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Monetary Policy in Inflation Targeting Regimes: An Empirical Analysis Based on VEC Model

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Abstract

This article assesses the performance of the Inflation Targeting Regimes (ITR) for six countries over the period 1990-2020. Empirically, this article was based on the Vector Error Correction model (VEC). The results indicate that the ITRs were not able to generate the expected outcomes in some of the analyzed countries, mainly in developing ones. In other words, ITR seems not to be appropriate for emerging countries because the main cause of inflation in these countries is not a "demand-pull" shock, as is supposed by the ITR. In this regard, the diversity of the observed results was due to the structural and institutional specificities of each country, but also because of the limits of the theoretical framework on which the ITRs are based.

Keywords

Inflation Target Regimes, Monetary Policy, VEC Model

1. Introduction

As is well known, the Inflation Targeting Regime (ITR), that is, a monetary regime framework for monetary policy that commits the central bank to achieve a specific annual rate of inflation, has been adopted as a monetary policy framework by a significant number of countries in recent decades. It also has been an important instrument for policymakers and central banks. This regime has been incorporated into the theoretical framework of mainstream economic models, more specifically those related to the New Consensus Macroeconomics (NCM), which is based on three main equations: IS Curve, Phillips Curve and Taylor rule.[1]

[1]For additional details, see Carlin and Soskice (2006).

This article aims to assess the performance of the ITR for six countries—Brazil, Canada, Chile, United Kingdom, Mexico, and New Zealand—whose selection criteria will be explained in Section 2, over the period 1990-2020. The main motivation of the article is that, in general, the empirical evidences show that larger and more developed countries are more successful in adopting the ITR, while, on the other hand, ITR is not successful in developing economies because supply shocks, such as commodity prices and exchange rate variations, among others, affect inflation rate in these countries positively. In other words, it seems that ITR is more appropriate for developed countries whose inflation rate is mainly related to demand-pull, as it is supposed by the framework of this monetary regime.

In line with this main objective and motivation, the empirical analysis is based on Vector Error Correction (VEC) model. The idea is to show that the ITR was unable to obtain the results expected by policymakers in some of the analyzed countries, more specifically in developing economies.

Several articles from both mainstream economics literature and heterodox approaches analyse the performance of ITR for developed and developing countries. Regarding mainstream economists, Ball & Sheridan (2004), Mishkin & Schmidt-Hebbel (2007), Lin & Ye (2009), Huang, Yeh, & Wang (2019), Stojanovikj & Petrevski (2021) and Petrevski (2023) are some examples that assess the performance of ITRs. In turn, some heterodox economists (Angeriz & Arestis, 2007; Arestis, Ferrari-Filho, & Paula, 2011; Modenesi & Araújo, 2013; Rocha & Oreiro, 2008; Araujo, Araújo, Fonseca, & Mourão, 2023) have criticized the *modus operandi* and the performance of ITR.

In addition to this introduction, this article is composed of three additional sections. Section 2 presents the institutional aspects of ITR for each of the six selected countries that adopted this regime. Section 3 estimates a VEC model and analyses the effects of monetary policy on other economic variables. Section 4 concludes.

2. Institutional Aspects of the ITR for All Selected Countries

Before presenting the institutional aspects of the ITR for the countries of our sample, it is important to mention that the main characteristics of the ITR framework are the following: 1) Monetary policy is the main instrument of macroeconomic policy, and it should be operated by "independent" central banks that, in general, have credibility in the financial markets; 2) Fiscal policy is no longer viewed as a powerful macroeconomic instrument; 3) The level of economic activity fluctuates around a supply-side equilibrium—it means that Say's Law holds; and 4) Effective demand does not play an independent role in the long-run level of economic activity.[2]

Focusing attention on the institutional aspects of the ITR, based on the methodology developed by Hammond (2012) and Huang, Yeh & Wang (2019), this section describes the main features of the ITR for the following countries: Brazil, Canada, Chile, United Kingdom, Mexico, and New Zealand. The sample was

[2]For additional details, see, for instance, Arestis, Ferrari-Filho, & Paula (2011).

based on three main criteria: 1) the inclusion of developed (Canada, United Kingdom, and New Zealand) and developing (Brazil, Chile, and Mexico) economies with the aim of analyzing different economic and institutional features; 2) the time of longevity of ITR adoption (Canada, Chile, United Kingdom, and New Zealand, at the beginning of the 1990s, and Brazil and Mexico in 1999 and 2001, respectively); and 3) the inclusion of Latin American countries with similar inflation histories (Brazil, Chile, and Mexico).

Hammond (2012) analyzes the institutional aspects of 27 countries that adopted the ITR. He emphasizes, among others, the horizon for target convergence, the target level, and the forecasting model adopted by each central bank. The author's main conclusion is that ITR has been successful in most countries that have adopted it in the last 20 years.

Table 1, based mainly on Hammond (2012)'s analysis, presents the main ITR features and inflation rate for each selected country at the end of 2023.

Table 1. The main features of ITR for all selected countries.

Country and date of adoption of the ITR	Monetary authority	Institutionality	Index of inflation core	Target horizon	Monetary Policy instrument	Target and band/2020	Annual inflation/ 2023
Brazil/June 1999	Central Bank of Brazil (CBB)	Target set by Government and CBB	CPIA	Yearly Target	Selic (overnight)	4.0%, tolerance interval ± 1.5 p.p.	4.6%
Canada/ February 1991	Bank of Canada (BC)	Target set by Government and BC	CPI	Every 5 years	Interest rate (overnight)	2.0% tolerance Interval ± 1.0% p.p.	3.4%
Chile/ September 1990	Central Bank of Chile (CBC)	CBC	CPI	Every 2 years	Interbank rate (overnight)	3.0%, tolerance Interval ± 1.0% p.p.	3.9%
United Kingdom/ January 1992	Bank of England	Government	CPI	Every Moment	Bank rate	2.0%	3.9%
Mexico/ January 2001	Bank of Mexico (BMEX)	Members' board (5 members)	CPI	3 years	Interbank rate (overnight)	3.0% tolerance Interval ± 1.0% p.p.	4.7%
New Zealand/ January 1990	Reserve Bank of New Zealand (RBNZ)	RBNZ and Minister of Finance	CPI	3 years	Official cash rate	Between 1.0% and 3.0%	4.7%

Source: Hammond (2012), CBB (2024), BC (2024), CBC (2024), Bank of England (2024), BMEX (2024) and RBNZ (2024).

Based on **Table 1**, in our view, the relevant features are the following: 1) central bank independence and monetary policy autonomy; 2) official inflation index; 3) time horizon for convergence to the inflation target and inflation target with its tolerance intervals; and 4) monetary policy instrument used by the Monetary Authority.

