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Short-run Price Dynamics in Guatemala

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SHORT-RUN PRICE DYNAMICS IN GUATEMALA

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SHORT-RUN PRICE DYNAMICS IN GUATEMALA

by

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THESIS

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Abstract

An equation is estimated to model short-run price dynamics for Guatemala using ordinary least squares. The data range from 1960 to 2012. Due to the lack of complete data for interest rates, fitted values for the deposit rate are calculated using the discount rate. The aim is to measure how the consumer price index responds to changes in monetary base, real output, interest rates and exchange rates. All coefficients have their expected signs. With the exception of real output, the coefficients are found to be statistically significant at a 5% confidence level.
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Introduction

Inflation is a major economic issue faced by developing economies due to its influence on economic growth and income distribution (Kemal, 2006). In response to inflation, developing and developed economies are adopting an inflation-targeting monetary policy. Guatemala’s inflation-targeting (IT) policy follows the lead of developed economies such as the United Kingdom. The European Union faces increasing pressure to adopt inflation-targeting as its official monetary policy (Svensson and Woodford, 2004).

Such a policy may be significant because of Latin America’s history of inflation. Guatemala faces inflation pressure largely from food and energy related commodities. These two categories account for 40% of all 279 goods and services that are included in the calculation of Guatemala’s consumer price index (IHS, 2014). In an effort to improve economic conditions the central bank, Banguat, has implemented various macroeconomic policies. These include, along with IT, increased authority on monetary interventions, a floating exchange rate, and a large increase in long term debt servicing.

Due to Guatemala’s history of political turmoil, its central bank has often reformed policies to accommodate regime change. Guatemala’s exchange rate policy has taken many forms. Exchange controls were established in 1962 shortly after Guatemala began to experiment with nationalization following a coup. Furthermore, large government borrowing and multiple exchange rate systems led the quetzal to be overvalued by 1980 (Edwards and Losada, 1994). Currently the central bank pursues a floating exchange rate policy. Exchange rate stability is significant for price stability because it helps control external debt, terms of trade and external shocks.

Guatemala continues to face increasing social unrest, social division and violence. The central bank has expressed hope that increased government transparency and more legitimate institutions will have positive impacts on the country (IHS, 2014). Social reform is important for developing economies because inflation has a disproportionate effect on the poor by eroding real wages (Cardoso, 1992). Also,
political instability is found to have a positive correlation with inflation and a large nominal government debt (Beetsma and Ploeg, 1996).
Previous Research

Latin American economies have struggled with chronic inflation and hyperinflation. Often inflation is related to trade imbalance, political turmoil and populist government. In the 1950’s inflation became increasingly persistent and Latin America earned a reputation for inflation. By studying various economies in Latin America, economists have found key factors that help explain the driving forces behind inflation, such as: unrealistic targets, lack of developed capital markets, monopolies, inequality, and inflation’s momentum (Pazos, 1977). Economists have also learned of ways to promote price stabilization; these include: the removal of overbearing financial restraints, price distortions, slow wage adjustments during output expansions, and avoidance of exchange rate crises (Pazos, 1977).

Economic theory establishes relationships but empirical analyses measure the magnitude of these relationships. Through econometric tools, economists try to map the evolution of Latin American economies. However, lack of data and inconsistent measurement of some Latin American variables can present some challenges for econometric modeling. Nevertheless, relatively recent development of monthly data for key variables and the availability of econometric software improved short-term modeling of Latin American economies and served as an aid in policy making (Fullerton and Araki, 1996).

