Determinants of Inflation in a Dollarized Economy: The Case of Ecuador

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Abstract

In this paper we estimate a structural VAR model to identify the causes of inflation in Ecuador. To examine the VAR dynamics, we use the decomposition of the variance because it provides information about the relative importance of each shock to the variables in the VAR. We differ from previous studies because we are able not only to identify the impact of each exogenous variable on the inflation rate but also to estimate the inflation rate from the exogenous variables in the model. We found that on the first quarter of 2008 the annual inflation rate in Ecuador was mainly caused by international prices, exchange rates and public policy.

Resumen

En este documento se estima un modelo VAR estructural para identificar las causas de la inflación en el Ecuador. La contribución de las variables exógenas en la inflación se analiza utilizando la descomposición de la varianza. A diferencia de estudios anteriores, no sólo se identifica el impacto de cada variable exógena en la tasa de inflación, sino que además se estima la tasa de inflación a partir de las variables exógenas del modelo. Los resultados muestran que en el primer trimestre del 2008 los principales determinantes de la inflación en el Ecuador fueron los precios internacionales, los tipos de cambio y las políticas públicas.

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1 Introduction

Ecuador is a middle income country located between Colombia and Peru, and it is characterized by its geographical and ethnic diversity. In 2007, Ecuador’s per capita GDP was 1,626 in constant 2000 dollars, and its main sources of income are exports of oil and primary commodities, such as bananas, flowers, and shrimp. In early 2000, following a major economic crisis, including high levels of inflation and a severe devaluation of its currency, the government of Ecuador implemented the dollarization of the economy. Inflation dropped after dollarization was implemented from 96.10% in 2000 to less than 8% in 2003. This is seen by many as the main advantage of this process because it helped to stabilize the economy and allowed the country as a whole to experience moderate economic growth. Yet, Ecuador’s income continues to rely on the production and export of raw materials. The problem of dependence on the price of commodities for Ecuador is greater than other countries because precisely the scheme of dollarization, which left the country at the mercy of fluctuations in world market prices. For example, the collapse of oil prices could send Ecuador’s economy into a crisis characterized by inflation, mounting debt service and uncompetitive industries. Because ending high inflation and restoring price stability was one of the main objectives to implement dollarization, a natural question that arises is, what factors can explain the uprising of inflation since September 2007 which has caused the current inflation to reach two digits levels, even though the economy is still dollarized?

To answer this question, we estimate a structural VAR (SVAR) model to identify the main causes of inflation at the aggregate level in Ecuador. The SVAR methodology is used because it can account for endogenous relationships between the variables in the model, and can summarize these empirical relationships without placing too many restrictions on the data. To examine the VAR dynamics, we use the decomposition of the variance because it provides information about the relative importance of each shock to the variables in the VAR. We differ from previous studies because we are able not only to identify the impact of each exogenous variable on the inflation rate, but also to estimate the inflation rate from the exogenous variables in the model.

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1 See Banco Central del Ecuador (2008).
2 Beckerman (2001) argues that are the main factors behind the economic crisis that forced Ecuador to implement the dollarization of the economy are:(a) the dependence of public revenue on volatile oil earnings, (b) the banking system’s exposure to volatile and risky activities, (c) bank borrowers’ exposure to exchange-rate depreciation, (d) inadequate banking supervision, (e) the massive public debt, (f) political fragmentation, (g) weak public administration, and (h) the government’s tendency to revert to energy subsidization.
3 The exogenous variables included in the model were commodity prices, exchange rates, public policy (government spending and wages), weather, freight, and political events (this
We found that on the first quarter of 2008, the inflation rate in Ecuador was mainly caused by international prices, exchange rates and public policy, which explains 62.04%, 18.49% and 7.75% of the inflation rate, respectively. Our results suggest that giving the high significance of commodity prices in Ecuador’s inflationary process, policymakers should conduct microeconomic studies of productive value chains to measure and identify the pass-through mechanisms of each specific commodity price to consumer prices in order to design more appropriate policy interventions aim to fight inflation in Ecuador.

