Inflation Targeting Venezuela's Hyperinflation

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Abstract

In recent decades, an increasing number of countries have adopted inflation targeting (IT) as a framework for monetary policy, wherein the country's central bank attempts to steer actual inflation toward a projected target rate. However, the question still remains whether or not IT can work in low-income countries experiencing hyperinflation, such as Venezuela. One of the main challenges facing such countries is the lack of credibility of their monetary institutions. Inflation targeting may help restore this credibility by committing the central bank to a transparent and accountable monetary policy. This paper delves into the theory of inflation targeting, examines the benefits and challenges associated with IT, and discusses the specific challenges that Venezuela may face when adopting IT. The paper also emphasizes the importance of accurate economic data in developing effective monetary policies and argues that forecasting can play a critical role in predicting the effectiveness of IT in Venezuela. Empirical evidence from other countries that have implemented inflation targeting will also be used to provide insights into the potential benefits and challenges of this policy for Venezuela.

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1   Introduction

In recent decades, an increasing number of countries have adopted inflation targeting (IT) as a framework for monetary policy. A country's central bank chooses a target inflation rate and attempts to steer inflation toward that target. It also forecasts the future path of inflation and analyzes the extent to which the current policy helps to achieve that goal. One of the key benefits of inflation targeting is that it can help to anchor inflation expectations, which can be an important factor in shaping inflation outcomes. By setting a clear and transparent inflation target, central banks can help to prevent expectations of high inflation from becoming embedded in the economy, which can lead to a self-fulfilling cycle of rising prices (Hale, 2015).

A considerable number of developing countries have introduced the IT regime successfully as an anchor to their respective monetary policies. Specifically, Latin American countries such as Brazil and Chile have shown economic stability and overall success after the implementation of IT regimes (Barajas, Steiner, Villar, and Pabon, 2014). Afterward, not only have the inflation rates in these countries followed a declining trend, but also their overall markets were free from any crises due to elevated prices. In Peru, for example, the annual inflation rate declined from over 20 percent to 3 percent in ten years since the adoption of the IT framework in 2001 (García-Solanes and Torrejón-Flores, 2012). In both these papers, it is evident that IT has been successful in reducing inflation in most countries in the region, although there is some variation in the speed and extent of inflation convergence.

Using this prior history with inflation targeting, it is important to explore how this regime can be implemented in other countries and, if so, whether there would be any significant changes to the health of their economies. Although a few Latin American countries have been the first to show the effectiveness of IT regimes, it is desirable to see how IT

regimes could impact the inflation rates of a country with hyperinflation and volatile inflation rates. One such country is Venezuela because it has been experiencing tumultuous inflation since the early 80s and hyperinflation since Nicolas Maduro came into power in 2014. Consequently, it is crucial that we emphasize the key factors that are responsible for Venezuela's economic crisis and hyperinflation, rooted mainly in the country's over-reliance on oil exports as well as the profligate and corrupt practices of the government.

1.1 Venezuela's Tumultuous Past and Present

The narrative begins in the 1970s, during which Venezuela boasted the largest oil reserves worldwide and was recognized as the wealthiest Latin American country. The country's fortunes improved further with the election of Hugo Chávez as president in 1998, as global oil prices surged over 100 dollars per barrel, resulting in increased wealth for Venezuela. With robust financial backing, the government invested export earnings in reducing inequality and poverty in the economy, leading to significant progress in areas such as the child mortality rate and the poverty rate. However, the government's spending obligations grew too high and ultimately unsustainable, from health initiatives such as Mission Barrio Adentro to literacy programs like Mission Robinson. In 2014, when oil prices plummeted, demand for the Venezuelan Bolivar crashed, causing the economy to spiral into a crisis. Regrettably, President Nicolás Maduro's solution, despite economists' disapproval, was to print money profusely. While this method succeeded in financing government spending in the short term, the fall in oil prices drove international investors away and exacerbated the issue. Consequently, the government triggered a vicious cycle: as prices soared, it printed more money to fund spending, resulting in one of the most severe episodes of hyperinflation in history.

To put it lightly, the state of the Venezuelan economy in the early days of Maduro's presidency was dire. According to reporting by the Peterson Institute for International Economics, the fiscal deficit in 2018 was estimated to be around 15 percent of GDP. (Huertas, 2019). Furthermore, extreme levels of money creation in the past year, driven by the government's spending needs, caused the monetary base to grow by over 73,000 percent, as shown in Figure 1. Inflation had been accelerating since mid-2017, which further worsened the already extreme price spiral. In addition, extreme inflation had led Venezuelans to avoid holding real money balances in their own currency, exacerbating the increase in the price level. As shown in Figure 2, the monetary base, expressed in real terms at the beginning of 2019 was less than one-tenth of what it had been in early 2011 due to a collapse in money demand. Overall, the economy suffered from high inflation and a drastic drop in the value of the Bolívar Soberano.

Figure 1: Monthly inflation rate and Growth of Monetary Base, January 2011–May 2019
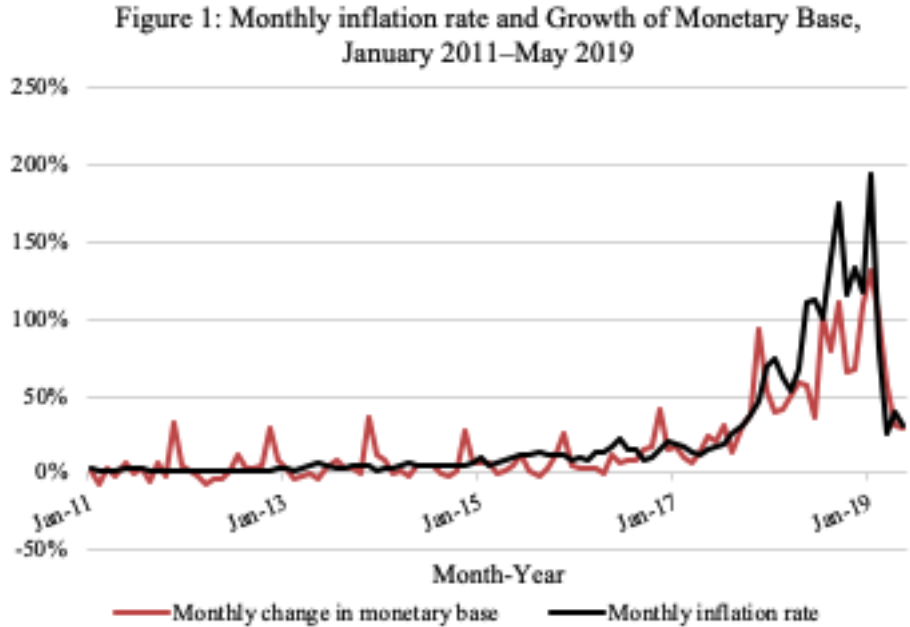
Source: Peterson Institute for International Economics