The first consideration to be highlighted is the independence of the central bank. All selected countries have independent central banks. This means that all central banks have complete autonomy in defining their inflation targets. Moreover, all countries analyzed in our sample guarantee the central bank's operational autonomy, which indicates that the implementation of monetary policy avoids the well-known inflationary bias.

The second consideration concerns the inflation index. All countries use the full Consumer Price Index (CPI).

The third consideration relates to the definition of inflation target. This aspect is known as ITR accountability. All selected countries define an inflation point target and have a tolerance band.

Finally, the central banks are free to choose the instruments necessary to reach a previously established inflation target. In our sample, the monetary policy used by central banks is generally overnight and the interbank rate.

To conclude this section, one additional observation: when comparing inflation in each country at the end of 2023, all countries in the sample had inflation rates close to average inflation, 4.2%.

3. Empirical Analysis of the ITRs

The purpose of this section is to assess the efficiency of the ITR. To this end, a VEC model was estimated for each selected country, inspired by Modenesi & Araujo (2013), Fonseca, Peres, & Araujo (2016), and Araujo, Araújo, Fonseca, & Mourão (2023).

It was decided to estimate a VEC model for each country, rather than estimating a panel model or even a joint regression. Although other models may have advantages over VEC model, they do not allow to separate and compare the analysis for each selected country, which is the focus of this section

3.1. Methodology

Considering that in our sample, some countries implemented the ITR in the 1990s and others in the 2000s, for comparative purposes, the number of observations (months) for the model estimation took into account the beginning of the ITR adoption period in each of the selected countries. For example, in 1990, New Zealand was the first country to adopt ITR and, as a result, the number of observations reached 360 months; in our sample, the last country to adopt ITR was Mexico in 2001, and, therefore, the number of observations is 240 months. Even with the data discrepancy, countries present appropriate observations for estimating the VEC model, as argued by Wooldridge (2002).[3]

Due to the difference in the data collected for each central bank, we sought to maintain a minimum standard in the data, with the objective of obtaining results that are compatible with the traditional theory. The analyzed variables are: interest rate (the effective interest rate of each country), CPI (monthly rate of change of

[3]It is important to mention that, once the data is monthly, the seasonality adjustments are done.

price indices for each country), GPD (industrial index of physical production, as a proxy for economic activity), and exchange rate (nominal exchange rate, monthly average). Analytically, Equation (1) is the estimated regression that will be estimated for each country of the sample:

$$D\log \text{Interest Rate}_t = \alpha_0 + \alpha_1 D\log CPI_{t-1} + \alpha_2 D\log GDP_{t-1} + \alpha_3 D\log \text{Nominal Exchange Rate}_{t-1} + \epsilon_{t-1}, \quad (1)$$

where D indicates the first difference and $\epsilon \sim (0, \sigma^2)$.

Finally, on the one hand, based on economic literature and reinforced by Granger causality tests (Granger, 1980), the price index precedes the activity proxy. On the other hand, the choice of variables was partly based on the previously mentioned empirical literature (Modenesi & Araújo, 2013; Fonseca, Peres, & Araújo, 2016).

Once the series were properly treated, we sought to assess whether the variables in question followed a stationary stochastic pattern, thus carrying out three unit root tests for each series of data extracted from each country. The unit root tests performed were those of Phillips-Perron (PP) (Phillips & Perron, 1988), Augmented Dickey & Fuller (ADF) (Dickey & Fuller, 1979, 1981), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski, Phillips, Schmidt, & Shin, 1992). The null hypothesis of the tests is that the analyzed series are non-stationary, with the exception of the KPSS test, whose null hypothesis is that the variable is stationary. The presence of constant, constant, and trend or no constant and no trend were included in the tests for each variable so that the tests could be performed as completely as possible. Considering all the tests performed, the variables of each country were integrated into order one (non-stationary).

3.2. VEC Model: Estimation and Results

After analyzing each variable, Johansen's cointegration tests (Johansen, 1988) were carried out in a summarized form to verify whether the linear combination of variables for each country is stationary, thus indicating that there is a long-term relationship between them. **Table 2** shows the results of the cointegration tests for all analyzed countries.

The null hypothesis of the test is that there is no cointegration relationship between variables. Thus, the tests show that all countries reject the null hypothesis at a significance level of five percent, both for the trace statistics and the maximum value statistics, thus indicating the existence of at least one cointegration vector for each country. Therefore, comparative estimates are made with the adoption of the VEC model, starting with the number of lags to be included in the model for each country, using selection tests of the system of Autoregressive Vector equations (VAR).

The results obtained were heterogeneous, and most tests point to the ideal of a maximum of one, two, or three lags for each country. However, there are results that point to a greater number of lags, as are the cases of four lags for Canada and the United Kingdom, five for Brazil, Canada, and New Zealand, seven for Mexico

and eight for Chile and the United Kingdom.

In addition to Johansen's cointegration test, a test of the inverse roots of the characteristic polynomial of each country was performed. The results were significant, indicating that the estimated VEC models were stable and empirically robust. Therefore, we estimate the following models for each country, as shown in Table 3.

Table 2. Johansen's cointegration test for all selected countries

Country	Cointegration numbers	Trace Statistics			Maximum Value Statistics		
		Observed	Critical Value 5%	P-Value	Observed	Critical Value 5%	P-Value
Brazil	R = 0	79.729	63.876	0.001	37.283	32.118	0.010
	R ≤ 1	42.445	42.915	0.055	22.342	25.821	0.135
Canada	R = 0	68.845	63.876	0.018	34.790	32.118	0.023
	R ≤ 1	34.054	42.915	0.286	21.699	25.821	0.160
Chile	R = 0	82.648	63.876	0.000	39.838	32.118	0.004
	R ≤ 1	42.810	42.915	0.051	23.440	25.821	0.100
United Kingdom	R = 0	59.614	54.079	0.014	31.038	28.588	0.023
	R ≤ 1	28.575	35.192	0.216	16.182	22.299	0.285
Mexico	R = 0	73.068	63.876	0.006	46.138	32.118	0.000
	R ≤ 1	26.929	42.915	0.685	12.603	25.823	0.832
New Zealand	R = 0	80.573	63.876	0.001	43.583	32.118	0.001
	R ≤ 1	36.986	42.915	0.172	18.999	25.823	0.305

Source: Software EViews 9. Elaborated by the authors.

Table 3. The number of lags used in the model.

Country	Lag
Brazil	19
Canada	17
Chile	26
United Kingdom	8
Mexico	14
New Zealand	21

Source: Software EViews 9. Elaborated by the authors.

Table 3 presents the following considerations. The first is the high number of gaps in developed countries, such as Canada and New Zealand. This option for high numbers of lags did not occur randomly, but rather, respecting the model's estimation, so that the residuals remained well behaved. The second point concerns the

problem of overparameterization, that is, a situation in which the number of estimated parameters exceeds the number of observations. Except for Canada, Chile, and the United Kingdom, the other countries had overparameterization problems. However, this is not especially serious since the purpose of the analysis is to compare the behavior and effectiveness of monetary policy under the ITR.