We proceed as follows: First, we describe the VAR methodology and how we estimated the inflation rate from the exogenous variables. The following section, describes the data and the construction of some variables. Then, we discuss the empirical findings for Ecuador. Finally, we conclude.

### 2 Methodology

In order to determine what factors can explain the uprising of inflation in Ecuador, we estimate a structural vector autoregressive model (SVARs). VARs are dynamic systems of equations that examine the inter-relationships between economic variables using minimal assumptions about the underlying structure of the economy. These models focus on deriving a good statistical representation of the interactions between variables, letting the data determine the model. SVARs combine the basic structure of the VARs approach with a number of widely accepted restrictions derived from economic theory used on traditional macroeconomic modeling.

There are many applications in the literature that use these models to empirically determine the mains causes of inflation. Examples of this work include estudies by Dhakal et al. (1994), who uses a vector autoregressive model that includes major variables interacting with the price level in the economy, and found that changes in the money supply, the wage rate, the budget deficit and energy prices are important determinants of the inflation rate in the United States. LLosa, Tuesta and Vega (2005) applied a simple variable takes the the value of one in each of those months where elections took place and/or there was political instability.)

4VAR models were first introduced by Sims (1980), who showed that these models provide a coherent and credible approach to data description, forecasting, structural inference, and policy analysis. His key insight was that the effect of policy interventions could be analyzed by examining the moving average representation relating macroeconomic reality (outcome variables of interest) directly to the structural economic shocks.

5See Stock and Watson (2005) for a complete discussion.
non-structural Bayesian VAR forecasting framework to predict key Peruvian macroeconomic data, in particular, inflation and output for Peru. Lack (2006) used a VAR model in order to forecast Swiss consumer price inflation. He found that bank loans and the monetary aggregate M3 are the most important variables for inflation forecasting in Switzerland. Pincheira and Garcia (2007) evaluate the inflationary impact of an oil shock on several components of the consumer price index for nine industrialized countries and Chile. They found that a significant response in headline inflation, energy inflation and non-core inflation on all countries and Chile’s inflationary response is one of the highest and most persistent in their sample. The Bank of England uses VAR models to produce forecasts of economic variables (especially inflation), and to examine the effects of economic shocks on the economy (Bank of England 1999).6

A basic VAR system can be expressed in the following form:7

\[ X_t = \sum_{i=1}^{r} A_i X_{t-i} + \sum_{j=1}^{s} \beta_j W_{t-j} + \varepsilon_t \]  

(1)

where \( X_{t-i} \) denotes the inflation rate of the basket of goods at time \( t \) (vector of endogenous variables),8 \( W_{t-j} \) is a vector of exogenous variables at time \( t \), \( A_i (i = 1, ..., r) \) and \( \beta_j (j = 1, ..., s) \) are coefficient vectors, \( i \) and \( j \) are the number of lags included in the system, and \( \varepsilon_t \) is a vector of residuals. One characteristic of these models is that the coefficients are difficult to interpret, due to the multivariate nature of the VAR. For this reason, impulse response functions and variance decompositions were developed to overcome this limitation. The former trace out the responsiveness of the dependent variables in the VAR to shocks to the error term, while the latter allow us to measure the movements in the dependent variables that are due to their “own” shocks, versus shocks to the other variables.9 We used the decomposition of the variance because it gives us information about the relative importance of each shock to

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6Since the seminal work by Sims (1980), SVAR models have also been applied to economic data to forecast macroeconomic time series, study the sources of economic fluctuations and/or test economic theories (e.g. Blanchard and Quah (1989) use of SVAR models in the analysis of the source of business cycle fluctuations and/or Kim and Roubini (1999) use a common structural model to identify the effects of monetary policy for the G7 economies).

7For a detail discussion on VAR methodology and estimation, we recommend Stock and Watson (2001) and Watson (1994).

8Below we explained how we constructed the different baskets of goods from the annual inflation rate.