With the long-run relationship between money and inflation fairly established, economists have begun to study short-run effects for use in discrete short-run inflation-targeting policy throughout Latin America (Bernanke and Mihov, 1997). The money supply is not the sole driver behind inflation. The Cambridge equation links inflation to the ratio of money stock and output times velocity. From this relationship it can be presumed that inflation is associated with growth of money relative to real output (Dwyer and Haffer, 1999). Walsh (2002) suggests the use of an output gap instead of real output is more suitable to measure price changes in economies actively targeting low inflation rates due to an inflation and output tradeoff.
The law of one price links inflation between trading partners through exchange rates (Edwards and Losada, 1994) as is the case for Guatemala and its major trading partner, the United States. Exchange rates have a significant impact on price levels in an economy with a floating exchange rate. A real depreciation may worsen terms-of-trade because the value of exports decreases relative to the value of imports. An increase in the value of imports tends to increase the rate of inflation. Furthermore, non-monetarists link inflation to changes in individual price levels, such as oil shocks (Meltzer, 1998). These shocks are transmitted by exchange rates and Guatemala’s economy is largely made up of food commodities which must be transported using petrol fuels (IHS, 2014).

Emerging economies throughout the world, including some in Latin America, have adopted inflation-targeting monetary policies. The aim of IT is price stability. A major concern among IT supporters is the possibility of a negative macro-economic effect due to a central bank’s increased authority in a country with limited fiscal capacity because of the temptation to finance debt with monetary expansions. In a case study, Lee (2011) tests for the effectiveness of IT using inflation and gross domestic product growth rates from 1980 to 2006 for sixty IMF emerging economies. Evidence is found to support IT as an effective policy tool. Emerging economies that adopted IT experienced lower inflation than those that did not. IT was found not to have a negative impact on economies which unsuccessfully implemented IT policies, such as Chile. In 2005, Banguat implemented IT as part of its monetary policy through use of overnight rate. Due to decreased inflation rates of past years, Banguat began to expand the money supply in an effort to increase consumption and credit.
Theoretical Model

Moroney (2002) estimates a regression using the quantity theory of money. This model follows the same approach by using the Cambridge equation which states the relationship between money, velocity, price and output as. This relationship can be stated as:

(1) \( MV = PQ, \)

where \( M \) is the money supply, \( V \) is velocity, \( P \) is the nominal price level, and \( Q \) is gross domestic product adjusted for inflation. After rearranging equation (1) to have the variable of interest on the left the equation is:

(2) \( P = \frac{MV}{Q}. \)

The variable \( X \) will be added to measure the effect that international input costs (Fullerton, 1996) or trade shocks have on price levels through exchange rates:

(3) \( X = \frac{P}{P_t}, \)

according to the law of one price the exchange rate is equal to the ratio of domestic to foreign prices of a good so that each good is uniformly priced throughout the world (Isard, 1977). Rearranging once more gives the previous equation in the form of:

(4) \( P = X \times P_t. \)

In this form the link between inflation and exchange rate fluctuations becomes more apparent.

After taking the natural logarithm of equation (2) to linearize the data (Moroney, 2002), substituting velocity with the cost of holding cash balances as a measure of velocity, adding the natural logarithm of the exchange rate as a regressor, and rendering the equation stationary by use of a first difference operator (\( D \)) (Fullerton and Tinajero, 2001), the new equation becomes:

(5) \( DLP_t = DLM_t - DLQ_t + DLt + DLX_t. \)

Due to the nature of univariate time series data, it may be necessary to add lagged variables to treat for serial correlation (Fullerton and Araki 1996). From equation (5) it can be inferred that an
increase in the money supply causes an increase in inflation and an increase in real output causes a
decrease in inflation in the short-run. Equation (5) also implies that the exchange rate has a positive
relationship to price levels. An increase in the interest rate increases the opportunity cost of holding cash
balances which, in turn, increases the rate of inflation.