The next step is to present the results of the Granger causality tests for the block variables, which are often used to assess whether a given variable causes another variable in the Granger sense. The lag selection for this test was based on the information criterion of Akaike (1974) and Schwarz (1978), which always adopts the smallest possible lag between the two criteria. The results are presented in Table 4, which shows only the relationships that reject the null hypothesis of the absence of Granger causality at five percent.

Table 4. Granger causality test for all selected countries.

Country	Lags	Variable	Cause
Brazil	19	CPI	Interest Rate
		Interest Rate	CPI
		Exchange Rate	Interest Rate, CPI
Canada	17	Interest Rate	CPI
		GDP	Interest Rate, CPI
		CPI	Interest Rate
Chile	26	CPI	Interest Rate, GDP
		GDP	Interest Rate
		Interest Rate	CPI
		Exchange Rate	CPI
United Kingdom	8	CPI	Interest Rate
		Interest Rate	CPI
		GDP	Exchange Rate
Mexico	14	Exchange Rate	CPI
		CPI	Exchange Rate
New Zealand	21	Interest Rate	GDP
		GDP	CPI
		CPI	GDP
		Exchange Rate	CPI, GDP

Source: Software EViews 9. Elaborated by the authors.

Table 4 shows the following: 1) in general, the interest rate helps to predict the CPI—that is, the test specifically shows that there is a causal relationship between interest rates and price levels; and 2) there is a relationship between exchange rate and CPI, given that exchange rate can influence the price level via pass-through.

After presenting the Granger test for all countries, we sought to highlight the cointegration vectors for each country analyzed, as shown in Table 5.

Table 5. Cointegration Vector for all selected countries*.

Country	Normalized Cointegration Vector				
	Interest Rate (−1)	C	CPI (−1)	GDP (−1)	Exchange Rate (−1)
Brazil	1	281.598	23.251	−3.7697	−49.516
	-		(−5.202)	(−2.284)	(−32.21)
	-		[4.469]	[−1.650]	[−1.536]
Canada	1	25.193	−0.5453	0.4167	−5.2600
	-		(−0.679)	(−0.2293)	(−2.1573)
	-		[−0.802]	[1.813]	[−2.437]
Chile	1	−70.30597	−0.59814	0.9093	0.0530
	-		(−0.131)	(−0.166)	(−0.009)
	-		[−4.544]	[5.454]	[5.408]
United Kingdom	1	−6.9157	0.1958	−0.0352	−1.7464
	-		(−0.055)	(−0.090)	(−3.983)
	-		[3.549]	[−0.390]	[−0.438]
Mexico	1	53.473	−0.3572	−0.397	−0.955
	-		(−0.171)	(−0.091)	(−0.194)
	-		[−2.081]	[−4.336]	[−4.914]
New Zealand	1	−121.338	1.9108	0.4081	−44.208
	-		(−0.387)	(−0.142)	(−6.462)
	-		[4.928]	[2.864]	[−6.840]

Source: Software EViews 9. Elaborated by the authors. Note: (*) Standard deviation in parentheses and t-statistic in brackets.

Based on Table 5, it is possible to interpret the cointegration equations as a reaction function of each central bank for each country in the long run. The equations were normalized for the variable of interest, which could compromise the interpretation of the magnitude of the estimated coefficients for each country. However, what matters is that the interest rate is an endogenous variable and depends directly and positively on three other variables: CPI, GDP, and exchange rate. In summary, the signs of the parameters of the equations are consistent with the results.

3.3. The ITR Performance: A Comparative Analysis of All Selected Countries

This subsection aims to verify the effectiveness of the monetary policy, that is, in

the sense of how the management of the interest rate affects the price level. To this end, we analyze the responses of the CPI variable to a positive shock (Generalized One Standard Deviation Innovations) on the interest rate, using impulse response function (IRF).

For each country, an increase in the interest rate receives a positive response to the price level. For comparative purposes, **Figures 1-3** present the results of the countries in which the price level responds partially, moderately and explosively, respectively, when the interest rate increases.