9Lütkepohl (2006) discuss to a greater extend these techniques.
the variables in the VAR.\textsuperscript{10} This decomposition allows us to examine how the contribution of these shocks has evolved over time and whether these shocks play a role in determining the long-run variation in the endogenous variables.\textsuperscript{11} However, we deviate somewhat from the main strands of the literature because we are interested in identifying the impact of each exogenous variable $W_{t-j}$ on the inflation rate $X_t$, which we discuss on the next section.

2.1 Inflation Decomposition

2.1.1 Market Goods Decomposition

The inflation rate of market goods is measured as the growth rate of the Consumer Price Index of market goods ($CPI_{mt}$).\textsuperscript{12} The $CPI_{mt}$ is given by:

$$CPI_{mt} = \sum_{i=1}^{I} \alpha_i CPI_{mt}^i$$

with $CPI_{mt}^i$ represents the CPI at market prices for good $i$ on time $t$, the value of $\alpha_i$ is the relative weight of each good on the $CPI_{mt}$, and $I$ is the total number of market goods $m$ used to estimate the Consumer Price Index of market goods.

Then, we can expressed the inflation rate of market goods as follows:

$$\Pi_{mt}^i = \frac{CPI_{mt}^i}{CPI_{mt-1}} - 1$$

In order to determine what factors can explain the uprising of inflation in Ecuador, we assume there are $J$ exogenous factors that can explain the inflation rate for all marked goods in the consumer price index.

\textsuperscript{10}On appendix A there is a technical explanation on we move from the traditional variance decomposition methodology to estimated impact of the exogenous variables in VAR presented below.

\textsuperscript{11}See Seymen (2008) critical overview on the variance decomposition.

\textsuperscript{12}In Ecuador, the Consumer Price Index is calculated as the sum of the weighted average of market and non-market goods; the difference between the two is that the prices of the latter are set by the government; and include among others the price of gasoline, electricity, and transportation.
\[ \Pi_{mt}^i = \beta_1^i X_{1t} + \beta_2^i X_{2t} + \cdots + \beta_n^i X_{nt} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma) \] (4)

Taking the expected value of equation 4.

\[ \mathbb{E}(\Pi_{mt}^i) = \beta_1^i X_{1t} + \cdots + \beta_n^i X_{nt} = \sum_{j=1}^{J} \psi_{ij}^t, \quad \psi_{it}^j = \beta_{ij} X_{jt} \] (5)

where \( \psi_{ij}^t \) represents factor \( J \)'s contribution to the inflation rate of market goods on time \( t \). \( \psi_{ij}^t \) are estimated from the VAR variance decomposition.

Now, we can rewrite the inflation rate as:

\[ \Pi_t^i = \frac{CPI_{mt}^i}{CPI_{mt-1}^i} - 1 = \sum_{j=1}^{J} \psi_{ij}^t + \varepsilon_t \] (6)

where \( \Pi_t^i \) corresponds to the inflation rate, and \( \psi_{ij}^t \) is the contribution of each exogenous variable to the inflation rate of the good \( i \).

From equation 6, we can defined the CPI as the product of its lagged value (\( CPI_{mt-1}^i \)) and the sum the contributions of the exogenous variables to inflation plus the value of 1 (\( \sum_{j=1}^{J} \psi_{ij}^t + 1 \)), as shown in equation 7.

\[ CPI_{mt}^i = CPI_{mt-1}^i \left( \sum_{j=1}^{J} \psi_{ij}^t + 1 + \varepsilon_t \right) \] (7)

Replacing 7 in 2:

\[ CPI_{mt} = \sum_{i=1}^{I} \alpha_i \left[ \sum_{j=1}^{J} \psi_{ij}^t + 1 + \varepsilon_t \right] CPI_{mt-1}^i \] (8)
Rearranging the terms in 8:

\[
CPI_{mt} = \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_i CPI_{mt-1}^i \psi_{ij}^{ij} + \sum_{i=1}^{I} \alpha_i CPI_{mt-1}^i + \sum_{i=1}^{I} \alpha_i \varepsilon_t CPI_{mt-1}^i
\]

