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SHORT-RUN PRICE MOVEMENTS IN ECUADOR

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Introduction

Similar to a number of other Latin American economies, Ecuador has faced persistently high rates of inflation in recent years. Although successive governments have promised to deal with this ongoing problem and have even utilized price stabilization goals as the center pieces for International Monetary Fund loan agreements (Banco del Pacifico, 1994), virtually no progress has been made over the course of the past decade. One difficulty confronting monetary authorities in Ecuador with respect to this topic is that very little econometric analysis using short-term forecasting methods appears to have been relied upon in developing policy targets.

In attempts to slow price movements, recent governments have relied upon a variety of standard macroeconomic mechanisms. They include import liberalization, fiscal austerity, and slower rates of currency depreciation. Price stability, in spite of the numerous false starts in this arena, remains an important goal. Reduced price pressures represent one means by which governments can help improve economic welfare via enabling the Ecuadorian economy to operate more efficiently. This argument is very similar to those applied in advanced economies (Motley, 1998) as well as in other developing nations (Zind, 1993). Better understanding of the short-run price environment can, therefore, play an important role in the continuing policy debate facing policy makers in Ecuador.

This paper examines potential results associated with two principal adjustment tools, money supply growth and

exchange rate movements. Careful econometric analysis of short-run price movements in Ecuador has not previously been conducted. To bridge this gap, a modeling framework is proposed, tested, and used to develop policy simulation exercises for monthly Ecuadorian data. Subsequent sections of the study present a review of the literature, theoretical model, and empirical results. Suggestions for future research are summarized in the conclusion.

Previous Research

The seminal research on inflationary dynamics in developing countries was conducted on Chilean data by Harberger (1963). That early paper interestingly points out that analyzing nominal data in level form could result in spurious correlations in equations estimated for highly inflationary economies. To circumvent this problem, percentage rates of change are utilized in a linear regression framework based on the quantity theory of money. What became known as the "Harberger" framework incorporates real income, current and lagged values of the money supply, and the opportunity cost of holding cash balances.

The success of this initial effort conducted on Chilean data spurred a series of replicated studies for other developing countries. Vogel (1974) estimates an inflation equation for several Latin American economies, including Ecuador, using annual data. Results confirm the overall usefulness of the Harberger model. Unlike the study at hand, Vogel utilizes a sample period during which inflation averaged less than 4 percent per year in Ecuador and the exchange rate was fixed.

Hanson (1985) extends the Harberger framework in a systematic fashion to incorporate an important missing component, import costs. An implicit cost function is utilized to derive an aggregate supply curve which includes local prices

of imported inputs. When the underlying production function is homogeneous of degree one, inflation becomes a weighted sum of money supply changes and import prices. This is important for studies using higher frequency data if the problem of measurement bias engendered by interpolated values of real output, generally published on either a quarterly or annual basis in developing countries, is to be avoided (see Bomberger and Makinen, 1979). Empirical results in the Hanson article strongly support the inclusion of import prices or the rate of devaluation in models of inflation.

Subsequent research has provided additional evidence in favor of the augmented Harberger-Hanson approach wherein the effect of import prices on inflation is considered. Koch, Rosensweig, and Witt (1988) and Fullerton, Hirth, and Smith (1991) both report positive linkages between the trade-weighted exchange value of the dollar and consumer prices in the United States. These empirical studies indicate a unidirectional channel of influence from the exchange rate to domestic prices exists in the United States economy. As will be discussed below, causality direction has important implications for both model form and estimation technique.

Developing country studies have also confirmed the usefulness of an augmented modeling treatment of inflationary dynamics. Sheehey (1980) reports several empirical tests that indicate that accurate assessment of austerity policy efforts will likely require explanatory variables representing cost push factors. More recently, Brajer (1992) provides evidence that the latter category of models may offer better specifications than those which rely solely on domestic economic factors. Similarly, Fullerton (1993a) successfully imbeds a variant of this approach in a large-scale macroeconomic forecasting model for Ecuador using annual data.

There have been very few dynamic models estimated on the basis of monthly data for developing economies. Given that most business decisions in highly inflationary countries are reached within a short-range context, this is an area which needs to be addressed. Fullerton (1993b) empirically examines Colombian anti-inflationary efforts utilizing monthly data with an autoregressive-moving average (ARMA) transfer function. The estimated model is found to generate realistic simulation scenarios for policy analysis. The results also support the hypothesis of inflation rate inelasticity with respect to monetary growth.