To create a single equation econometric model using ordinary least squares (Fullerton and Araki, 1996), parameters are set and equation (5) takes the form:

\[
(6) \ DLP_t = a_0 + a_1 DLM_t - a_2 DLQ_t + a_3 DLI_t + a_4 DLX_t + u_{5t}.
\]


Empirical Analysis

Table 1 is a list of variables and sources. The period analyzed ranges from 1960 to 2012, a period for which complete data series are available with the exception of a complete deposit rate data series. A deposit rate is available from 1978 to 2012. For the period from 1960 to 1977 fitted values for the deposit rate are estimated using the discount rate because there is a strong and extensive trend between the two variables (Dreborg, 1996) and estimating a model backwards in time allows for the estimation of parameters (Bloomfield, 1985). The regression equation used to estimate the deposit rate is shown in equation (7) and the regression output is shown in Table 2. The special drawing rights unit is used for the exchange rate due to the lack of conventional exchange rate data. The special drawing rights unit serves as an additional foreign exchange reserve used by IMF members that can be traded for another country’s currency on the open market but it is not a currency or a claim on the IMF (IMF, 2014a). The role of the special drawing rights unit is to prevent worldwide liquidity shortages (Williamson, 2009).

Table 1
Variable Names and Data Description

<table>
<thead>
<tr>
<th>Series</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLP</td>
<td>First Difference of the Natural Logarithm of the Consumer Price Index, 2005=100</td>
<td>World Bank</td>
</tr>
<tr>
<td>DLM</td>
<td>First Difference of the Natural Logarithm of Broad Money Supply, Millions of Quetzals</td>
<td>World Bank</td>
</tr>
<tr>
<td>DLQ</td>
<td>First Difference of the Natural Logarithm of Real Gross Domestic Product, Millions of 2005 Quetzals</td>
<td>World Bank</td>
</tr>
<tr>
<td>DLI</td>
<td>First Difference of the Natural Logarithm of the Nominal Deposit Rate, Percent Per Year</td>
<td>IMF</td>
</tr>
<tr>
<td>DLX</td>
<td>First Difference of the Natural Logarithm of the Nominal Exchange Rate, Quetzal per Special Drawing Rights Unit</td>
<td>IMF</td>
</tr>
</tbody>
</table>

Notes

(7) \( i_t = c_0 + c_1 r_t + u_{2t} \)

Table 2
Deposit Rate Backcasting Output

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>2.547</td>
<td>1.610</td>
<td>1.581</td>
<td>0.139</td>
</tr>
</tbody>
</table>
To check that the differenced series are stationary, a unit-root test is used. The Augmented Dickey-Fuller t-statistics are calculated with intercept only and with trend and intercept. The intercept captures a mean not equal to zero and the trend captures a deterministic time trend or drift term (Elder and Kennedy, 2001). Results are found in Table 3 and Table 4. The first differenced logarithmic form of price, money, output, the interest rate, and the exchange rate are found not to have unit roots using a 5% critical value. This indicates the data series are indeed stationary.

### Table 3
Augmented Dickey-Fuller Unit Root Stationarity Tests (with intercept)

<table>
<thead>
<tr>
<th>Series</th>
<th>Non-differenced ADF Test Statistic</th>
<th>ADF Test Statistic</th>
<th>5% MacKinnon Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLP</td>
<td>-0.053396</td>
<td>-3.627624</td>
<td>-2.919952</td>
</tr>
<tr>
<td>DLM</td>
<td>-2.294625</td>
<td>-3.575005</td>
<td>-3.500495</td>
</tr>
<tr>
<td>DLI</td>
<td>-2.829295</td>
<td>-4.148465</td>
<td>-4.150495</td>
</tr>
</tbody>
</table>

Notes
Next, Granger causality tests are used to check for causality. The Granger causality test validates monetarist theory affirming that if money supply is equal to money demand, a nominal increase of the monetary base leads to higher price levels (Friedman, 1983). The results are found in Table 5. These results exhibit strong statistically significant evidence that changes in the dependent variable are preceded by movements in the money supply. For the other independent variables, Granger causality cannot be clearly established. In a test for causality, Kholdy and Sohrabian (1990) find that consumer prices do no cause a change in the exchange rate for 3 major US trading partners (Canada, Germany and Japan).