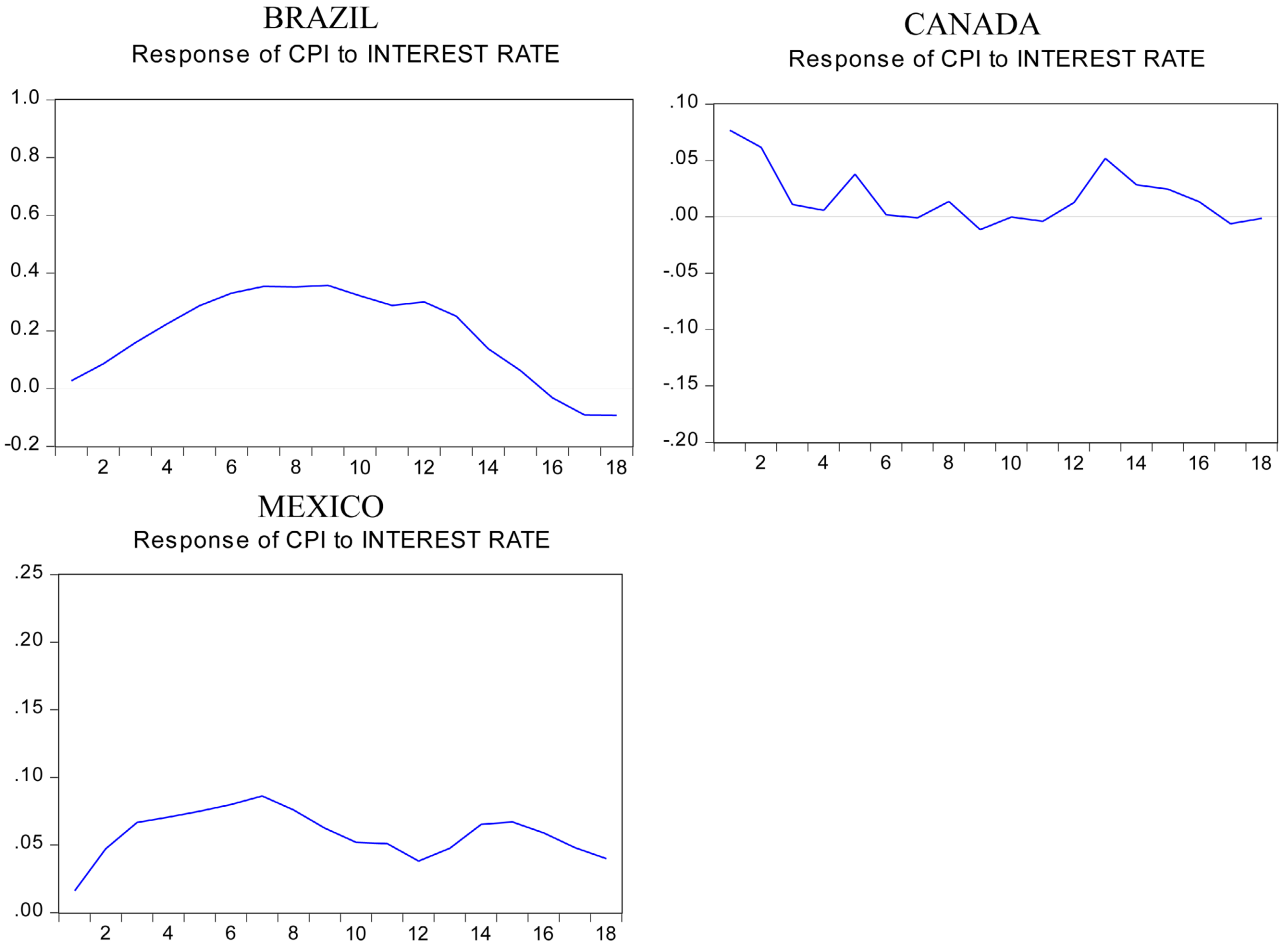

Figure 1. IRF for countries where the price level responds partially when the interest rate increases. (Source: Software EViews 9. Elaborated by the authors)

The results for Brazil show that the price response to a restrictive monetary policy (increase in interest rates) presents a declining and negative trajectory only in period 13. Moreover, the response to a contractionary monetary policy is followed by an initial rise in inflation, with a decreasing trajectory.

There are cases in which the IRF gave results that are counterintuitive to what is expected from a restrictive monetary policy. These results were expected given the complexity of a comparative empirical exercise in which there are intrinsic differences for each country. In Chile, the effect of a restrictive monetary policy is

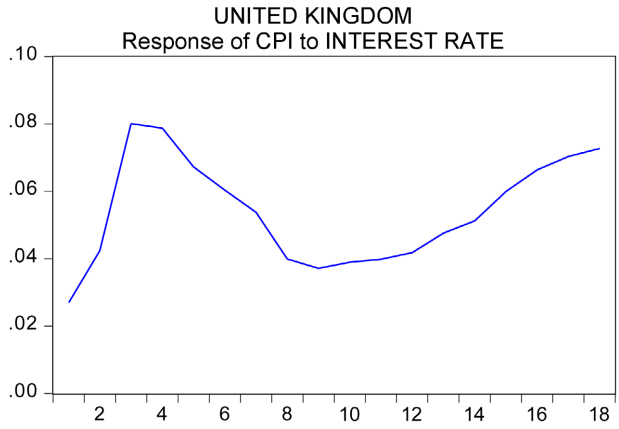

Figure 2. IRF for the United Kingdom where the price level responds with a moderate increase when the interest rate increases. (Source: Software EViews 9. Elaborated by the authors)

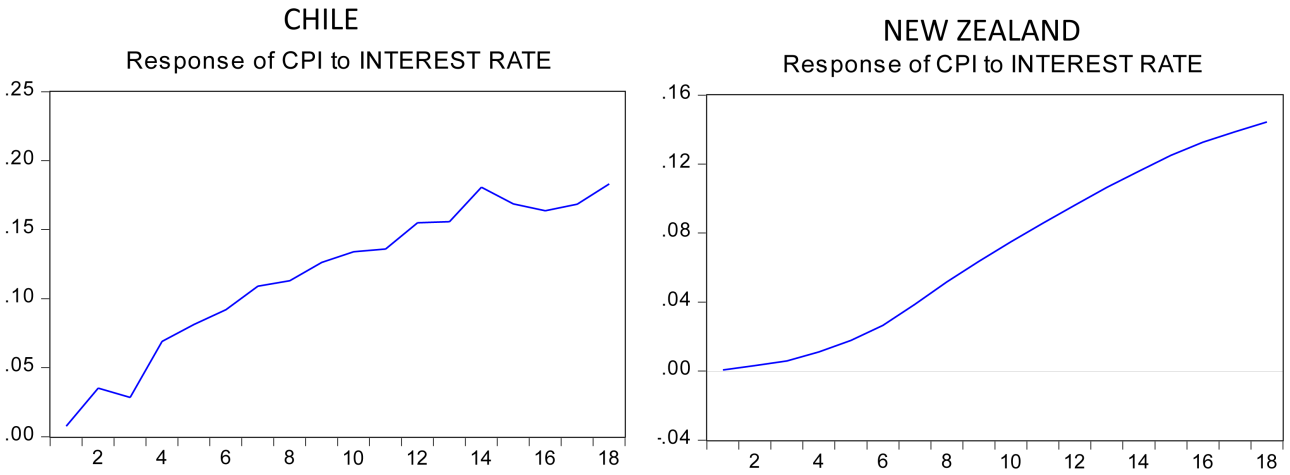

Figure 3. IRF for countries where the price level responds explosively when the interest rate increases. (Source: Software EViews 9. Elaborated by the authors)

a permanent increase in inflation, while in New Zealand, the effect is a huge increase in inflation.

Chile, New Zealand and the United Kingdom registered very low inflation rates over almost the entire period and the increase in inflation in the last years of the sample was followed by increases in interest rates, which explains the positive relationship between inflation and interest rates.

In the case of Canada, although the relationship between interest rate and inflation is economically significant, due to the negative relationship between the two variables, the coefficient of interest rate was not significant in the long-term function and in the IRF, which cuts the zero axis at a few moments. Perhaps the low variability of interest rates in Canada is an explanation for this, as for almost 10 years, interest rates have not changed in the country.

In the case of Mexico and Brazil, interest rates and inflation are higher and more volatile and, therefore, the negative relationship between interest and inflation is confirmed.

Although this subsection has explored only the price level responds to the interest rate, the other IRFs, such as interest rate to exchange rate, CPI to interest rate, CPI to exchange rate, GDP to interest rate, GDP to exchange rate and exchange rate to interest rate, for all countries, are shown in the Appendix.

To sum up, the analysis of the empirical results presented indicates that the ITR, by itself, does not seem to be an efficient regime to guarantee price stability in the selected economies. There are, at least, two reasons: 1) In developed countries of our sample, despite the fact that these economies have more exchange rate flexibility, central bank independence, and higher level of financial development, that are some important conditions to adopt the ITR (Petrevski, 2023), the relationship between inflation and interest rates was not economically significant in the estimated models; and 2) In developing countries, specifically Brazil and Mexico, despite the negative effects of interest rate shocks on inflation, the inflation rate, in the last years, has been higher than most developed and developing economies, and it also has been noted that the trajectory of the GDP, in these two countries, exhibited lower growth rate than that of the world economy, most of the time (see, for instance, IMF, 2024). Exploring the second reason, it is important to mention that, historically, the exogenous shocks played a relevant role in explaining inflation in Brazil and Mexico, namely, the commodity index and exchange rates, among others. Thus, considering that the ITR supposes that inflation rate is a consequence of a demand-pull situation, therefore increasing the interest rate to mitigate the negative impacts of exogenous shocks ends up leading to suboptimal results.