(9)

Equation 9 can also expressed as follows:

\[
CPI_{mt} = \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_i CPI_{mt-1}^i \psi_{ij}^{ij} + CPI_{mt-1} + \sum_{i=1}^{I} \alpha_i \varepsilon_t CPI_{mt-1}^i
\]

(10)

From equation 10, it is straightforward to see that the inflation of market goods can be expressed as the weighted average sum of the contributions of the exogenous variables to the inflation rate defined above:

\[
\frac{CPI_{mt} - CPI_{mt-1}}{CPI_{mt-1}} = \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_i CPI_{mt-1}^i \psi_{ij}^{ij} + \sum_{i=1}^{I} \alpha_i \varepsilon_t CPI_{mt-1}^i
\]

(11)

or

\[
E(\Pi_{mt}) = \frac{\sum_{i=1}^{I} \alpha_i CPI_{mt-1}^i \psi_{ij}^{ij} + \cdots + \sum_{i=1}^{I} \alpha_i CPI_{mt-1}^i \psi_{ij}^{ij}}{CPI_{mt-1}}
\]

(12)

Generalizing, we can conclude from equation 12 that the inflation rate of the market goods can be estimated form the individual contribution of a group of exogenous variables to inflation. This implies that we can measure the impact of each exogenous variable on the inflation rate. But since we are interested on the overall inflation rate, we need to include the contribution of non-market goods to this variable, which is explain on the next section.
2.1.2 Total Inflation Decomposition

Rearranging the terms on equation 2 we can obtain the individual contribution of market and non-market goods to the total consumer price index as follows:

\[
CPI_t = \sum_{i=1}^{I} \theta_i CPI_{mt}^i + \sum_{k=I+1}^{I+T} \theta_k CPI_t^k, \quad \sum_{i=1}^{I+T} \theta_i = 1
\] (13)

where \(CPI_{mt}^i\) and \(CPI_t^k\) correspond to the consumer price indexes of market good and non-market goods, respectively. \(I\) is the total number of market goods, and \(T\) represents the number of non-market goods. The relative weight of marked and non-market goods is now defined by \(\theta_i\) and \(\theta_k\), respectively. To estimate the total inflation rate form market and non-market goods, we start by replacing 7 in 13:

\[
CPI_t = \sum_{i=1}^{I} \theta_i CPI_{mt}^i - \sum_{j=1}^{J} \psi_{ij} + \sum_{i=1}^{I} \theta_i CPI_{mt}^i - \sum_{j=1}^{J} \psi_{ij} + \sum_{i=1}^{I} \theta_i CPI_{mt}^i - \sum_{j=1}^{J} \psi_{ij}
\] (14)

Equation 14 can also be expressed as:

\[
CPI_t = \sum_{i=1}^{I} \theta_i CPI_{mt}^i \sum_{j=1}^{J} \psi_{ij} + \sum_{i=1}^{I} \theta_i CPI_{mt}^i + \sum_{i=1}^{I} \theta_i \varepsilon_{it} CPI_{mt}^i + \sum_{k=I+1}^{I+T} \theta_k CPI_t^k
\] (15)

In equation 15 \(\psi_t^k\) is the inflation rate of non-market goods \(j\) on time \(t\). We then group the last two terms of equation 15 to obtain equation 16:

\[
CPI_t = \sum_{i=1}^{I} \theta_i CPI_{mt}^i + \sum_{k=I+1}^{I+T} \theta_k CPI_t^k + \sum_{i=1}^{I} \theta_i CPI_{mt}^i + \sum_{j=1}^{J} \psi_{ij} + \sum_{k=I+1}^{I+T} \theta_k \psi_{ik} CPI_t^k + \sum_{i=1}^{I} \theta_i \varepsilon_{it} CPI_{mt}^i
\] (16)
or

\[
CPI_t = CPI_{t-1} + \sum_{i=1}^{I} \theta_i CPI_{t-1}^i \sum_{j=1}^{J} \psi_t^{ij} + \sum_{k=l+1}^{l+T} \theta_k \psi_t^k CPI_{t-1}^k + \sum_{i=1}^{l} \theta_i \varepsilon_t CPI_{mt-1}^i \tag{17}
\]

