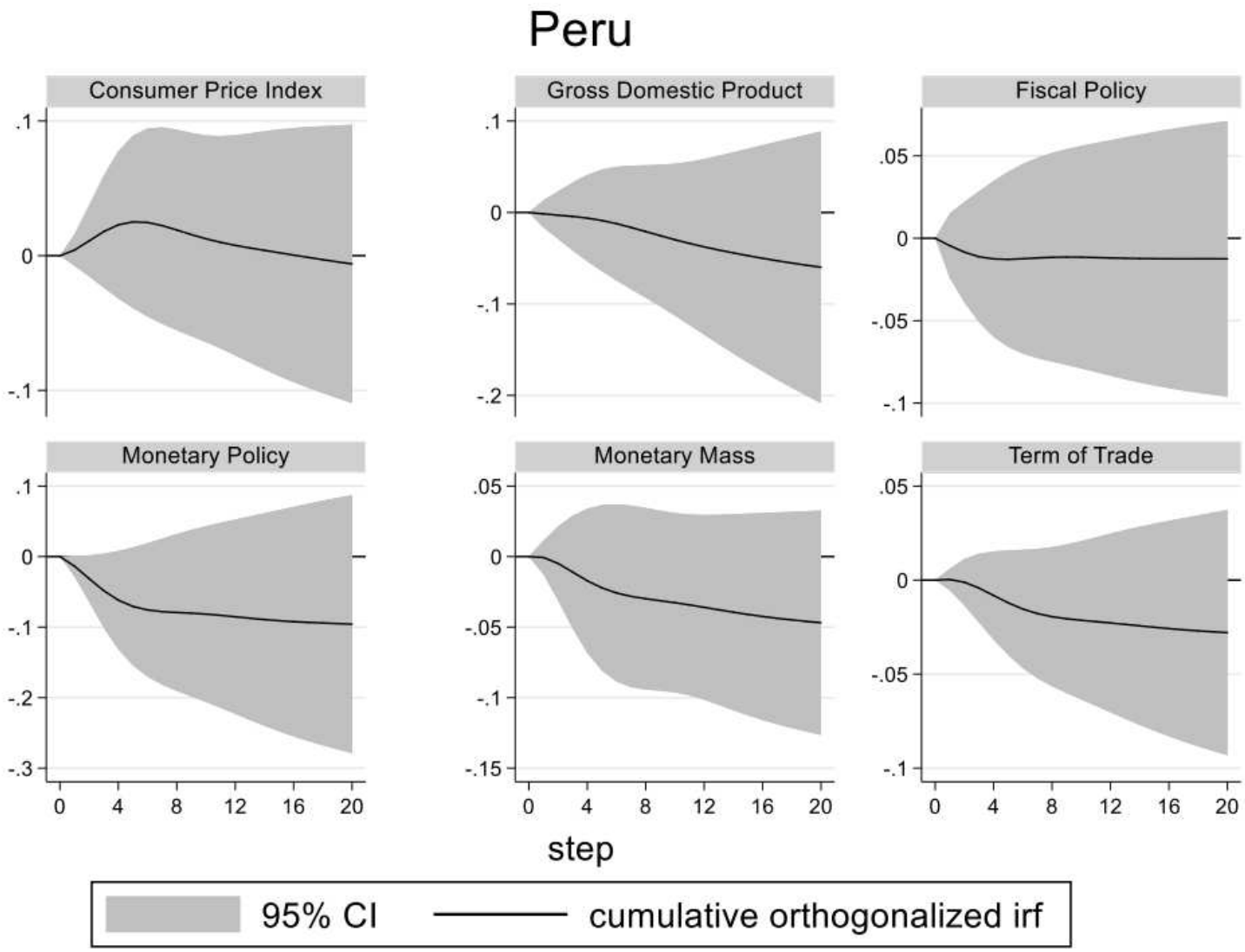

Peru
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 16

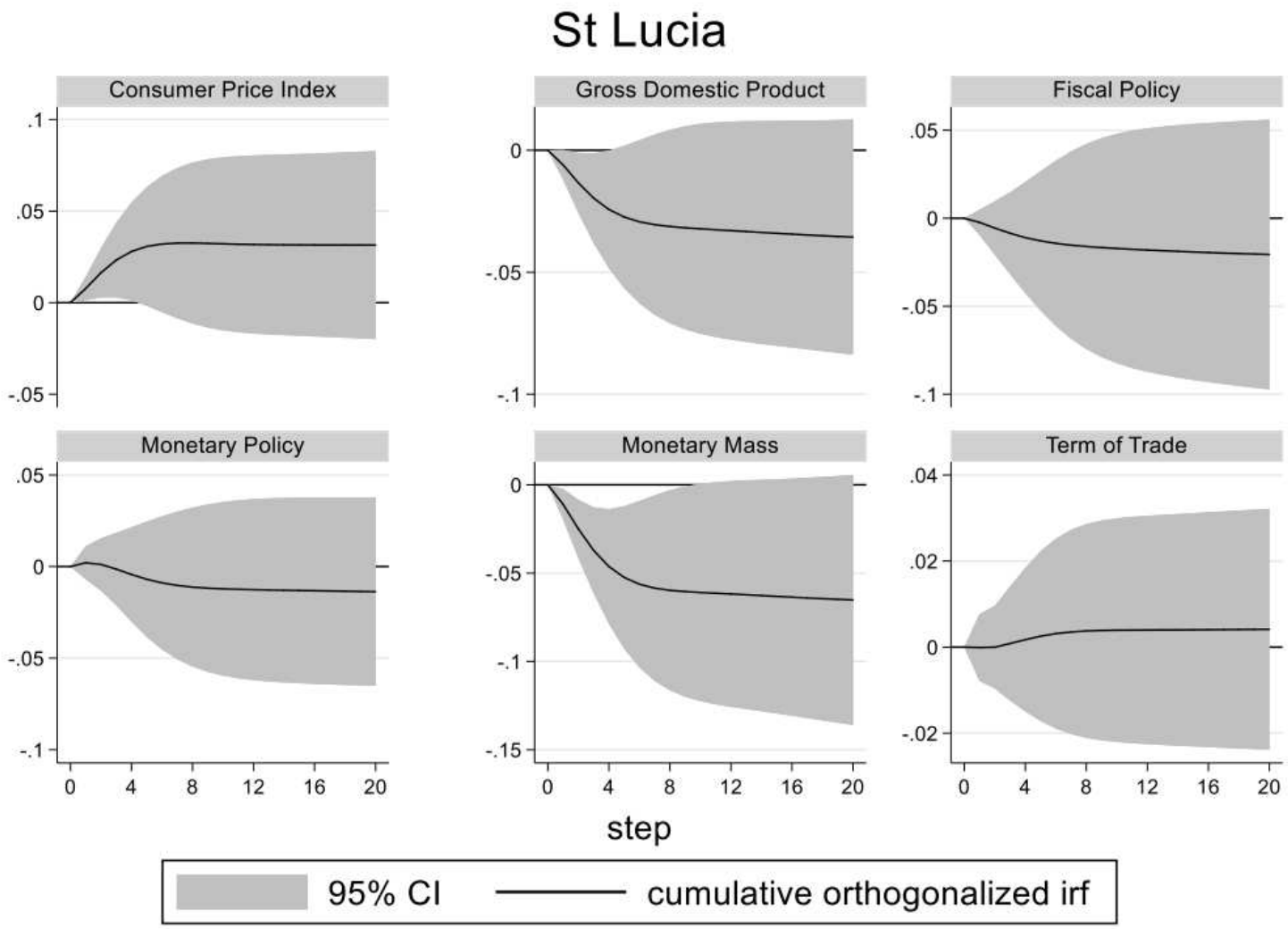

St Lucia