4. Conclusion

This article presents a comparative analysis of six countries that adopted the ITR, evaluating the efficiency of such a regime for the period 1990-2020. From an empirical point of view, this contribution is based on the estimation of the VEC models. The results obtained in the sample of the analyzed countries indicated that in some countries, the ITR was not completely successful, mainly in developing countries, in reducing and stabilizing the inflationary process. The reason for the "failure" of ITR in developing countries is related to the fact that, in these countries, inflation is not necessarily demand-driven, as it is supposed by ITR, but rather supply and exogenous shocks. For instance, looking specifically at the Brazilian case, it is notable that over the period 1999-2020, the targets were missed in 2001, 2002, 2003, 2004, 2015 and 2020, while in 16 years, the inflation rate rates were greater than the inflation targets set by the CBB. From our point of view, this finding must be associated with both the structural and institutional features of each country and the limits of the theoretical framework on which ITR is based. Thus, in the case of Brazil, non-traditional instruments, such as foreign exchange interventions, could be important to reduce and keep inflation under control, imposing less sacrifice on the economy, that is, in terms of GDP growth and unemployment.

Finally, the contribution of the article to the empirical literature related to the

analysis of ITR is its diverse sample, not only temporally and geographically, but also for having covered both periods of prosperity and economic recession.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

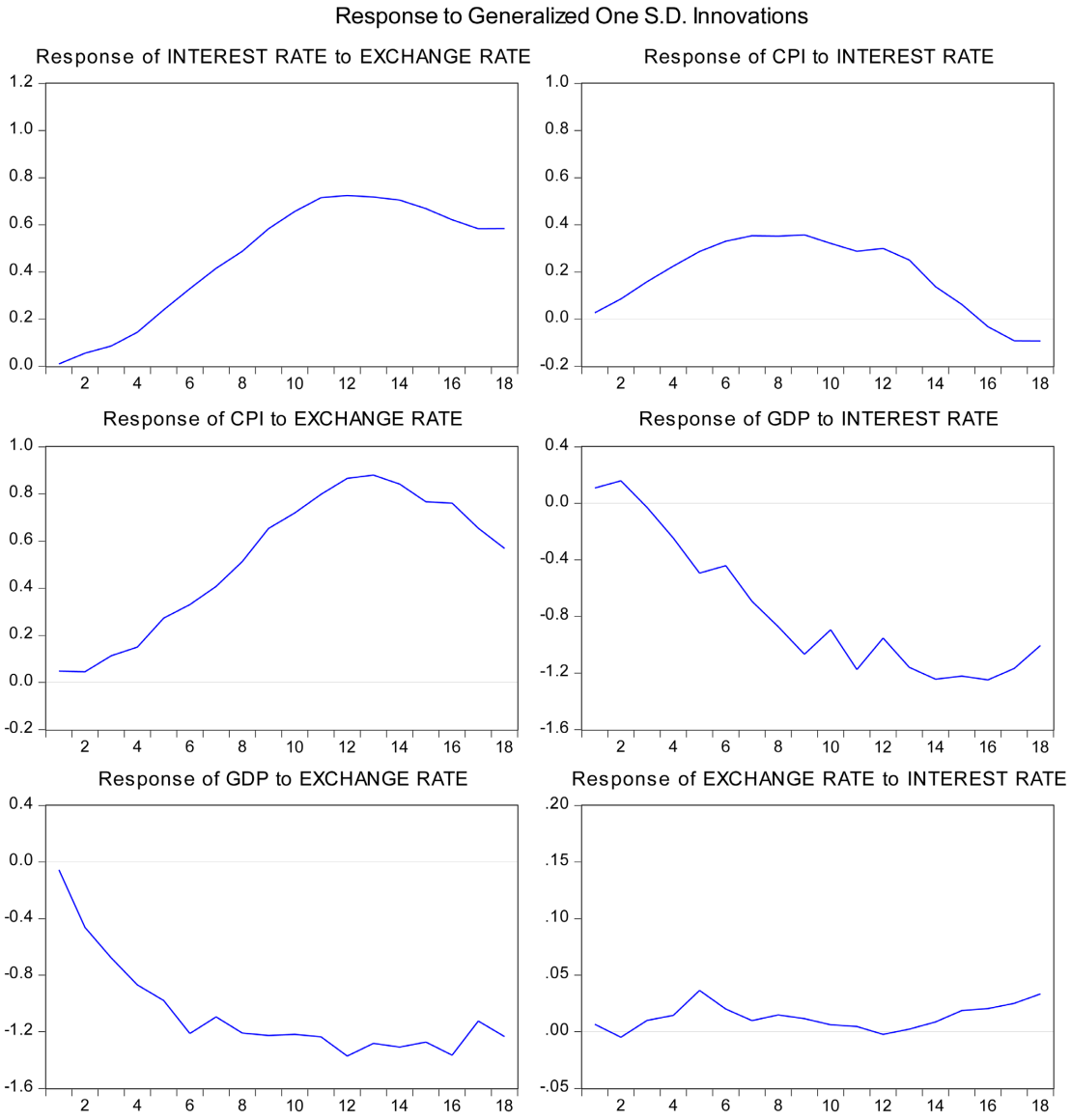
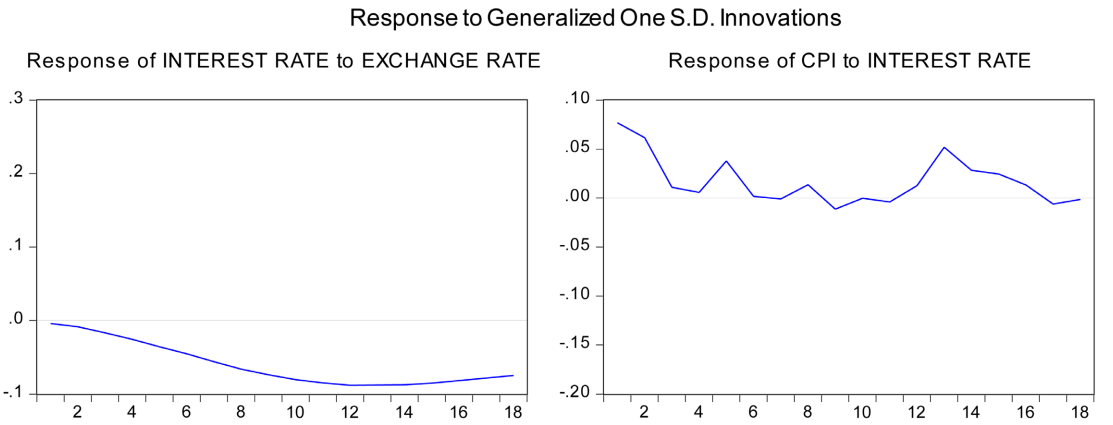


Figure A1. IRF to Brazil.