Solving equation 17, we can take the expected value and obtain the annual inflation rate which is the same as equation 2, but estimated from the contribution of each exogenous variables represented by \(\frac{\sum_{i=1}^{J} \sum_{j=1}^{I} \theta_i CPI_{t-1}^i \psi_t^{ij}}{CPI_{t-1}}\) plus the contribution of the non-market goods given by \(\frac{\sum_{k=l+1}^{l+T} \theta_k \psi_t^k CPI_{t-1}^k}{CPI_{t-1}}\).

\[
E\left(\frac{CPI_t - CPI_{t-1}}{CPI_t}\right) = E(\Pi_t) = \frac{\sum_{i=1}^{J} \sum_{j=1}^{I} \theta_i CPI_{t-1}^i \psi_t^{ij} + \sum_{k=l+1}^{l+T} \theta_k \psi_t^k CPI_{t-1}^k}{CPI_{t-1}} \tag{18}
\]

Now, we can replace \(\psi_t^k\) on equation 18.

\[
E(\Pi_t) = \frac{\sum_{j=1}^{J} \sum_{i=1}^{I} \theta_i CPI_{t-1}^i \beta j X_{jt} + \sum_{k=l+1}^{l+T} \theta_k \psi_t^k CPI_{t-1}^k}{CPI_{t-1}} \tag{19}
\]

Equation 19 shows that the inflation rate can be expressed as the sum of \(k\) exogenous factors that can explain the inflation rate for all marked goods, plus the inflation rate of non-market goods.

### 3 Data

For our empirical analysis we compiled a data set comprised of observations on inflation rate, international prices, exchange rates, public policy variables, weather, freights and transportation cost, and political events. The inflation rate is measured by weighted averages of the Consumer Price Index of market and non-market goods, which is estimated by the Instituto Nacional de...
Estadísticas y Censos (INEC). Ecuador’s national statistics office. To estimate equation 2, hierarchical cluster analysis was conducted to classified CPI of market goods with similar characteristics on five baskets of goods: Agriculture Inflationary, Agriculture Non-inflationary, Agroindustry, Industry and Services (See Maldonado 2007). This methodology is appealing because is allows us to detect some basic patterns and trends on different groups of goods whose evolution behave in similar ways. These groups can then be considered to be driven by common factors.

To construct the weather variable, we used factor analysis to estimated an index form the average number of days with rainfall on each of the 24 provinces in the country collected on each major airport in the country by Dirección de Aviación Civil. Factor analysis is particularly useful in situations where a large number of variables are believed to be determined by a relatively few common causes of variation, such as our weather variable. We only have data on this variable until March 2008.

The vector of international prices which includes the prices of whole milk, chicken cuts, soya bean, rice and yellow corn was obtained from the online Primary Commodity Price dataset maintained by the International Monetary Fund. Exchange rates from Colombia, Peru, and the Euro Zone were obtained from each country Central Bank’s website. The public policy variable which consist of public spending, wages and non-market goods; as well as the freights and transportation cost from Colombia and Brazil were taken from the Central Bank of Ecuador’s dataset. The political events is a dummy variable constructed by Secretaría Nacional de Planificación (SENPLADES) that takes the value of one in each of these months in which elections took place, there was political instability in the country and the national assembly. Finally, we include a set of dummy variables to control for the stationary process on March, April, May, September, and October to control for the beginning of the school year and drought or flood incidence.

While we compile a data set that contains monthly observations from 1994 to 2008, we restrict the estimation sample to the period from January 2004 to March 2008. As shown in figure 1, between January 2000 and December 2003 the annual inflation there is clearly mark a point of structural break, which could bias our results. To avoid any potential problems in estimating our model, it seems appropriate to estimate our model since 2004.