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Observations</th>
<th>F-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLM does not precede DLP</td>
<td>50</td>
<td>6.38415</td>
<td>0.0036</td>
</tr>
<tr>
<td>DLP does not precede DLM</td>
<td>50</td>
<td>0.45414</td>
<td>0.6379</td>
</tr>
<tr>
<td>DLQ does not precede DLP</td>
<td>50</td>
<td>0.15646</td>
<td>0.8556</td>
</tr>
<tr>
<td>DLP does not precede DLQ</td>
<td>50</td>
<td>0.34325</td>
<td>0.7113</td>
</tr>
<tr>
<td>DLI does not precede DLP</td>
<td>50</td>
<td>0.14171</td>
<td>0.8683</td>
</tr>
<tr>
<td>DLP does not precede DLI</td>
<td>50</td>
<td>1.14153</td>
<td>0.3284</td>
</tr>
<tr>
<td>DLX does not precede DLP</td>
<td>50</td>
<td>0.38451</td>
<td>0.6830</td>
</tr>
<tr>
<td>DLP does not precede DLX</td>
<td>50</td>
<td>2.13055</td>
<td>0.1306</td>
</tr>
</tbody>
</table>

Notes
2. Test form: Granger causality equations for this Table included 2 lags.

Table 6 contains the estimation output generated using ordinary least squares on equation (6). Results show the output coefficient not to be statistically significant at a 10% level of significance. All
other variables are statistically significant at a 5% level. Lags of the money supply and of the dependent variable are included. The latter is added to treat for serial correlation (Fullerton and Araki 1996). The significant coefficient of the lagged money and price variables implies that changes in the consumer price index are in part determined by the money supply and price levels during the previous year. All variables carry their expected sign.

Table 6
Estimation Output

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.003274</td>
<td>0.013291</td>
<td>0.246343</td>
<td>0.8066</td>
</tr>
<tr>
<td>DLM</td>
<td>0.263720</td>
<td>0.064046</td>
<td>4.117676</td>
<td>0.0002</td>
</tr>
<tr>
<td>DLQ</td>
<td>-0.283966</td>
<td>0.182975</td>
<td>-1.551936</td>
<td>0.1278</td>
</tr>
<tr>
<td>DLQ</td>
<td>0.075882</td>
<td>0.030500</td>
<td>2.487961</td>
<td>0.0167</td>
</tr>
<tr>
<td>DLX</td>
<td>0.167640</td>
<td>0.049494</td>
<td>3.387096</td>
<td>0.0015</td>
</tr>
<tr>
<td>DLP(-1)</td>
<td>0.279715</td>
<td>0.090699</td>
<td>3.083985</td>
<td>0.0035</td>
</tr>
<tr>
<td>DLM(-1)</td>
<td>0.177772</td>
<td>0.081053</td>
<td>2.193277</td>
<td>0.0336</td>
</tr>
</tbody>
</table>

R-Squared | 0.747438 | Mean dependent var. | 0.081285 |
Adj. R-squared | 0.712998 | S.D. dependent var. | 0.074001 |
S.E. of regression | 0.039644 | Akaike info criterion | -3.490880 |
Sum Squared resid | 0.069152 | Schwarz criterion | -3.225728 |
Log likelihood | 96.01744 | Hannan-Quinn criterion | -3.389557 |
F-statistic | 21.70247 | Durbin-Watson | 1.726345 |
Prob(F-statistic) | 0.000000 |

Notes
2. Dependent variable: DLP.

The coefficient of determination is 0.747. The adjusted coefficient of determination is 0.712, meaning the model explains 71.2% of the variation in the consumer price index from 1960 through 2012. The F-statistic surpasses all conventional critical values indicating that it is possible to reject the null hypothesis that all parameters are jointly equal to zero. The estimation output in Table 6 exhibits desirable statistical characteristics. The t-statistics for the intercept and output are not statistically significant. There is a significant probability that the true random mean value of the output coefficient is zero.
The positive intercept represents conditional inflation and is indicative of a positive trend in the consumer price index. Conditional inflation is the intermediate target during inflation targeting (Svensson, 1999). The large positive coefficients for money at t0 and t-1 indicate that growth of the money supply leads to higher prices in the short-run and that a change in the money supply leads to the largest change in price levels. This reinforces the necessity of monetary restraint while implementing inflationary targeting policy.