Figure 2: Real Monetary Base in Venezuela, January 2011–May 2019

Source: Peterson Institute for International Economics

The impact of the Venezuelan government's increased money supply to fund spending can be seen more closely in an LRAS-AD diagram, shown in Figure 3, where inflation is affected by the variables in the aggregate demand equation (AD = Consumption + Investment + Government Spending + (Exports - Imports)). The increase in money supply causes AD to shift rightward, resulting in a larger real output and a movement from point E0 to E1. However, high inflation leads to several costs, including shoe leather costs, menu costs, wealth redistribution, erosion of purchasing power, and widespread uncertainty, which shift the long-run average supply (LRAS) curve leftward, decrease investment and consumption in AD, and reduce the size of the labor force due to significant emigration. Despite investment and consumption in AD decreasing, government spending and exports grow strongly due to a weaker Venezuelan Bolivar, causing AD to shift further upward. The combined effect of leftward LRAS and upward AD shifts lead to a spiral of hyperinflation and massive drops in real

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gross domestic product over time, as seen in the past few years in Venezuela (Chandak, 2020).

Figure 3: The Link between Monetary Growth and Inflation in Venezuela
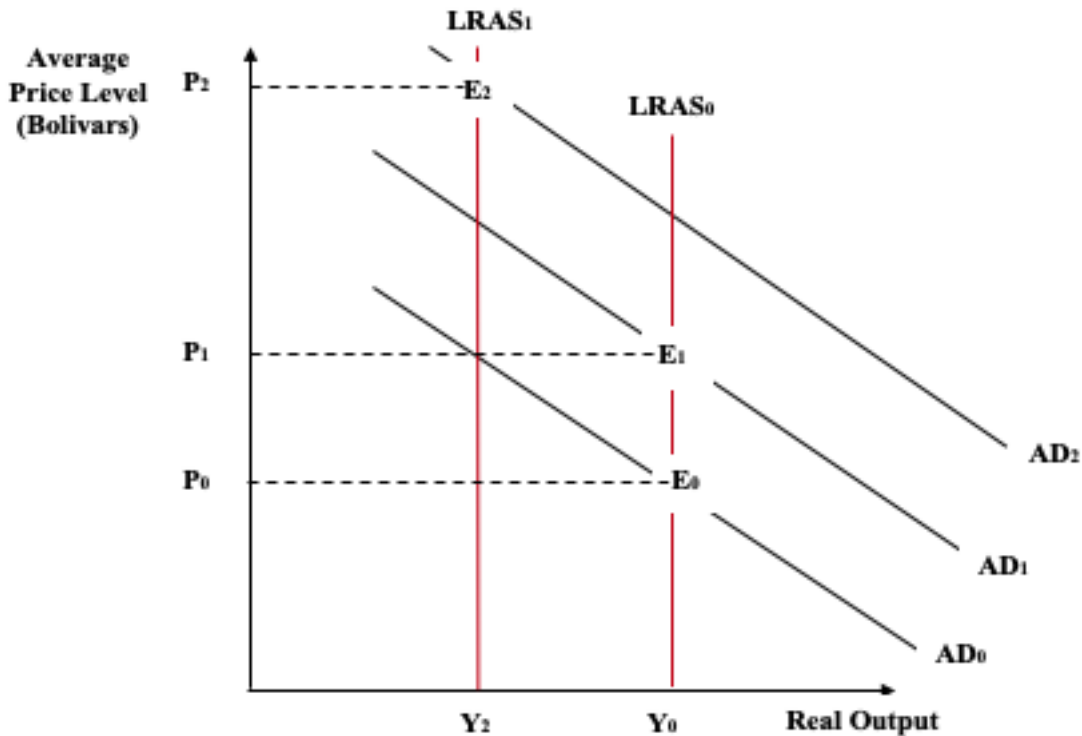
Source: World Affairs: The Journal of International Issues, Summer 2020

In an attempt to stabilize inflation, the Venezuelan government implemented a mix of fiscal, monetary, and exchange rate policies in early 2019. This included cutting government spending, increasing taxes, shortening tax collection lags, increasing banking reserve ratios, and removing some controls on access to foreign currency while conducting interventions in the foreign exchange market. However, it's difficult to estimate the true effects of these policies as the official budget is unreliable, and there are discretionary "additional credits" from the Treasury that are often undisclosed. Despite reduced imports and tentative reports

from NGOs, it's uncertain if real government expenditures have actually contracted. Monthly price increases did fall from almost 200 percent in January 2019 to 31 percent in May, but hyperinflation resurfaced in July, and weekly rates have remained around 10 percent. Furthermore, the government made changes to the exchange rate system by partially lifting currency controls in 2018, allowing citizens and firms to buy and sell foreign exchange, unifying and devaluing the exchange rate, and introducing a new currency at an informal price. This led to a reduction in the black market spread, but the fixed exchange rate system came under pressure in April 2019, leading to a 57 percent currency devaluation in May, and a move towards a less managed exchange rate system.

Despite these efforts, the corrupt government and financial institutions make it difficult to determine the effectiveness of these policies. Additionally, most of these policies, if implemented alone, will most likely fail to stabilize inflation in the long run.