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 17

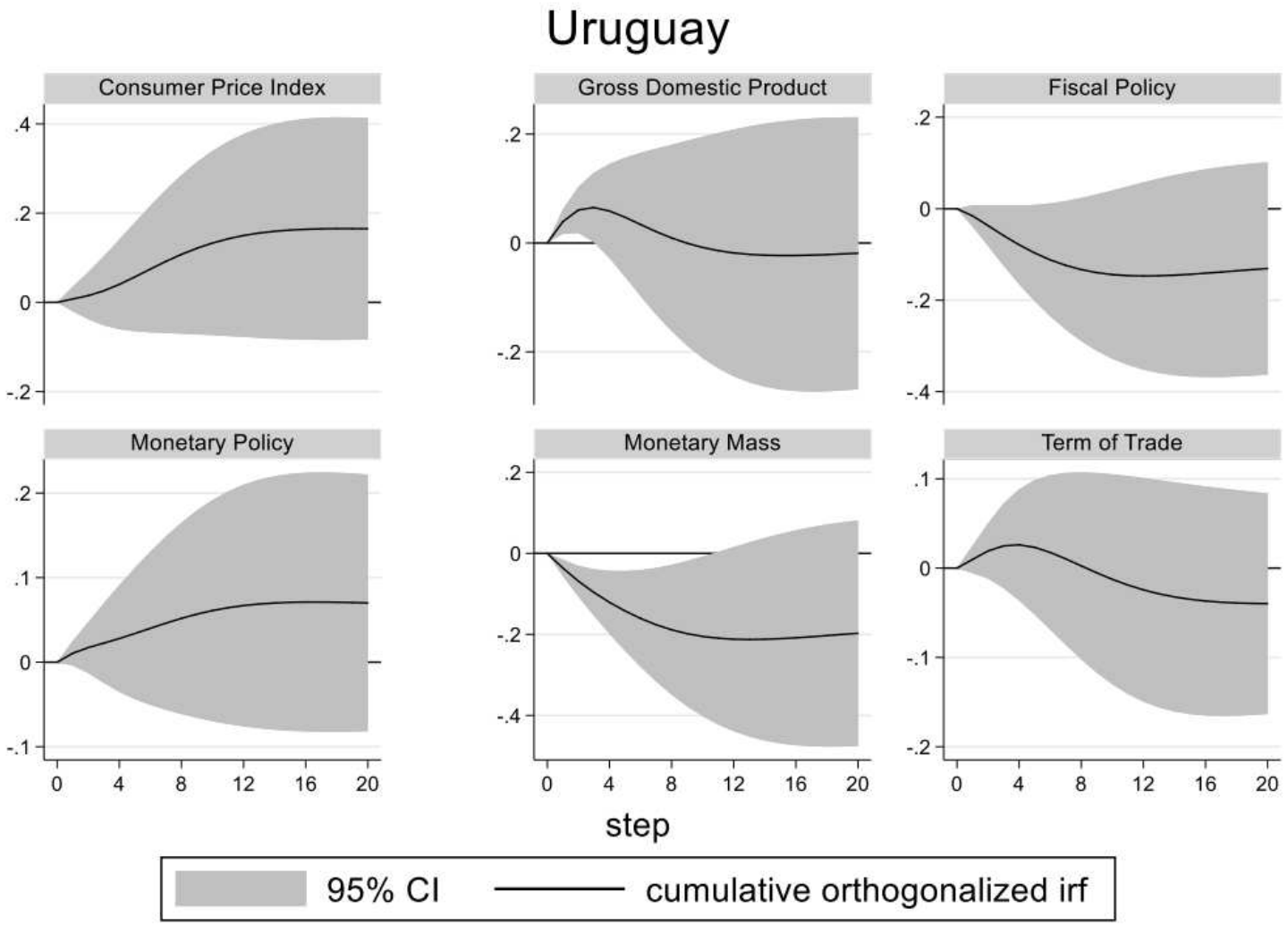

Uruguay
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 18