Theoretical Model

Harberger's (1963) model is based on the traditional quantity theory of money macroeconomic equation of exchange:

$$1. MV = PQ,$$

where M represents some measure of the money stock, V is the velocity of circulation, P is the price level, and Q is real output. Velocity is allowed to vary in this model and is assumed to be a predictable function of other macroeconomic variables, such as the cost of holding cash balances.

To utilize percentage changes, the variables can be transformed by natural logarithms and first differenced. Introduction of a time subscript, and rearrangement of the terms, yields the basic Harberger equation:

$$2. DP_t = DM_t - DQ_t + D(DP_{t-1}),$$

where the last term results from substituting for velocity and D represents a difference or backshift lag operator (logarithmic transformation of the data is carried out prior to taking first differences). Usage of the lagged change in the inflation rate as a proxy for the implicit cost of holding money is mandated by

the fact that government regulations on interest rates have occasionally caused savings and loan rates to become negative in real terms. Unadjusted interest rates from these periods in Ecuadorian economic history do not, therefore, provide accurate estimates for the cost of holding cash. Because the velocity of circulation in South American economies is usually not constant, the aforementioned step is important (Clavijo, 1987).

Equation 2 implies that inflation will vary positively with the money supply and inversely with respect to real output. A statistically significant intercept term will enter the estimated equation if there is a unidirectional trend in the velocity of circulation. If only contemporaneous lags of M and Q enter in the equation, the parameters for both variables are hypothesized to be unitary. This can be tested empirically with the following specification:

$$3. DP_t = a_0 + a_1DM_t - a_2DQ_t + a_3D(DP_{t-1}) + u_3,$$

where a_1 and a_3 are hypothesized to be positive, and the absolute values of a_1 and a_2 should both be statistically indistinguishable from one. The last argument in the expression represents the disturbance term.

Hanson (1985) proposes an implicit cost function dual of an aggregate production function which is homogeneous of degree one. Derived output supply functions from this framework will be homogeneous of degree zero in input and output prices. Equation 4 expresses this relationship using logarithmic first differences:

$$4. DQ_t = b_0 + b_1DP_t - b_2DPI_t + u_4,$$

where PI represents imported input prices. When the relative prices of imported inputs increase, output is assumed to decline.

The standard homogeneity assumptions for production and derived supply relations imply that $b_1 - b_2 = 0$.

Equation 4 can be substituted into Equation 3 to eliminate the output term from the expression to be estimated. As noted above, this step is useful for avoiding interpolation bias in empirical studies of monthly inflation for countries such as Ecuador where GDP is published at quarterly and/or annual frequencies. The resulting equation can be written as follows:

$$5. (1 + a_2b_2)DP_t = a_0 - a_2b_0 + a_1DM_t + a_2b_2DPI_t + a_3D(DP_{t-1}) + u_5.$$

Equation 5 can be further simplified prior to estimation. Dividing through by the left-hand side constant term and rearranging terms such that the price series remains as the dependent variable yields the following relation:

$$6. DP_t = c_0 + c_1DM_t + c_2DPI_t + c_3D(DP_{t-1}) + u_6,$$

which also has testable properties. The most significant change in terms of model characteristics is that the coefficient on the monetary variable, c_1 , is now hypothesized to be significantly less than one. The latter result is a consequence of dividing a_1 by $(1 + a_2b_2)$ in order to reach the expression shown in Equation 6. With the possible exception of the intercept, all of the regression parameters in Equation 6 are expected to be positive.

As indicated in the literature review, Equation 6 has provided a useful framework for analyzing quarterly and annual inflation rates. But because the lag structure in this model is fairly short, it may require additional modification prior to estimation. This possibility does not reflect any deficiencies in the theoretical model as such, but arises due to the fact that this study relies upon monthly data. As a result, if the inflationary impact of a change in the money supply is felt over the course of one calendar year, the implied lag structure for a model

estimated with data published at a monthly frequency would potentially range up to 12 months in length. Equation 7 takes into account this empirical issue.

$$7. DP_t = c_0 + \text{Sum}(c_{1i}DM_{t-i}) + \text{Sum}(c_{2j}DPI_{t-j}) + \text{Sum}(c_{3k}D(DP_{t-1-k})) + u_7.$$

The above model provides an attractive starting point for examining inflationary trends in an economy. It is not, however, without potential problems for analyzing price movements in a relatively high inflation country such as Ecuador. The principal concern arises from utilizing first differenced, log-transformed time series data in the equation to be estimated. If the resulting series are stationary, the equation can be estimated without risk of obtaining spurious correlations in the results. As shown in many studies of hyperinflationary economies, however, higher order differencing may be required to induce stationarity during periods in which prices increase rapidly (see Engsted, 1993). Because Ecuador has not undergone any hyperinflationary episodes, first differencing should remove nonstationary trends from the variables in question but this assumption must be tested.