Given the devastating effects of this economic situation, it is essential to explore potential solutions that could help mitigate the problem. One possible approach is the implementation of an inflation-targeting program. This thesis aims to test the effectiveness of such a program in Venezuela and answer the research question: *"To what extent can implementing an inflation targeting program in Venezuela help reduce the issue of hyperinflation given the country's non-autonomous Central Bank and current policy failures?"* To answer this question, we must focus on understanding the contributing factors in Venezuela and incorporate them into our economic models to test the policy's effectiveness. Specifically, by using data from nearby countries such as Brazil, Colombia, and Peru, we can create a baseline for the impact of inflation targeting on similar economies and use this as a framework to forecast the potential effects on Venezuela.

2   Related Literature

The popularity of the inflation-targeting regime as a nominal anchor for monetary policy has been growing since its initial establishment in New Zealand during the 1990s. This trend has caused many researchers across the world to delve deeper into the theory behind inflation targeting and carefully analyze its contributions to economies of various sizes (Samarina, Terpstra, and De Haan, 2014). This abundant literature in this field has allowed us to form specific questions around issues that still need to be addressed and create new economic tools to help us answer those questions.

In a 2008 paper by Gonçalves and Salles, the authors compared countries' economic performance using a "diff-in-diffs" estimation to a group of 26 emerging economies, 13 of which opted for the inflation targeting framework using data from 1980 to 2005. They investigated whether changes in average inflation, inflation variability, and growth volatility were greater in targeters when compared to non-targeters. Their diff-in-diff regressions are based on the following specification:

$$\Delta X_f^i = C + \beta x^i + \alpha D + \epsilon_t \tag{1}$$

The change in "x" is calculated by subtracting the final and initial values of an economic variable, i. A dummy variable, D, equals 1 when the country inflation targets, and is 0 otherwise. The variable, X_i, takes values of average inflation, inflation volatility (s.d), and growth variability (s.d). They control for the dependent variable by adding the variable as a right-hand side regressor because it might be that if initial inflation is higher, a more significant reduction in the level of this variable might simply be a result of mean reversion and not a direct result of the IT regime. For robustness, they experimented with their model

using three different initial periods (1980, 1985, 1990). The authors find that the average inflation rate in the sample of IT countries declined from 22 percent in the pre-IT period to 7.4 percent in the post-IT period. The paper does provide evidence that IT has been effective in reducing inflation in emerging economies, but it has not had a significant impact on output volatility.

The paper also has several limitations. Firstly, it only focuses on inflation targeting in emerging economies, neglecting to explore its effectiveness in developed economies. Secondly, the reliance on cross-sectional data may not accurately capture the dynamic nature of inflation and the economy over time. Thirdly, the paper does not consider the potential impact of external shocks on inflation rates, which can significantly impact the effectiveness of inflation targeting. In addition, the assumption of a stable relationship between inflation and its determinants may not always hold true in practice. Furthermore, the paper does not account for political economy constraints that may limit the effectiveness of inflation targeting in certain countries. Lastly, although the paper acknowledges that there may be other factors beyond those included in the model that contributes to inflation rates, it does not explore these factors in depth.

The authors conclude that despite the limitations of their study, inflation targeting can still be an effective monetary policy tool in some emerging economies. However, they note that further research is needed to fully understand the heterogeneity in the effectiveness of inflation targeting across countries and to identify the specific factors that contribute to successful IT implementation.

In a 2020 paper by Morozumi, Bleaney, and Mumuni, they looked at the effects of an IT regime in low-income countries (LIC) as compared to emerging market economies (EMC). Firstly, they find that IT is not effective in reducing inflation in LI countries. They

use the previously established fact that IT regimes are less effective in HICs than in EMCs to conclude that the "effectiveness of IT and income levels are non-monotonic (situation-dependent). They support their initial findings by paying attention to the central bank's instrument independence. The authors show that when CB independence is low, IT loses its effectiveness in reducing inflation rates. To examine the role of income levels in the effectiveness of IT, they apply a panel regression method wherein they use 3 main models:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \sum_{i}^{n} \theta z_{i,j,t} + \mu_{i,t} + \gamma_i t + \epsilon \tag{2}$$

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta_1 LIC * IT_{i,t} + \beta_2 EMC * IT_{i,t} + \beta_3 HIC * IT_{i,t} + \sum_{i}^{n} \theta z_{i,j,t} + \mu_{i,t} + \gamma_i t + \epsilon \tag{3}$$

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \delta y_{i,t} + \zeta y_{i,t} IT_{i,t} + \omega_1 y_{i,t}^2 + \omega_2 y_{i,t}^2 + \sum_{i}^{n} \theta z_{i,j,t} + \mu_{i,t} + \gamma_i t + \epsilon \tag{4}$$

Model (2) is the standard approach to test for an IT effect. Model (3) allows them to investigate how the effects of IT may differ across different income groups and Model (4) is used as a complement to the second model to more robustly show the relation between IT effects and income levels.

The paper highlights two key takeaways regarding inflation targeting in low-income countries (LICs). Firstly, the authors note that implementing inflation targeting in LICs can be challenging, particularly when central bank independence is low and governments are highly corrupt. The effectiveness of inflation targeting in reducing inflation rates is reduced

in such cases, suggesting that institutional reforms may be necessary to support successful IT implementation. Secondly, LICs typically have underdeveloped financial systems, which can make it difficult for the central bank to control the money supply and interest rates. This can limit the effectiveness of inflation targeting as a tool for managing inflation. The authors suggest that policies to develop the financial sector, such as improving access to credit and strengthening financial regulation, can help to overcome these challenges and support successful IT implementation in LICs. However, a key limitation of this paper is that it does not account for the potential impact of exogenous shocks on inflation rates, which can significantly impact the effectiveness of inflation targeting.

Overall, the paper highlights the challenges of implementing IT in LICs and suggests that alternative policy frameworks may be more effective in these countries. The authors call for further research to better understand the factors that contribute to the effectiveness of IT in LICs and to identify alternative policy frameworks that may be better suited to the institutional and economic constraints facing these countries.