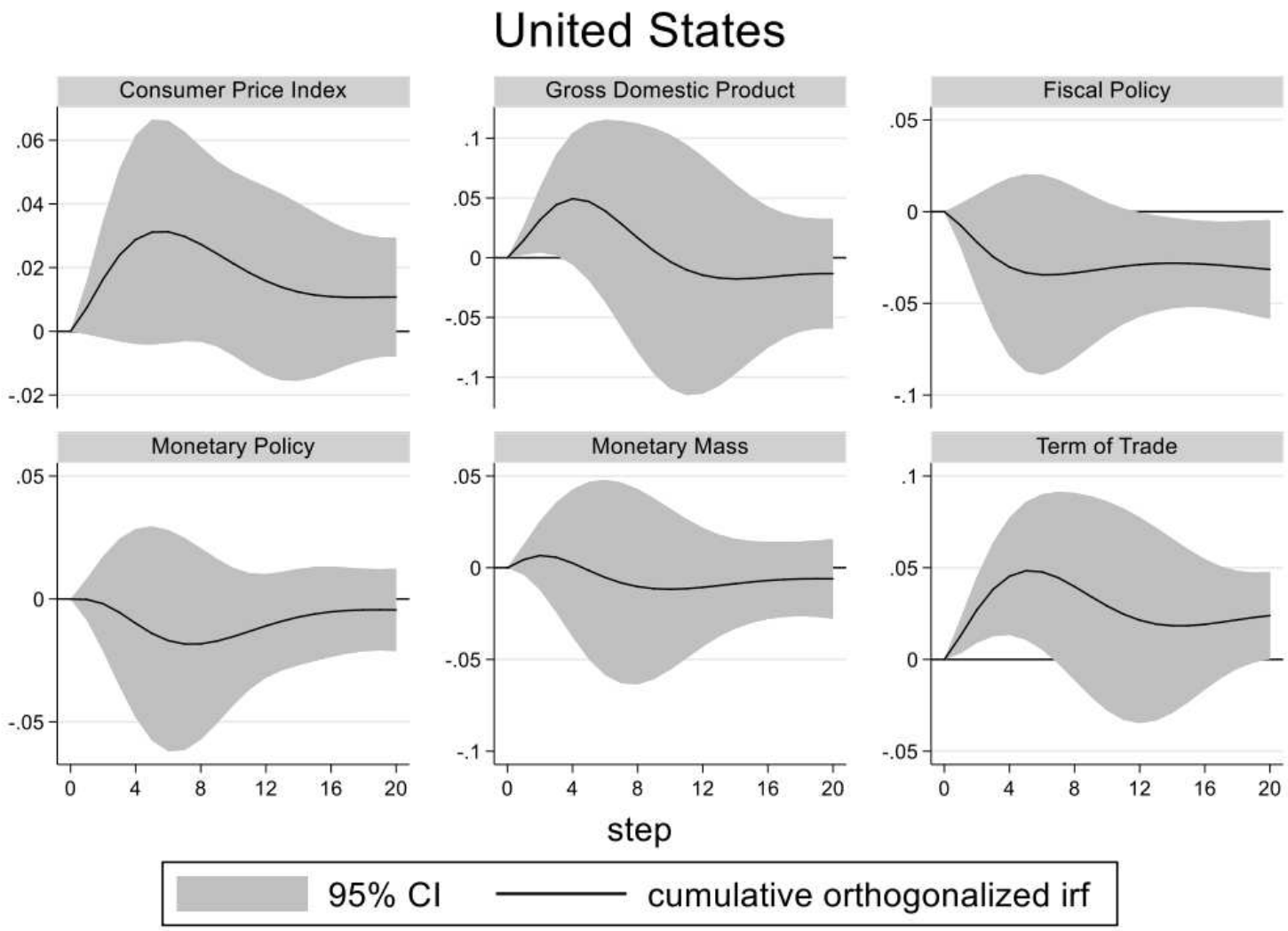

United States
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 19

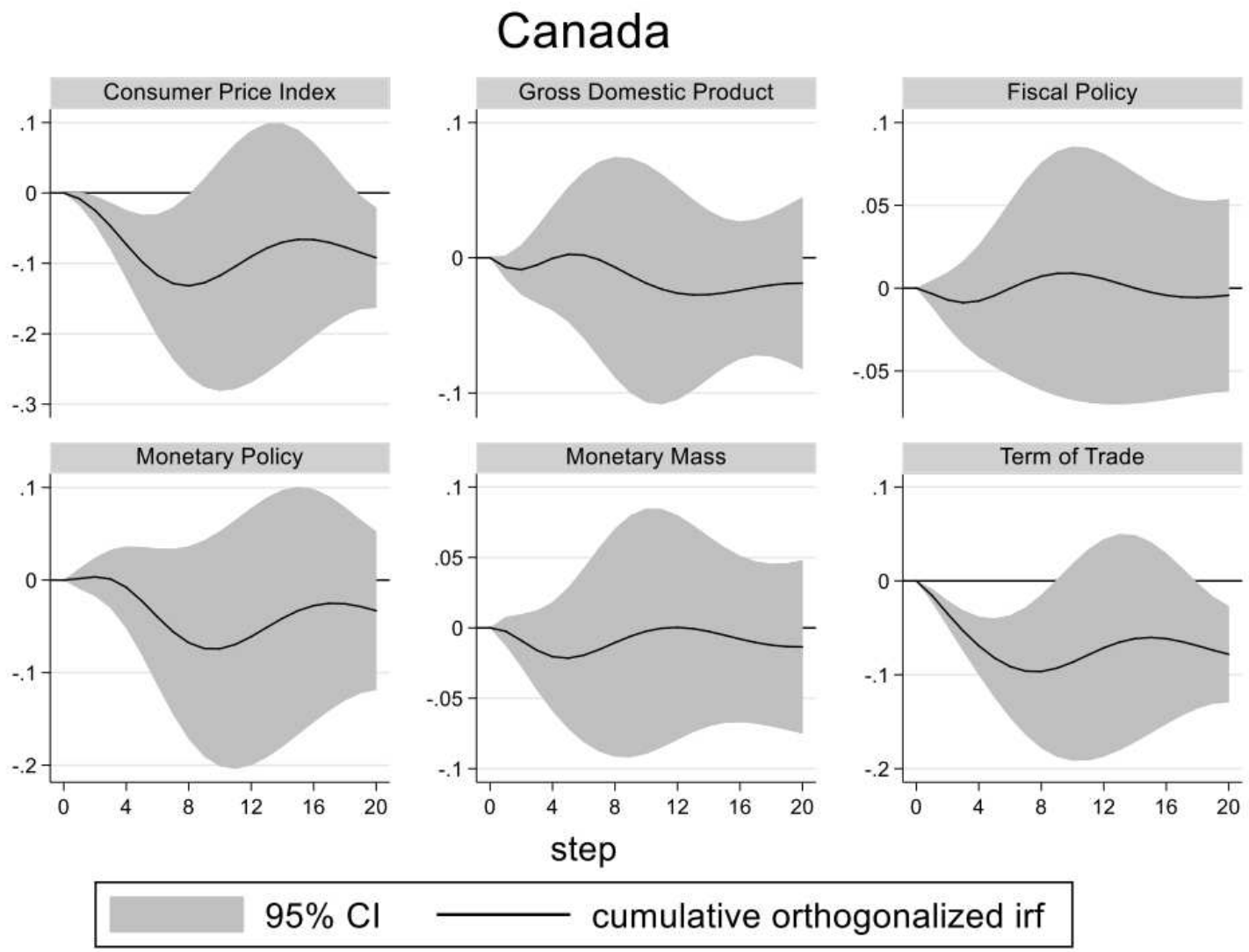

Canada
Consumer Price Index
Gross Domestic Product
Fiscal Policy
Monetary Policy
Monetary Mass
Term of Trade
step
95% CI
cumulative orthogonalized irf