13 The individual components on each basket is available upon request.
14 Recent research in dynamic factor models suggests that the information from a large number of time series can be usefully summarized by a relatively small set of estimated indices. See for example Bernanke (2005), Stock and Watson (2005) and Kapetanios and Marcellino (2006).
15 Threshold Vector Autoregressive Models have been used when we have a structural
4 Main Results

This section discusses the fit and the main results from our model which can guide us on explaining what drives inflation in Ecuador. We first estimate our structural VAR model from equation 1 (see above) in which each basket of goods is explained by a structural equation that has an error term associated with it. The results are reported on appendix B. Second, we used equation 7 to estimate the individual contribution of each exogenous variable to the individual basket of goods, but first we arrange the equations in the model into seven vectors: a) international prices, b) exchange rate, c) public policy, d) break in the data. These models divide the sample into two regimes that is determined by a break-point, which allow us to estimates different dynamics before and after the break (See Tong and Lim (1980), Tsay (1998), and/or Correal and Peña (2008) to go deeper in to this subject). But further research is needed to evaluate wheatear or not these models are appropriate to deal with the Ecuadorian structural breaks.
weather, e) stationary dummy variables, f) freights; and, g) politics. Third, from equation incorporated the weighted averages of the Consumer Price Index of market and non-market goods into the calculation of the variance decomposition using 19. This will allow us to estimate the inflation rate as the sum of our $k$ exogenous.

Figure 2 shows that our model adequately captures the general trend of inflation, and theretofore, it is possible estimated the individual contribution from our group of exogenous variables to the annual growth rate of inflation.

Figure 2: Inflation Rate: Forecast vs. Actual Inflation Rate

The results from our model provided some stylized facts about what drives inflation in Ecuador. On March 2008 the annual inflation rate was 6.26% and was mainly caused by international prices, exchange rates and public policy, which explained 60.90%, 19.72% and 8.10% of the inflation rate, respectively.

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16 See appendix A.2 and A.1 for the exogenous variables contribution to each individual basket of goods and overall inflation rate, respectively.

17 We also estimated Jarque-Bera normality test and the Portmanteau join independence which ensures the good fit of the model. These tests are available from the authors upon request.
The economically and statistically significant correlation between commodity-price shocks and inflation implies that sharp increases in commodity prices eventually translated into sharp increases in Ecuador’s core inflation. However, we expect that the high impact of this variable on the Ecuadorian inflation rate to be transitory, since we are already seen a fall in the commodity prices at the international markets as shown on appendix C.

Our results suggest that the effect of public policy on the overall rate of inflation has remained constant over the period studied, despite the fact that the government increase wages and and Bono de Desarrollo Humano (Ecuador’s cash transfer program which is based on the Mexican experience with Progresa) early this year. The insignificant impact this policies on the annual inflation rate might be explain by the fact that these policies represent less than one per cent of the GDP and that households used this additional income to pay for debts, health services and so on, and might not have an impact on inflation.\textsuperscript{19}

\textsuperscript{18}Appendix C shows the exogenous variables impact on the annual inflation rate from 2008 to 2005.

\textsuperscript{19}On 2008, the Ecuadorian government started an aggressive investment program on infrastructure in the country which might have an impact on inflation, but at the time when
It is also interested to see that the impact of the political events on the annual inflation rate decreases from March 2007 to March 2008. This can be explained by the fact that Ecuador had presidential elections during 2007; and, the believe by many Ecuadorians that the new government policies were going to bring growth and stability to the country. Finally, at this moment, we cannot give an economic interpretation to the negative contribution from the weather variable to inflation (see Table 1 in the appendix), which indicates that further research is needed in this area.

5 Conclusions

Our empirical results can be summarized as follows:

First, we were able to estimated the inflation rate form the individual contribution of a group of exogenous variables to inflation which includes international prices, exchange rates, public policy variables, weather, freights and transportation cost, and political events, plus the inflation rate of non-market goods.