A third paper, published in 2011 by (Mollick, Cabral, and Carneiro, 2011), uses data from industrial and emerging economies to assess whether inflation targeting matters for output growth. They conclude that the adoption of a fully-fledged IT regime results in higher real income per capita for these industrial economies. A positive aspect of this and the last paper is that it uses EMCs and HICs as evidence to present their conclusions which will be good for me to present as well. Their proposed model for assessing the role of ITs is as follows:

$$IR_t = \beta_0 + \beta_{1i} + \beta_2 Z_{it} + \beta_3 G_{it} + \beta_4 IT_{it} + Yit - 1 + \epsilon_t \tag{5}$$

The term, $B_{1,i}$ represents a vector of country-specific factors, $Z_{i,t}$ represents a vector of

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explanatory variables, Gi,t represents a vector containing any three measures of globalization (IFI, GEQ, or TO), and $IT_{i,t}$ is a dummy variable that is defined either as IT_{soft} or IT_{full}. The authors define these terms earlier in the paper; IT_{soft} refers to a simple announcement of a numerical target and IT_{full} refers to the adoption of a fully-fledged IT regime in which there exists a public target and commitment to lower inflation. The sign on the IT coefficient will determine if there are positive or negative output effects as a result of IT.

Lastly, a paper published in 1998 by (Kenny and Quinn, 1998), discusses the use of Bayesian VAR models to forecast inflation in Ireland. The money supply, currency rates, interest rates, wages, and oil prices are just a few of the macroeconomic factors the writers utilize to forecast the country's inflation rate. They estimate the VAR model's parameters using Bayesian techniques, and they produce probabilistic inflation projections. The study demonstrates that compared to conventional forecasting techniques, Bayesian VAR models can generate more precise inflation estimates. Their proposed model for forecasting inflation is given in Equation 6, where the inflation rate is regressed on the different explanatory variables mentioned previously.

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + B X_t + \epsilon_t \tag{6}$$

The related literature shows an emphasis on the effectiveness of inflation targeting in emerging market economies. The 2020 paper shows that inflation targeting does not seem to help low-income countries. Venezuela, where 65 percent of the population lives below the poverty line, is considered a low-income country. Assessing the impact of IT in a low-income country with hyperinflation will be a challenging task due to the difficulty in accurately forecasting the actual inflation trend. To create a feasible model with reasonable estimates, it is imperative to consider the relatively important economic variables when evaluating the

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effectiveness of IT implementations. The 1998 paper provides a reasonable framework for using relevant variables within a VAR model to predict inflation within a country.

By exploring the impact of IT in LICs with hyperinflation, researchers can help to identify the factors that contribute to the effectiveness of IT in different economic environments. This can help to refine our understanding of the conditions under which IT is most effective and the factors that may limit its effectiveness in certain contexts. Since the related literature stems away from addressing the issue of hyperinflation, I plan to contribute to this field by exploring the extent to which IT impacts tumultuous and high inflationary trends.

3 Background, Data, and Methods

To answer the proposed question stated in Section 1, there needs to be an extensive analysis of the data for the countries of interest. The previous literature, outlined in Section 2, offers insights into how certain variables affect these different groups of countries and to what extent that information can be used to assess the effectiveness of an IT regime.

The ability to make any claims or suggestions about the issue of hyperinflation in Venezuela will require support from similar countries, both in terms of location and economic stability. The proposed model(s) can be implemented in surrounding South American countries, such as Brazil, Colombia, and Peru. These countries have all adopted IT regimes at different points in time, which makes them good for analysis and comparison. Ideally, the model constructed from this data set should eventually help to give accurate forecasts for Venezuela with and without the proposed implementation.

3.1 Data

3.1.1 Brazil, Colombia, and Peru

In this paper, the inflationary data for Brazil, Colombia, and Peru are panel data with the time period chosen for this study as 1991-2021 (30 years). The data set is divided up into fourths, where each set, representing a country, contains specific data for each year. The specific variables included for each country are as follows: Unemployment Rate (percentage), Real Interest Rate (percentage), Output Growth (percentage), GDP Per Capita (current USD), Labor Force Participation Rate (percentage), and Inflation Rate (percentage). The data for these variables are from the World Bank's Developmental Indicators (WDI), complemented by IMF's World Economic Outlook (WEO) and Statista when WDI does not provide data.

Tables 1-3 below shows the summary statistics (mean, standard deviation, minimum, maximum) for the variables described above for the three countries. (Note: Summary statistics do not include data from Venezuela. Since the VAR model is initially dependent on the data of these three countries, the latter is not included.)

Table 1: Summary Statistics for Brazil

Variable	Observations	Mean	Std. Dev.	Min	Max
UNR	31	8.92	9.09	6.03	14.40
RIR	25	39.37	2.31	17.03	77.61
OUTG	31	2.29	14.73	-3.87	7.53
GDDPC	31	6672.06	2.81	2127.51	1325.39
LFPR	31	65.8271	3419.99	59.63	68.97
INFR	31	181.40	2.317	3.19	2075.88

Table 2: Summary Statistics for Colombia

Variable	Observations	Mean	Std. Dev.	Min	Max
UNR	31	11.49	3.20	7.8	20.52
RIR	31	9.69	6.06	11.13	23.38
OUTG	31	3.35	3.19	7.04	10.56
GDDPC	31	4391.03	2178.54	1456.69	8218.35
LFPR	31	63.37	6.65	45.9	69.48
INFR	31	9.63	8.32	2.02	30.34

Table 3: Summary Statistics for Peru

Variable	Observations	Mean	Std. Dev.	Min	Max
UNR	31	4.29	0.79	3.21	7.18
RIR	31	20.41	11.15	2.35	61.18
OUTG	31	4.35	4.38	-10.95	13.34
GDDPC	31	3952.08	2108.89	1488.03	7023.08
LFPR	31	71.41	7.56	51.17	79.24
INFR	31	21.22	73.63	0.19	409.53