Although the coefficient for real output is not statistically significant, it has the expected negative relationship with inflation reported in Grimes (1991). Karras (1993) shows that in the post war period prices are countercyclical because supply shocks dominate demand shocks; the empirical analysis shows that output and inflation are negatively related along aggregate demand but positively related along aggregate supply. The lack of significance could be indicative of an output sacrifice in favor of a lower inflation rate (Corbo and Schmidt-Hebbel, 2002). A change in the output-gap will cause a change in inflation in the same direction (Walsh, 2002) due to an inefficient use of resources. Holding nominal gross domestic product constant, an increase in real output will cause a decrease in the consumer price index.

In support of the Gibson Paradox, which claims a positive correlation between nominal interest rates and price levels (Shiller and Siegel, 1977), the effect of the interest rate on price levels is found to be greater than zero. Interest rates and velocity have a positive correlation. Because money demand is downward sloping, when interest rates rise consumers want to hold less cash balances and purchase financial assets. Furthermore, an effect of a free market with limited distortions is the transmission of information that would otherwise be unwieldy or difficult for consumers to extrapolate (Read, 1958). Interest rates transmit information about inflation. Consumers who consider an increase in interest rates as a sign of upcoming inflation have an incentive to purchase financial assets as a safeguard against
inflation. Fama (1975) determines that for efficient markets nominal interest rates contain meaningful information about change in purchasing power.

The coefficient for the exchange rate is greater than zero. This means that a depreciation of the quetzal increases price levels because imports become more expensive. As Banguat expands the money supply, the quetzal is expected to depreciate relative to the dollar over the next four years. The depreciation will put upward pressure on price levels over the next few years. Cáceres (2003) finds Guatemala’s inflation and monetary variables are the main determinants that lead to a currency crisis. However, Neumann (1973) concludes that special drawing rights units do not have an impact on domestic price levels because the monetary base remains unchanged and the only time special drawing rights units increase domestic inflation is when a country trades special drawing rights units for another currency in order to finance a trade deficit.

The following is an explanation of other model specifications taken into consideration but ultimately dismissed. The estimation output generated using a one period lag of the money supply has t-statistics greater than 2 for all variables but shows signs of serial correlation (Table 7). After re-estimating the model with lagged price and money variables (Table 6) and then adding a second lag on money (Table 8) within a 10% level of significance yields a coefficient for real output that is statistically significant at a 10% level of significance and greatly reduces serial correlation. The coefficient for the second money lag variable has a negative coefficient which could be indicative of transmission lag in monetary policy which causes money to behave in an opposite manner than is expected (Osinubi, 2005). Using a linear transfer function approach with a first order auto-regressive term and a one period lag on the money supply (Table 9) also yields a significant output coefficient at a 10% level of significance and decreases serial correlation. Lastly, results in Table 6 show the highest log likelihood.

### Table 7

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.015004</td>
<td>0.013887</td>
<td>0.080435</td>
<td>0.2857</td>
</tr>
</tbody>
</table>


### Table 8
**Estimation Output (with a dependent variable lag and one and two period money supply lags)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.013312</td>
<td>0.015091</td>
<td>0.882133</td>
<td>0.3827</td>
</tr>
<tr>
<td>DLM</td>
<td>0.260958</td>
<td>0.063618</td>
<td>4.101970</td>
<td>0.0002</td>
</tr>
<tr>
<td>DLQ</td>
<td>-0.346975</td>
<td>0.184037</td>
<td>-1.885354</td>
<td>0.0663</td>
</tr>
<tr>
<td>DLI</td>
<td>0.081613</td>
<td>0.030274</td>
<td>2.695823</td>
<td>0.0101</td>
</tr>
<tr>
<td>DLX</td>
<td>0.161920</td>
<td>0.049111</td>
<td>3.297045</td>
<td>0.0020</td>
</tr>
<tr>
<td>DLP(-1)</td>
<td>0.387373</td>
<td>0.108460</td>
<td>3.571581</td>
<td>0.0009</td>
</tr>
<tr>
<td>DLM(-1)</td>
<td>0.184631</td>
<td>0.080765</td>
<td>2.286020</td>
<td>0.0274</td>
</tr>
<tr>
<td>DLM(-2)</td>
<td>-0.133658</td>
<td>0.078099</td>
<td>-1.711385</td>
<td>0.0944</td>
</tr>
</tbody>
</table>