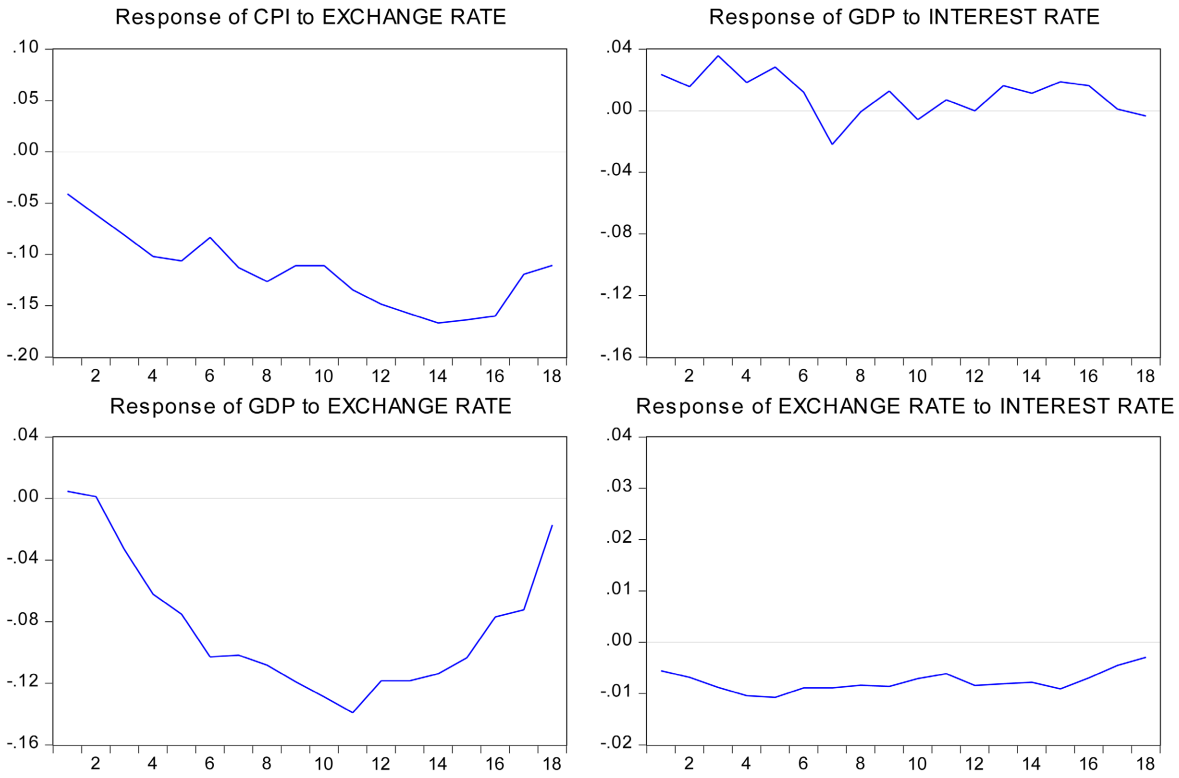
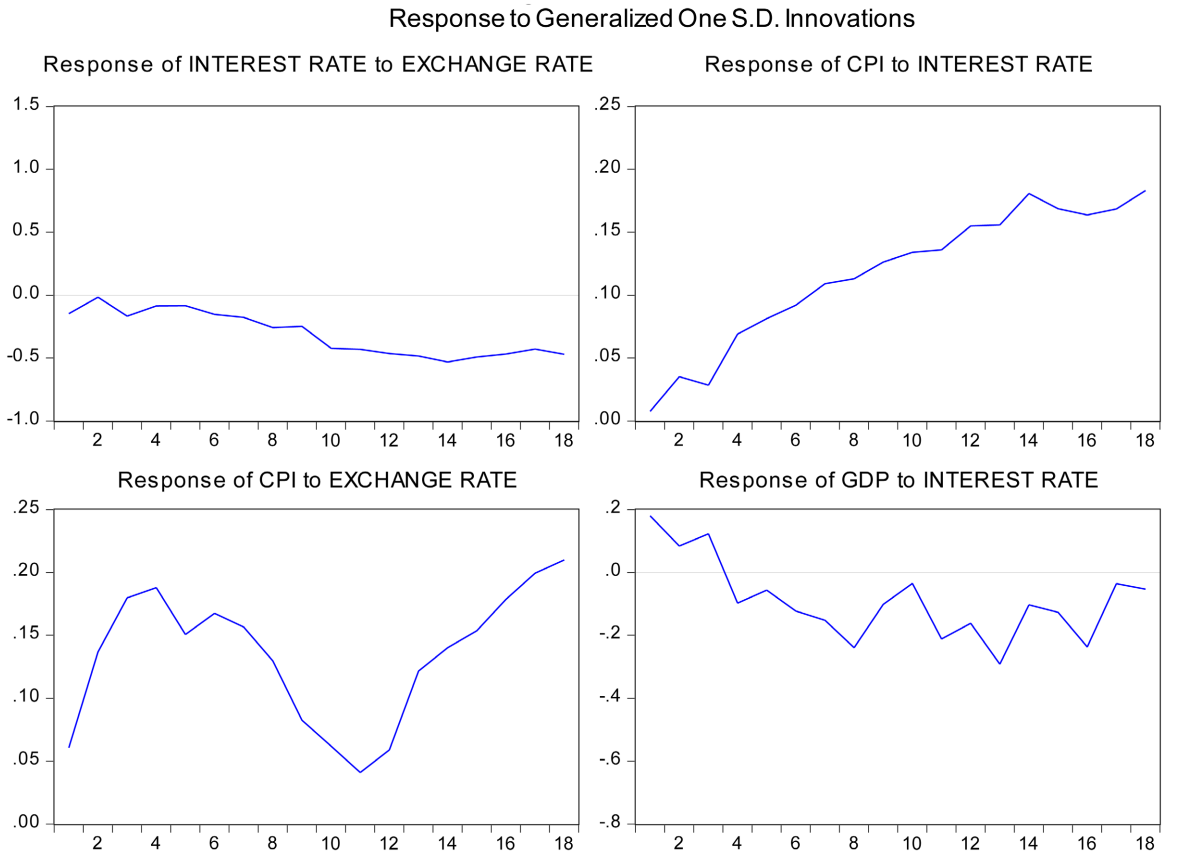
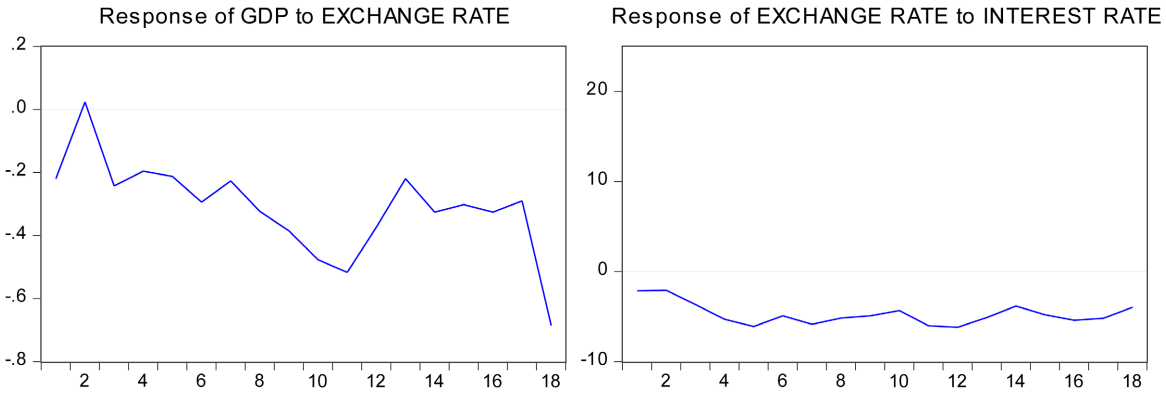