Another concern is that monthly import price deflators do not exist for Ecuador. To circumvent this problem and also avoid interpolation bias, a trade-weighted exchange rate index is used as a proxy for imported input prices. The index utilized was developed econometrically and takes into account trade volume changes with Ecuador's major trading partners. It also offers a single monthly index for periods when the government has instituted multiple exchange rate systems (for discussion, see Fullerton, 1989). The model to be estimated thus takes the following form:

$$8. DP_t = g_0 + \text{Sum}(g_{1i}DM_{t-i}) + \text{Sum}(g_{2j}DXR_{t-j}) + \text{Sum}(g_{3k}D(DP_{t-1-k})) + u_8,$$

where XR stands for logarithmic first differences of a nominal version of the monthly trade-weighted exchange rate index

calculated for the sucre by The WEFA Group (formerly Wharton Econometrics; see Fullerton, 1989).

As a final note, the above model has its roots in the traditionally utilized monetary construct that has long supported inflationary research and policy analysis. In recent years, this basic framework has periodically come under fire (Meltzer, 1998). A large volume of international empirical research supports such theoretical treatment of nominal price variations (Rolnick and Weber, 1997; Dwyer and Hafer, 1999). Ultimately, the applicability of this or other closely related models (Fullerton, 1999) is an issue that can only be resolved on a careful case-by-case basis. Such verification is attempted with respect to Ecuador in the material that follows.

Empirical Analysis

In order to examine whether the working series included in Equation 8 are stationary, a battery of unit root tests are utilized. Estimation is conducted for the 1964-1994 sample period for which complete data are available for the currency index. All other data may be downloaded from the IMF electronic data banks (International Monetary Fund, 1999) or referenced in the periodic statistical releases of the Central Bank of Ecuador. Applying unit-root tests to a relatively short time span of this nature may be risky due to the fact that these tests typically have low power unless long-run data sets are used (Hakkio and Rush, 1991). Because time series data in Latin America generally date back to 1957 at most, there is little at present that can be done to circumvent this potential problem.

Augmented Dickey-Fuller t-statistics were estimated for equations without intercepts; with constant terms, but without trend variables; and with both intercepts and trends. In all cases, tests for unit roots in the first differenced log transformed

series for consumer prices, money, and the trade-weighted exchange rate index are rejected at the 1-percent level. Based on this evidence, the first-order differenced series used to estimate Equation 8 are assumed to be stationary.

As specified above, the model is explicitly built around a set of unidirectional causality relations from movements in the regressors to consumer prices. To examine whether the absence of simultaneity in the model is plausible, a set of Granger causality tests were calculated for the stationary components of the series of interest for lags of 6, 12, 18, and 24 months. Results associated with these tests did not render strong evidence either in favor of, or against, the assumptions regarding causality direction in the data set. This possibly reflects the fact the central bank has utilized both money and the exchange rate as policy variables implying that the reduced form expressed in Equation 8 will not generate results as accurate as those associated with larger-scale models such as Fullerton (1993a). Data constraints for Ecuador, however, preclude replicating the aforementioned study using monthly frequency time series information.

The inconclusive nature of the causality tests contains several important implications with respect to implementing an empirical version of the theoretical model presented above. From an optimistic perspective, the results do not indicate that endogeneity exists between the dependent variable (consumer prices) and the regressors (money and the exchange rate index). Consequently, equation estimation can be accomplished without resorting to instrumental variables, or developing a system of simultaneous equations, and the resulting coefficients should be both unbiased and consistent. From a more pessimistic vantage, the absence of Granger causality from the regressors to the left-hand side variable raises the possibility that the regression results will not be statistically significant.

Regression results for Equation 8 are summarized as follows:

$$\begin{aligned}
 9. \quad DP_t = & 0.015 + 0.013*DM_t + 0.028*DM_{t-4} + 0.039*DM_{t-9} + \\
 & (10.224) \quad (0.797) \quad (1.735) \quad (2.333) \\
 & 0.060*DXR_t + 0.007*DXR_{t-2} + 0.063*D(DP_{t-6}) + \\
 & (5.932) \quad (0.642) \quad (1.638) \\
 & 0.369*MA(1) + 0.405*AR(2), \\
 & (7.101) \quad (8.439)
 \end{aligned}$$

R ²	0.379	S.E.R.	0.015	Log likelihood	1013.715
DW	2.087	F-stat	26.798	Prob(F-stat)	0.001,

where the numbers in parentheses are computed t-statistics. Lag lengths of 24 months were used in the initial estimates for Equation 9. To avoid potentially spurious estimation results (see Hamilton, 1994), a nonlinear ARMAX procedure is utilized to correct for serially correlated residuals. The ARMAX procedure is useful because of its flexibility in handling a wide variety of different error generating processes.