**Summary Statistics**

- R-Squared: 0.761866
- Adj. R-squared: 0.722177
- S.E. of regression: 0.039127
- Sum Squared resid: 0.064299
- Log likelihood: 95.45881
- F-statistic: 19.19587
- Prob(F-statistic): 0.000000

**Notes**
2. Dependent variable: DLP.

### Table 9
**Linear Transfer Function Estimation Output (with a one period money supply lag)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.015119</td>
<td>0.017052</td>
<td>0.886663</td>
<td>0.3802</td>
</tr>
<tr>
<td>DLM</td>
<td>0.257332</td>
<td>0.063618</td>
<td>4.029175</td>
<td>0.0002</td>
</tr>
<tr>
<td>DLQ</td>
<td>-0.321602</td>
<td>0.181527</td>
<td>-1.771652</td>
<td>0.0835</td>
</tr>
<tr>
<td>DLI</td>
<td>0.067655</td>
<td>0.027409</td>
<td>2.468694</td>
<td>0.0176</td>
</tr>
<tr>
<td>DLX</td>
<td>0.175320</td>
<td>0.048225</td>
<td>3.635490</td>
<td>0.0007</td>
</tr>
</tbody>
</table>

**Notes**
2. Dependent variable: DLP.
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AR(1)</td>
<td>0.454550</td>
<td>0.137346</td>
<td>3.309516</td>
<td>0.0019</td>
</tr>
<tr>
<td>DLM(-1)</td>
<td>0.272028</td>
<td>0.075795</td>
<td>3.588984</td>
<td>0.0008</td>
</tr>
</tbody>
</table>

| R-Squared    | 0.750727 | Mean dependent var. | 0.082504 |
| Adj. R-squared | 0.715945 | S.D. dependent var. | 0.074233 |
| S.E. of regression | 0.039564 | Akaike info criterion | -3.492640 |
| Sum Squared resid | 0.067307 | Schwarz criterion | -3.224957 |
| Log likelihood | 94.31599 | Hannan-Quinn criterion | -3.390704 |
| F-statistic   | 21.58365 | Durbin-Watson    | 1.946401 |
| Prob(F-statistic) | 0.000000 |               |         |

Notes
2. Dependent variable: DLP.
Conclusions

Stabilization policy is important for developing economies. Inflation lowers real interest rates, erodes purchasing power, and redistributes wealth between lenders and borrowers. It is important for developing economies to restrict monetary expansions. However, monetary expansions may be warranted in an effort to stimulate demand, prevent a recession, or in response to supply shocks. As a remedy for inflation the central bank can slow down the nominal GDP growth rate. This is costly but effective. Another cure for inflation is to raise production costs through government policy. Lastly, in an attempt to ease inflation, restrictive monetary and fiscal policies can be implemented. Benefits of a lower inflation rate include: an increase in real money supply, lower interest rates, increased planned spending and an increase in real output.

A price model is generated for Guatemala by incorporating the Cambridge equation and exchange rates. Due to logarithmic differencing, the model can be used for short-term policy making. The results could be more informative if monthly data becomes available. Future testing can shed light on the effects of fiscal policy, inequality and violence on Guatemala’s consumer price index.

The model exhibits signs of possible multicollinearity and serial correlation problems. More precise parameter estimates may be possible if more data becomes available. Due to lack of data for Latin American economies it may prove more useful to increase the efficiency of the estimators by modeling consumer prices using data from adjacent Latin American Countries through a seemingly unrelated regression approach (Giannone, Reichlin and Small, 2005). In short, empirical testing may improve as more data becomes readily available.
References


Vita

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