Upon closer examination of the dataset and table above, there seems to be a discrepancy in the number of observations for each of the variables within a specific country. In Brazil, for example, there are 31 data points for each of the variables, except for "RIR", or the real interest rate, which has only 25 data points. There were no records of the Brazilian real

interest rate values either on the databases listed previously or on the Brazilian Central Bank website. Instead of estimating certain numbers or guessing the magnitude, it was decided to omit the data because not doing so could lead to incorrect forecasts. Although not evident from the summary statistics table, there were certain gaps in the dataset. For example, the labor force participation rates were missing from 1994, 2000, and 2010. Since most of these gaps were for a single year and the data was not found in the database, we decided it would be best to average out the participation rates. The above changes can serve as a minor limitation, but this can certainly affect the accuracy of the forecasts and affect any conclusions at the end. Surely, the proposed correction would ensure that the predictions were following the trend in the data and no predictions were completely off by a certain magnitude.

3.1.2   Venezuela

The analysis for the Venezuelan model includes several new variables that will be used in addition to the ones mentioned in the analysis for Brazil, Colombia, and Peru. The data for all these variables will span from 1991 to 2014. The variables used in the Venezuelan model include the Venezuelan exchange rate (EXR), the Venezuelan budget deficit (BD), the total amount of crude oil production in Venezuela (COP), the total amount of Venezuelan crude oil exports (OE), and the broad money growth of the Venezuelan economy (BMG).

Firstly, the Venezuelan exchange rate (EXR) is a crucial variable to include in the revised inflation-targeting model. This rate represents the value of the Venezuelan currency in relation to the US dollar. The inclusion of this variable in the model is important because changes in the exchange rate can significantly impact the domestic price level. This means that the EXR helps to capture the effects of exchange rate changes on domestic prices,

which in turn allows for more accurate policy recommendations to be made based on the inflation targeting model. The data was obtained from St. Louis FRED online data set (St. Louis Fed, 2023).

Secondly, The Venezuelan budget deficit (BD) is also a key variable for the model. The budget deficit represents the amount by which government expenditures exceed revenues, expressed as a percentage of the country's GDP. This inclusion will help the model can better capture the effects of changes in government spending on inflation, especially in a country that is highly dependent on oil exports. This allows for more accurate policy recommendations to be made to stabilize the economy and control inflation. This data was obtained from the International Monetary Fund (IMF) (World Economic Outlook Database, 2023).

Thirdly, Venezuelan crude oil production (COP) and oil exports (OE), both given in millions of barrels, are important variables to include since Venezuela is one of the world's largest oil-producing countries and the country's economy is heavily dependent on oil exports. Therefore, any minor changes in this total amount can significantly affect the country's overall economic growth and inflation rate. The data for these two variables are obtained from the website of the United States Energy Information Administration (EIA) (Energy Information Administration, 2023a) (Energy Information Administration, 2023b).

Lastly, the Venezuelan Broad Money Growth (BMG), represents the growth rate of the total money supply in the economy, including physical currency, demand deposits, and time deposits. When the money supply increases at a faster rate than the production of goods and services, this can lead to an increase in demand, which in turn can lead to higher inflation. Therefore, the model can better capture the effects of changes in the money supply on inflation. The data on the monetary aggregates were obtained from the World Bank

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database (World Bank, 2023). The summary statistics are given in Table 4.

Table 4: Summary Statistics for Venezuela

Variable	Observations	Mean	Std. Dev.	Min	Max
UNR	24	10.00	3.39	6.1	16.78
RIR	24	-2.13	13.41	-35.31	23.09
OUTG	24	2.65	6.41	-8.85	18.29
GDDPC	24	6659.33	4253.52	2643.94	15975.73
LFPR	24	64.03	0.75	61.75	65.03
INFR	24	34.28	20.13	12.53	99.88
EXR	24	-907.87	907.87	4.3	2445
BD	24	-3.01	5.14	-15.6	3.79
COP	24	2.66	0.27	2.22	3.11
OE	24	1.52	0.36	.992	2.19
BMG	24	40.56	19.91	7.37	72.74

3.2 Methodology

To answer the question of whether or not inflation targeting can help Venezuela, we need to first use the variables at our disposal to create a model for forecasting inflation. The standard approach will be to use a "Vector Auto Regressive" model or VAR, where several series are assumed to be functions of their past values. It is important to assume that the errors have zero expected values given the past values of the independent variables in the regression.

The variables described in Section 3.1 all help to predict inflation, or at the very least, explain its trend. To construct the model, we need to test if the included variables "Granger cause" inflation, decide on the number of lags, and determine whether or not first-differenced terms are necessary. The Granger Causality test allows us to confirm that the variables in the regression do help to predict the inflation rate. Since the dataset is longitudinal and includes values for each year, a total of two lags is appropriate for the model. Lastly, it is important to test for the presence of a unit root to see whether or not the time series shows a systematic pattern that is unpredictable. The dickey fuller test can be used to the null hypothesis that a unit root is present in each of these variables. Please refer to Section 4 for the results of these statistical tests. After including the information gathered from these tests and from the theory, the initial construction of the VAR model is as follows:

$$IR_t = \beta_0 + \beta_1 \Delta UNR_{t-1} + \beta_2 \Delta RIR_{t-1} + \beta_3 \Delta GDPPC_{t-1} + \beta_4 \Delta LFPR_{t-1}$$
$$+ \beta_5 OUTG_{t-1} + \beta_6 INFR_{t-1} + \beta_7 IT + \epsilon_t \quad (7)$$

The variables with either t and $t\text{-}1$ as the subscripts denote the value of the variable in the current time or in the previous period. The inflation-causing variables themselves, along with their derivations are defined above. The variable IT is a dummy variable that takes on the value 1 if an IT regime is in place in the specific country and 0 otherwise. It is important to note that the VAR model given by equation (12) will only be used in generating the forecasts for Brazil, Colombia, and Peru. By modeling inflation in similar countries, we are then able to create an improved model for Venezuela that will help us to see how inflation is impacted either with a theoretical IT regime or without one.