Figure 20

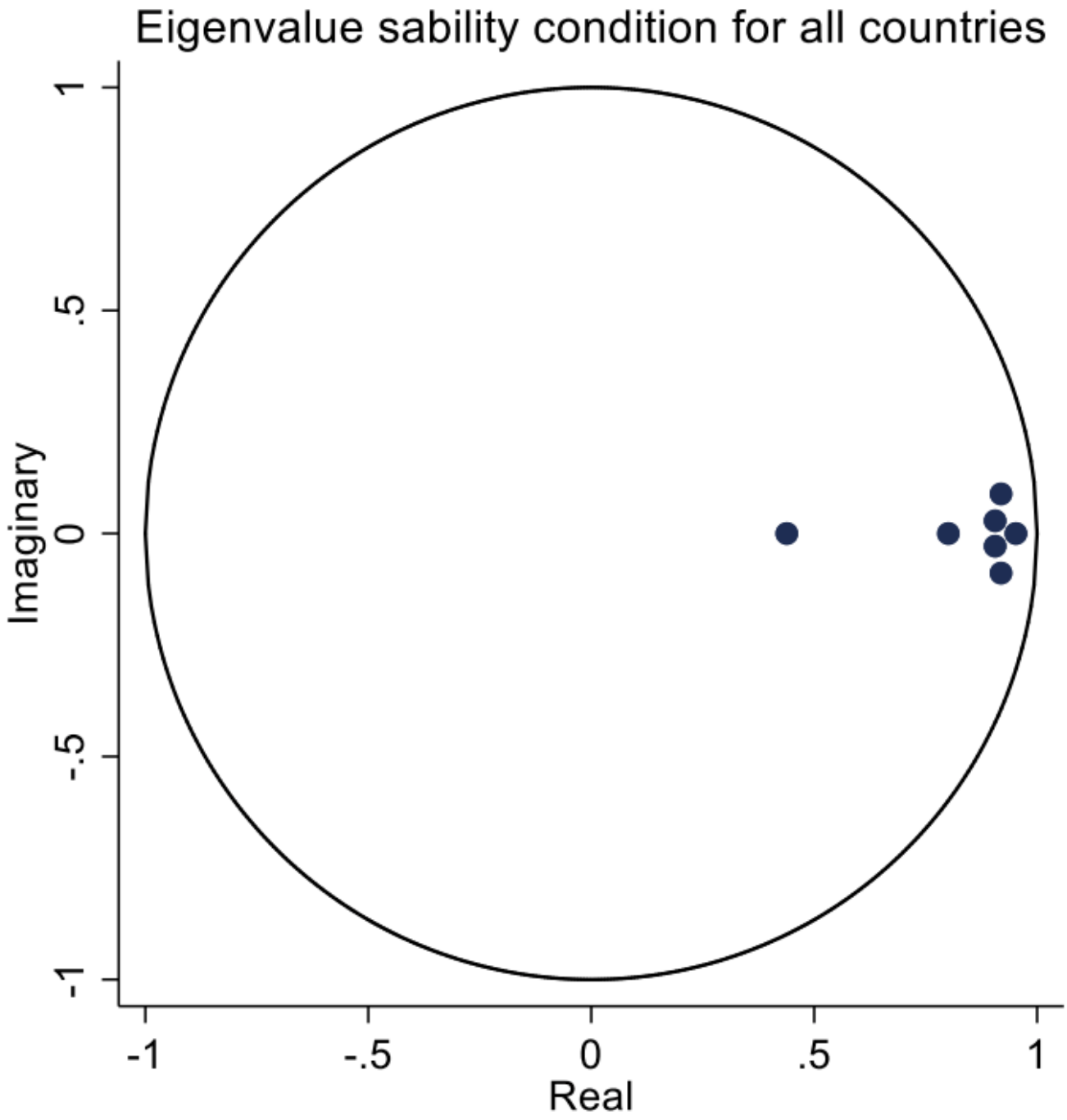

Eigenvalue sability condition for all countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