Figure A2. IRF to Canada.





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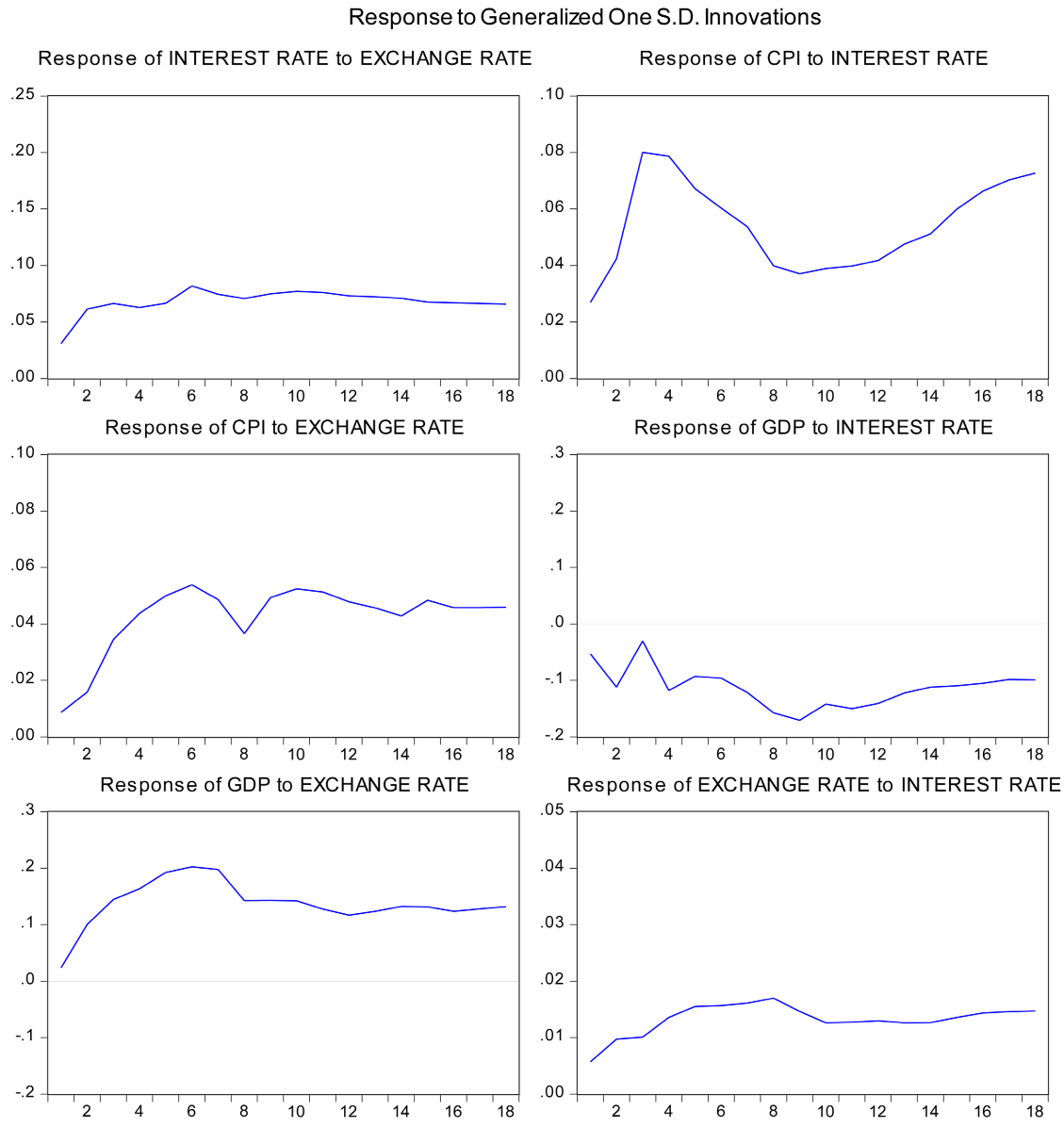
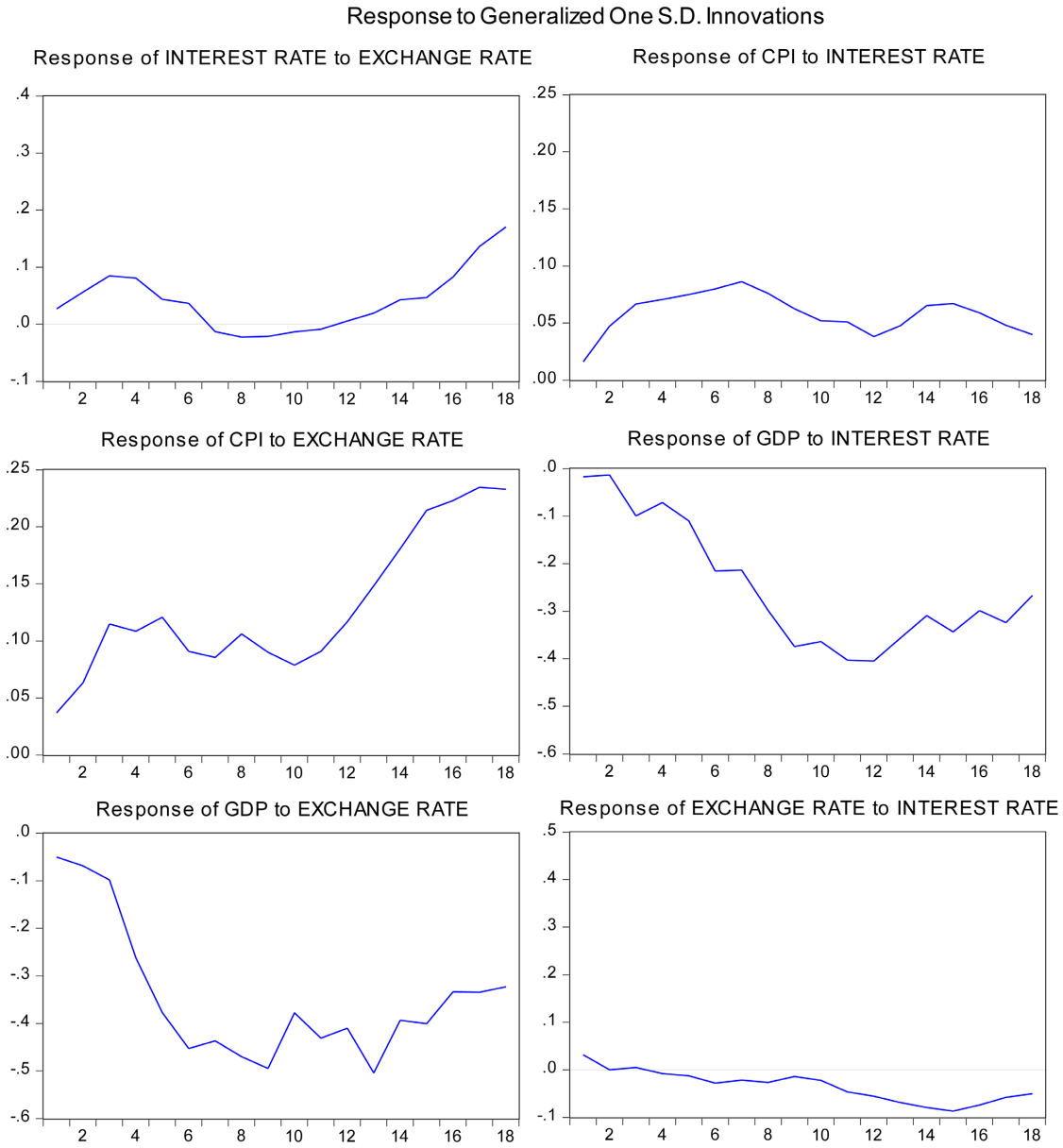