In the case of Venezuela, we need to include the additional variables mentioned in

Section 3.1.2 in the VAR model. Then, the improved model is given as follows:

$$IR_t = \beta_0 + \beta_1 \Delta UNR_{t-1} + \beta_2 \Delta RIR_{t-1} + \beta_3 \Delta GDPPC_{t-1} + \beta_4 \Delta LFPR_{t-1}$$

$$+ \beta_5 OUTG_{t-1} + \beta_6 IR_{t-1} + \beta_7 EXR_{t-1} + \beta_8 BD_{t-1} + \beta_9 COP_{t-1}$$

$$+ \beta_{10} OE_{t-1} + \beta_{11} BMG_{t-1} + \beta_{12} IT + \epsilon_t \quad (8)$$

Additionally, Venezuela underwent significant and drastic changes in its social policy after February 2, 1999. The country moved away from the previous government's official stance of adopting a free-market economy and liberalization reform principles toward implementing income redistribution policies and social welfare programs. The changes were strictly enforced once Hugo Chavez regained power after the 2000 election. With these sweeping social policy changes that took place in Venezuela, there was a possibility of implementing monetary policy reform such as inflation targeting around this time. In the inflation targeting model, the period of 1991-1999 will consist of periods where the IT regime has not been implemented, with the dummy variable IT taking on the value 0. From 2000-2014, the dummy variable IT will take on the value 1, indicating that the program has been implemented. Using this model, the inflation rate of the Venezuelan economy will be forecasted across a 24-year timeline from 2000 to 2024 under two scenarios: with inflation targeting and without inflation targeting. This analysis will provide insights into the impact of implementing inflation targeting on the Venezuelan economy's inflation rate over the years.

4   Results

4.1   Analysis of Brazil, Colombia, and Peru

As highlighted in Section 3, making any predictions about the effect of inflation targeting in Venezuela will require the need to analyze inflationary trends in nearby countries. This can be done with the help of forecasting inflation for Brazil, Colombia, and Peru and seeing how well the predictions match the actual inflation trend.

Firstly, the results of the initial statistical tests for the VAR model are important to interpret because they give meaning to the variable transformations in the regression. The results of the Granger Causality test for Brazil between 1991-2021 are given in Table 5 below. *(Note: Although it is not provided, the Granger Test has been done on remaining countries to verify that the same variables help to predict inflation as with Brazil.)*

Table 5: Granger Causality Tests for Brazil, 1991-2021

Variable	Prob >chi2
UNR	0.594
RIR	0.989
OUTG	0.490
GDDPC	0.549
LFPR	0.280

Secondly, the results of the Dickey-Fuller test for Brazil are given in Table 6 below shows that some variables in our regression are stationary. *(Note: The test has also been done for the remaining countries but are not included below.)*

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Table 6: Dickey-Fuller Tests for Brazil, 1991-2021

Variable	Test Statistic
UNR	-0.158
RIR	-1.395
OUTG	-4.159
GDDPC	-1.387
LFPR	-1.542
INFR	-2.358

For the unemployment rate, the test statistic of -0.15 is greater than the critical values provided. For the real interest rate, the test statistic of -1.395 cannot be rejected at the 10 percent level of significance. For the GDP per capita, the test statistic of -1.387 also cannot be rejected at the 10 percent level. For the labor force participation rate, the test statistic of -1.542 is also much greater than the test statistic. Lastly, for the inflation rate, the test statistic of -2.358 is close to the test statistic of -2.624 but is still greater. Therefore, we fail to reject the null hypothesis for these five variables, suggesting that these data are unlikely to contain unit roots. For the output growth variable, the test statistic of -4.159 is less than the 1 percent critical value of -3.716. Thus, we can reject the null hypothesis, suggesting that growth data are not stationary. After taking these results into consideration, four out of five variables previously mentioned are differenced in the regression, with the exception of inflation.
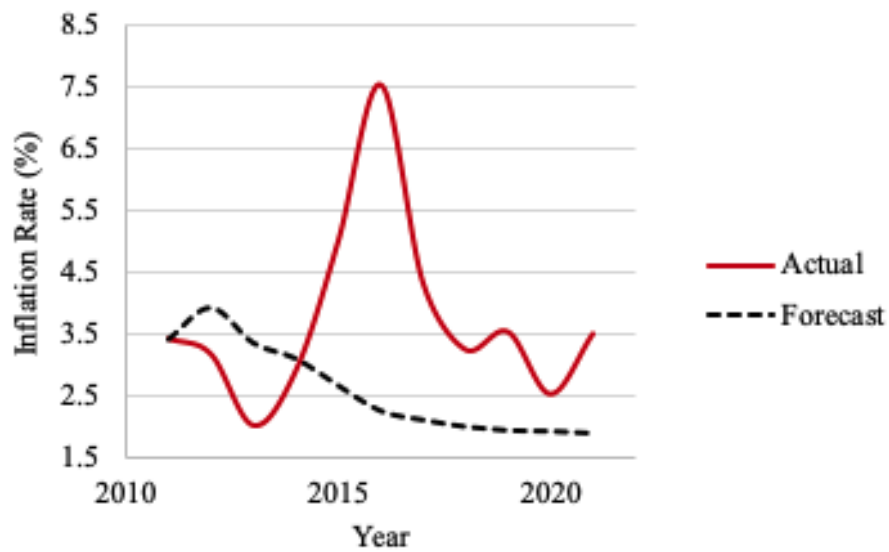
After the specific changes to the VAR model were made, a 10-step ahead forecast was made for Brazil, Colombia, and Peru between 2011 and 2021. Figure 4-6 compares the actual inflation trend with the calculated forecast for these three countries.