Figure 21

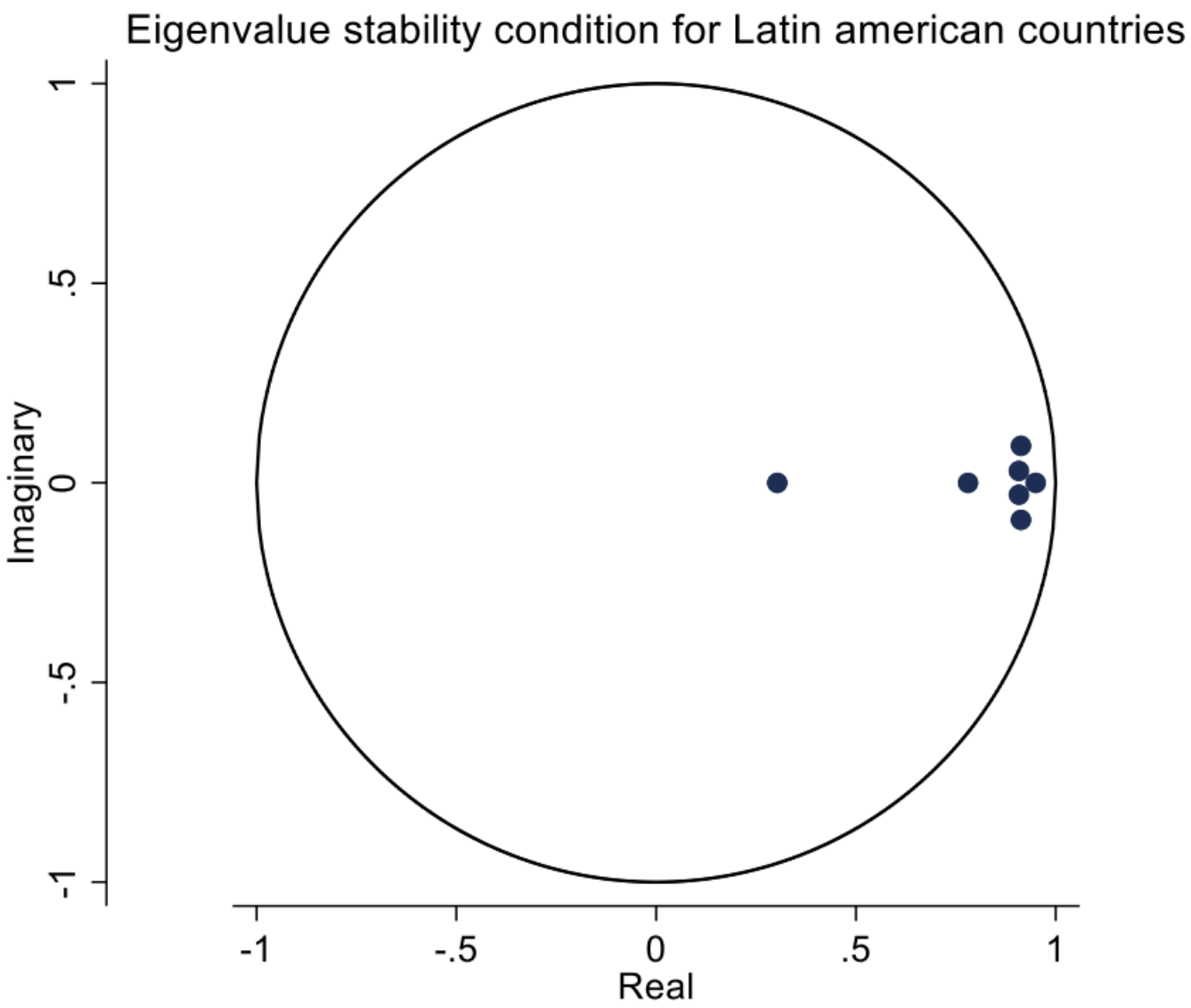

Eigenvalue stability condition for Latin american countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