Second, our methodology showed that the high levels of inflation since early 2008 in Ecuador are mainly caused by international prices, exchange rates and public policy. However, the overall impact of commodity prices on inflation should be seen as temporary as shown on appendix C.

Third, our results should be seen as the first attempt analyzed what drives inflation on Ecuador and the begin of a new research oriented to answer important questions oriented to analyzed the inflationary process in the country such as: What are the pass-through mechanisms from international prices and exchange rates to inflation in Ecuador? What is the relationship between monopolies or oligopolies with the price level? And so on, and so forth.

we wrote this paper we did not have data to test this hypothesis.
References


A Variance Decomposition: Simple Case

Let's assume that we know the coefficients $A_1$ from a no-structural VAR such as:

$$Y_{t+1} = A_1Y_t + \varepsilon_{t+1}$$  \hspace{1cm} (20)

where:

$$Y_{(t+1)} = \begin{bmatrix} Y_{(t+1),1} \\ Y_{(t+1),2} \\ \vdots \\ Y_{(t+1),n} \end{bmatrix}$$  \hspace{1cm} (21)

from equation 21 we want to estimate $Y_{t+i}$ conditioned to the observed value of $Y_t$, then the expected value of $Y_{t+1}$ can be express as follows:

$$E(Y_{t+1}) = A_1Y_t$$  \hspace{1cm} (22)

And the error in $t_{t+1}$ is:

$$Y_{t+1} - E(Y_{t+1}) = \varepsilon_{t+1}$$  \hspace{1cm} (23)

Once we estimate equation 23 recursively, we can estimate the error in $n$:

$$Y_{t+n} - E(Y_{t+n}) = \varepsilon_{t+n} + A_1\varepsilon_{t+n-1} + \cdots + A_1^{n-1}\varepsilon_{t+1}$$  \hspace{1cm} (24)

$$= \sum_{i=0}^{n-1} A_1^i\varepsilon_{t+n-i}$$  \hspace{1cm} (25)

$$= \sum_{i=0}^{n-1} \phi_i\varepsilon_{t+n-i}$$  \hspace{1cm} (26)
The individual contribution of each element in equation 27 can be written as follows:

\[ Y_{t+1} - E(Y_{t+n}) = \sum_{i=0}^{n-1} \phi_{11}^{(i)} \varepsilon_{t+i+1} + \cdots + \sum_{i=0}^{n-1} \phi_{1n}^{(i)} \varepsilon_{t+n+1} \]  

(27)

From equation 27, we can estimate the error variance for each component in the VAR:

\[ \sigma^2_{y(n)} = \sigma^2_1 \sum_{i=0}^{n-1} \phi_{11}^{(i)} + \cdots + \sigma^2_n \sum_{i=0}^{n-1} \phi_{1n}^{(i)} \]  

(28)

Rearranging the terms in equation 28 the individual contribution of each exogenous variable can be expressed as follows:

\[ \underbrace{\frac{\sigma^2_1 \sum_{i=0}^{n-1} \phi_{11}^{(i)}}{\sigma^2_{y(n)}}} + \cdots + \underbrace{\frac{\sigma^2_n \sum_{i=0}^{n-1} \phi_{1n}^{(i)}}{\sigma^2_{y(n)}}} \]  

First Component Contribution  n Component Contribution  

(29)
## B SVAR Model Results

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* Corresponds to international price of these commodities at the international markets.
C Inflation Decomposition

C.1 Exogenous Variables Impact on the Annual Inflation Rate

Figure 4: Exogenous Variables Impact on the Inflation Rate

Table 1: Exogenous Variables Impact on the Annual Inflation Rate

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Annual Inflation Rate 0.637 3.917 1.392 6.264
C.2 Exogenous Variables Contribution on the Individual Basket of Goods

Figure 5: Agriculture Inflationary

Figure 6: Agriculture Non-Inflationary

Figure 7: Agroindustry

Figure 8: Industry

Figure 9: Services
D  Inflation Rate vs. Commodity Prices