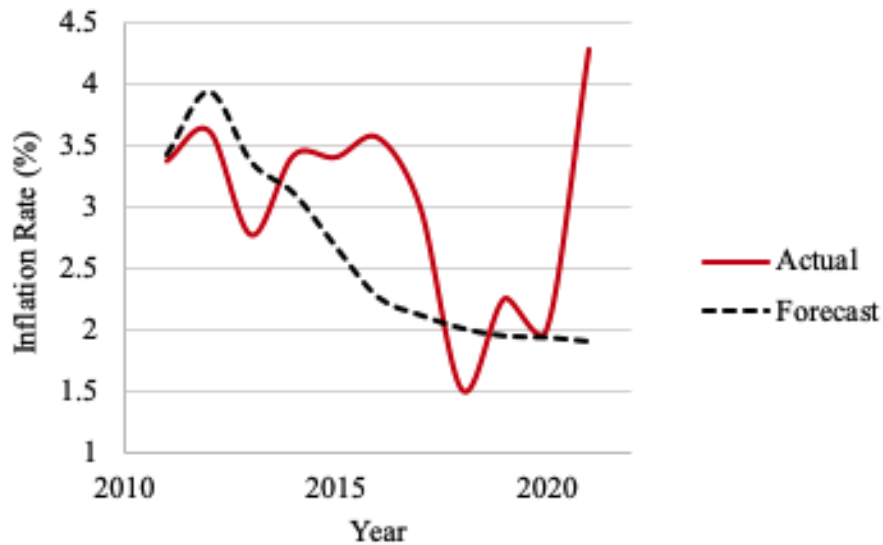## Figure 4: Actual Inflation vs. VAR Forecast for Brazil
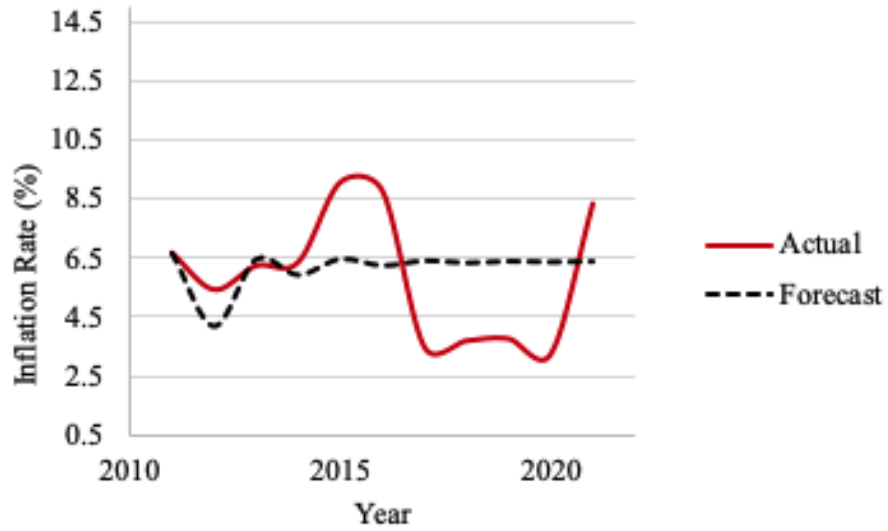
Source: International Monetary Fund

Figure 5: Actual Inflation vs. VAR Forecast for Colombia

Source: International Monetary Fund

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Figure 6: Actual Inflation vs. VAR Forecast for Peru

Source: International Monetary Fund

Overall, the forecasts seem to start with the correct trend, but then it does not seem to perfectly overlay the actual values. This suggests room for improvement in the model, either by removing or adding some variables. Going forward it would be good to include variables for government deficits and exchange rate pegs since these can have a significant impact on the price level as well as the monetary policy of a country. These additions can serve to make our model stronger so that it can start picking up on the fluctuations in inflation, as demonstrated by Brazil and Colombia's trend in the late-90s to early-2000s.

4.2   Analysis of Venezuela

The forecasts for Brazil, Colombia, and Peru all show that the VAR model can be used to predict inflation in these countries with some errors. It now remains to be shown whether or not improvements to this model by the addition of new variables described earlier might improve forecasts for Venezuela. The inflation forecasts with the IT and without the IT
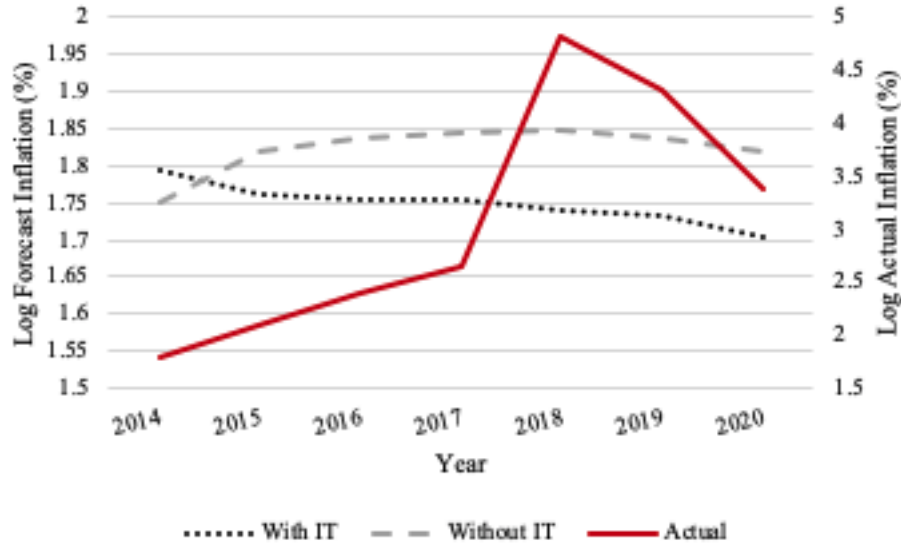
conditions and their comparisons to the actual inflationary trend are shown below in Figure 7. As shown in the legend, the maroon line represents the actual trend, the black dotted line represents the inflation with an IT regime in place, and the gray dashed line represents the inflation rate without an IT regime in place. Although the trend starts in 1999 and ends in 2015, both the forecasts begin in 2000 and continue till 2024.