Figure 22

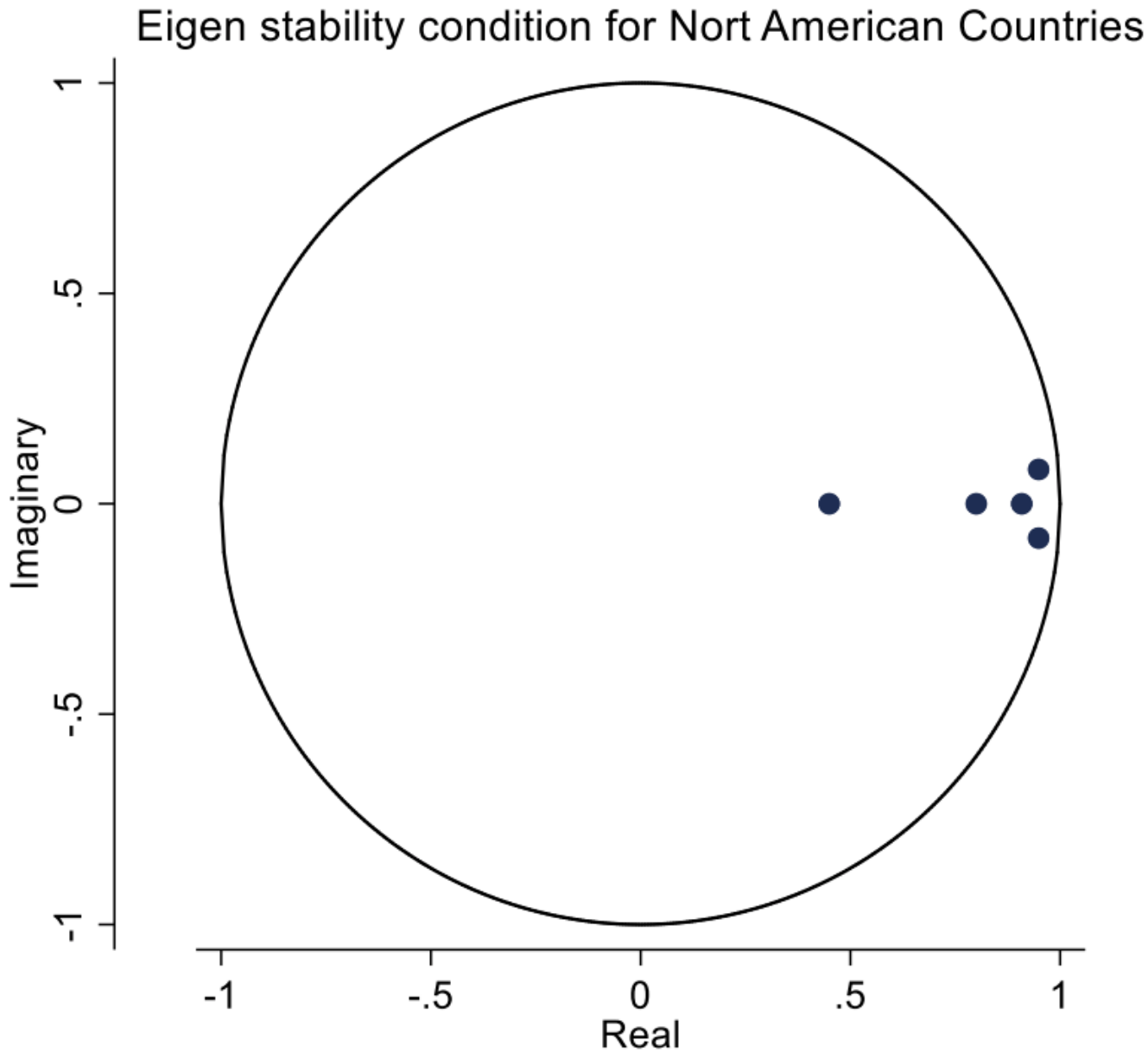

Eigen stability condition for Nort American Countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