Figure A4. IRF to United Kingdom.



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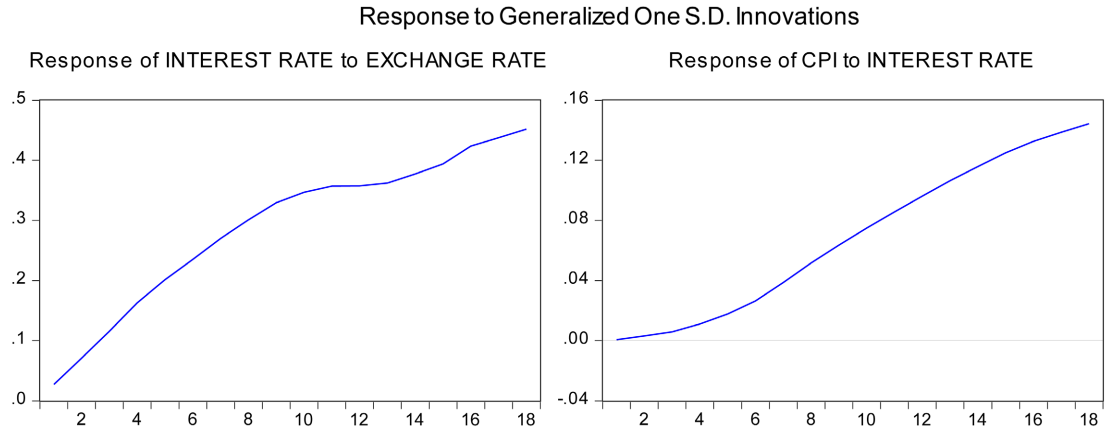

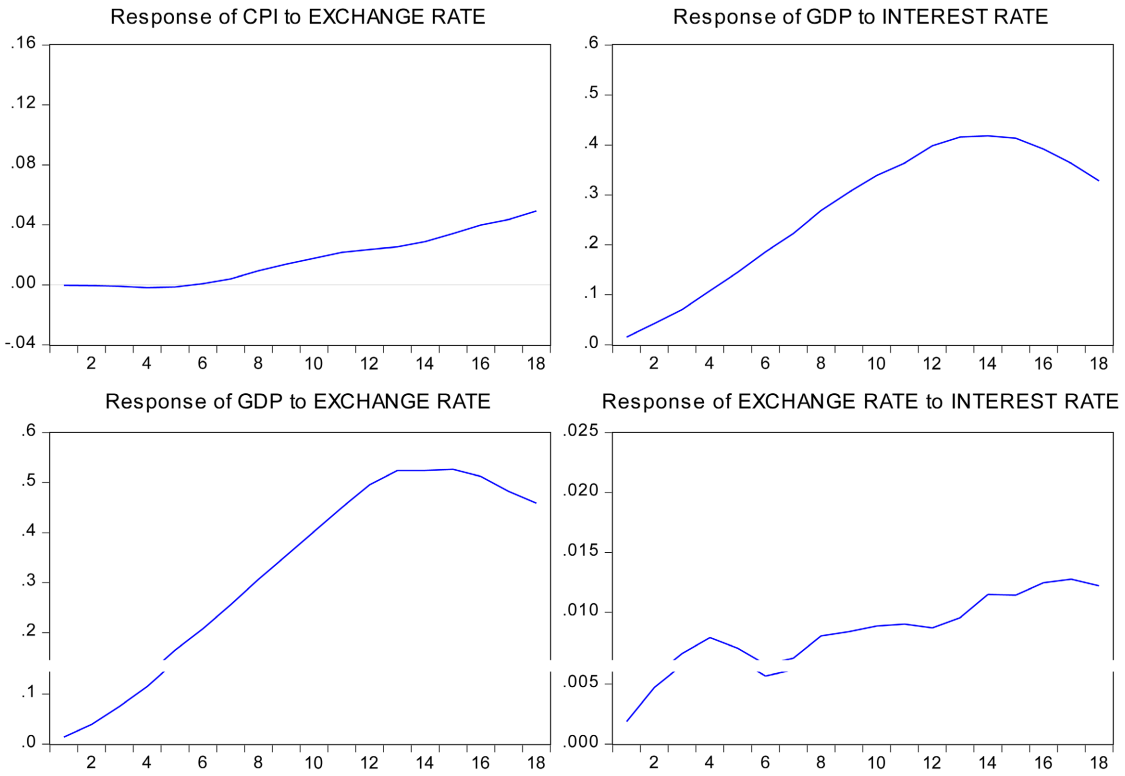

Figure A6. IRF to New Zealand.