Figure 7: Venezuelan Inflation Rate with and without IT
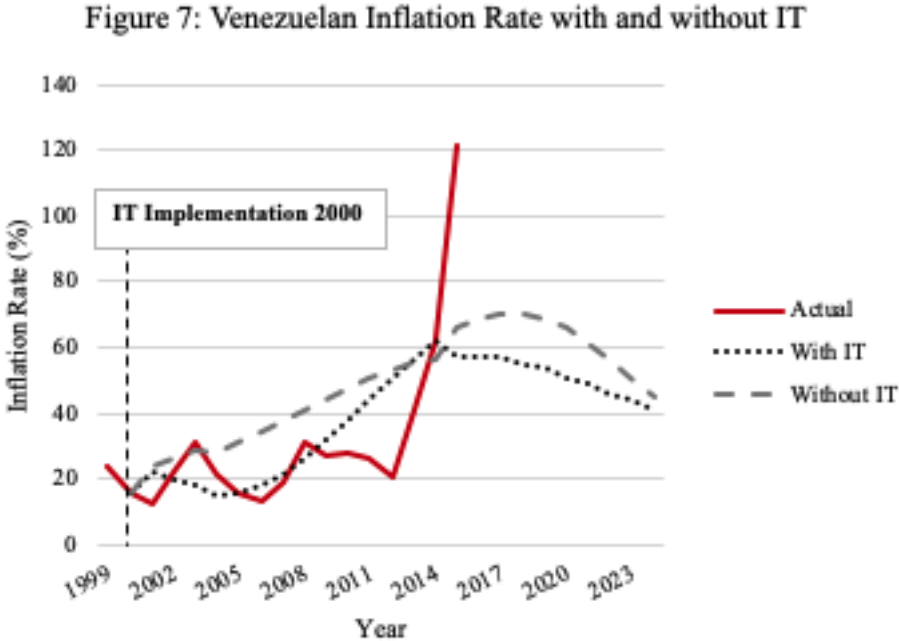
Source: International Monetary Fund, St. Louis Fed, USEIA, World Bank

A closer examination of the trends is given in Figure 8 below. It is important to note two key differences: First, the scaling of this graph is different from the previous one; the vertical axes represent the base-10 logarithm of the inflation rate (actual vs. forecast). Second, the data only spans from 2014 to 2020, also considered the period with the highest increases in the overall price level.

Figure 8: Closer Examination of Venezuelan Inflation Rate with and without IT

.... With IT   — — Without IT   ——— Actual

The first figure clearly shows us that the inflation rate is consistently higher when no IT regime is in place across the 24-year period. As the actual inflation increases uncontrollably, the forecasts show that the growth of prices is less and relatively weaker. The first and second graphs both show that inflation does peak around the 2017–2018 period before experiencing a slower downward trend without the IT regime. Despite the trends being relatively similar, the forecast without IT does not predict the correct magnitude of the actual inflation trend. The model seems to be picking up this increase, but not accurately. This is why the gray logarithmic values are two times less than the maroon logarithmic values. Specifically, forecasting the peak in inflation rates in 2018 proved to be a challenging task due to the omission of certain variables in the second forecasting model. However, the inclusion of variables that explain the rise in inflation indicates that the estimates from this model demonstrate lower inflation rates when inflation targeting is implemented. It is important

to note that there may be other variables that contributed to the increase in inflation rates beyond those included in the model, suggesting that the actual impact of inflation targeting on inflation rates may be even greater. Furthermore, while the trend is consistently lower when inflation targeting is implemented, it is equally likely that inflation rates could be higher than predicted without such policies in place.

All in all, the results do support the idea that implementing an IT regime should help reduce the issue of hyperinflation. Assuming the Maduro government had continued this hypothetical inflation-targeting program from the time he was elected to power, our results show that the price level increase would not have been as abrupt and tumultuous because of a variety of factors. In fact, inflation would experience a downward trend from 63 percent in 2014 to 50 percent in 2020. Nevertheless, we are still unable to make any claims on the magnitude of the decrease in inflation due to the errors associated with the forecasting models described previously.

5 Conclusion

In conclusion, this thesis has analyzed the effectiveness of inflation targeting as a monetary policy tool in the Venezuelan economy. Through the econometric analysis using multiple regressions, it was found that implementing an inflation-targeting regime can help Venezuela in the short term to reduce inflation.

However, it is important to recognize that there may come a point where adding more variables to the econometric models won't necessarily improve the forecast accuracy for the inflationary trend. This is because certain exogenous shocks, such as political instability or external economic events, might be unforecastable or difficult to model accurately.

In order to stabilize hyperinflation in Venezuela, it is important to use a combination of policies rather than relying solely on inflation targeting. While inflation targeting can be an effective tool for reducing inflation, other policies must work in conjunction to create a comprehensive approach to managing inflation and promoting economic stability.

Fiscal adjustments can help to reduce the fiscal deficit and limit the need for the central bank to print money to finance government spending. This can be achieved by reducing government spending and increasing tax revenue. Additionally, financing from abroad can provide the necessary capital to invest in infrastructure and social programs while reducing the burden on domestic resources. Moreover, new exchange rate policies such as a managed float or fixed exchange rate can help to stabilize the value of the currency and reduce the uncertainty that drives inflation.

By combining these policies with inflation targeting, the central bank can signal to the market its commitment to price stability. Fiscal adjustments and financing from abroad can provide the necessary resources to invest in the economy without driving inflation. Furthermore, new exchange rate policies can help to stabilize the currency and reduce the impact of external shocks on the economy.

Looking to the future, continued research in this field can help to shed light on the effectiveness of inflation targeting as a tool for managing inflation in low-income countries such as Venezuela. Specifically, research can focus on how inflation targeting can be used in conjunction with other policy tools to achieve economic stability and growth. By emphasizing the need for a comprehensive approach that involves multiple policy tools, policymakers can better identify the most effective monetary policies to manage inflation and ensure a healthy Venezuelan economy. Ultimately, the successful implementation of these policies will require strong political commitment and cooperation among policymakers, international

organizations, and the private sector.

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Appendices

No additional material is included in this appendix.