Figure 23

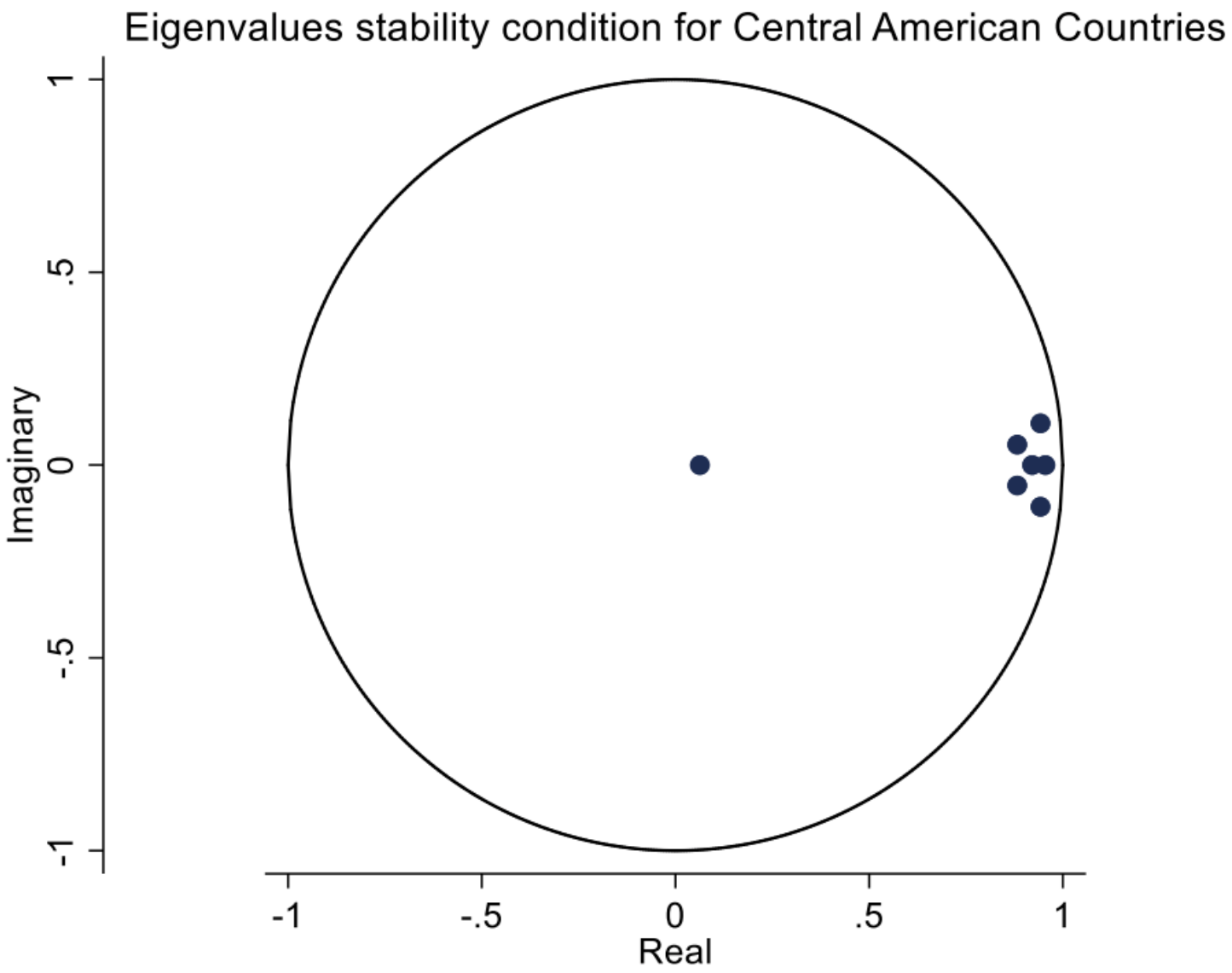

Eigenvalues stability condition for Central American Countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

Figure 24

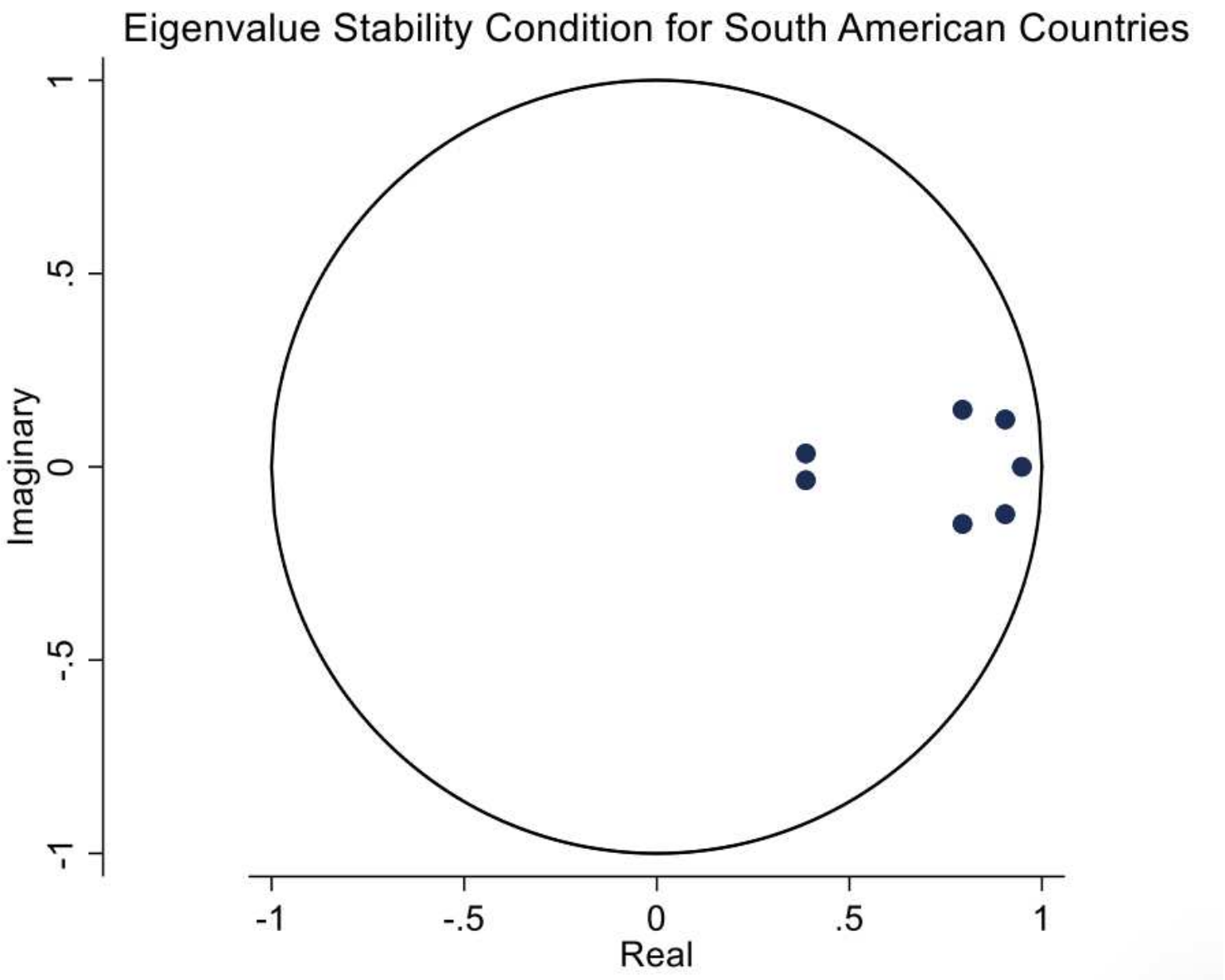

Eigenvalue Stability Condition for South American Countries
Imaginary
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Real

Figure 25