Because inclusion and exclusion of different lags did not yield clear results, the model structure reported in Equation 9 was selected on the basis of likelihood ratio tests. Although the relatively short lag components may seem unexpected, they were confirmed by cross correlation function analysis. With respect to the disturbance term, an ARMA(2,1) specification was used to characterize the data generating process for the residuals. Given that the model is estimated using differenced data, the positive sign on the intercept indicates that a systematic and statistically significant upward trend exists in the Ecuadorian consumer price index.

As hypothesized by Hanson (1985), the sum of the coefficients for the lagged monetary series is significantly less than one. Similar to Fullerton (1993a, 1993b), but unlike Kamas (1995), the exchange rate appears to play an important

role in determining price movements. That result is also in contrast to theoretical arguments previously developed for Latin American economies (Herrera, 1985), but undoubtedly reflects the importance of import prices in internationally oriented economies such as Ecuador. Multicollinearity causes four of the estimated coefficients to individually fall below the 5-percent type-1 error criterion, but the parameter estimates are jointly significant. Despite the potential pitfalls identified in earlier sections of the paper, the empirical characteristics associated with Equation 9 are strongly in line with what is expected on the basis of the underlying theoretical model.

In 1983, the central bank introduced new exchange rate policies that allowed the sucre to fluctuate more freely. To allow for potential parameter heterogeneity caused by structural change associated with periodic currency devaluations, a shorter sample was also used for estimation purposes. Results from these exercises, not reported here, are also in line with the theoretical model and empirical estimates presented above. Experimentation with the lag structure over the shorter sample period does not yield strong evidence of parameter instability or any other major shortcomings with Equation 9.

Simulation exercises with the model indicate that consistent application of the traditional anti-inflationary policy steps can reduce price pressures, but generally require time periods that extend more than one year into the future. Given that the 1998 end-of-year inflation rate in Ecuador rose to 43 percent, it is fairly obvious that monetary authorities have faced difficulties in creating a stable price environment (Fuentes, 1999). Accordingly, a credible disinflationary policy stance may require more intense short-term efforts. Simulations with the model indicate that immediate reduction of money supply growth and exchange rate depreciation by 50-percent or more will result in 10-percentage point (or greater) improvements in the prevailing inflation rate within a 6-month time frame.

On the basis of the empirical evidence obtained above, it appears that while anti-inflationary programs are likely to be at least somewhat successful, this conclusion is predicated upon eventual deceleration in the rates of liquidity growth and currency depreciation brought about by the central bank. Ecuador, however, has traditionally avoided setting firm inflation targets (Bernanke and Mishkin, 1997). With ongoing economic integration occurring within South America and throughout the globe, a stable price environment may become a priority for policy makers. Credible price disinflation will generally require fairly stringent implementation measures that will probably lead to sharp output reductions (Filardo, 1998). Reliable analysis of the potential impacts associated with such measures would likely be of interest to policy makers.

Conclusion

An empirical model of Ecuadorian consumer price inflation is developed and estimated by incorporating both monetary and import cost effects in a theoretically plausible manner. Specification and simulation of the model are relatively easy to accomplish. Experimentation with the estimated equation indicates that lower rates of inflation are attainable, but require Ecuadorian monetary authorities to adhere to stabilization programs over potentially long periods of time. Because the model does not pose stringent data requirements, it is also applicable to other Latin American economies where inflation remains a problem. Examples include Brazil, Colombia, Mexico, and Venezuela where authorities continue to grapple with short-term price stabilization goals.

Additional econometric testing may prove useful. Initial results obtained in this paper indicate this framework may benefit from incorporating more sophisticated time series

techniques to the analysis. Parameter heterogeneity due to structural change and policy innovations may be present in other economies in Latin America where monetary authorities have traditionally been subject to political pressures. It may also be useful to expand the scope of the model to include additional equations which allow for potential endogeneity between inflation, money, and exchange rates. Even if the latter are not required for parameter estimation consistency, they could enrich subsequent policy simulation analyses.

These suggested changes represent avenues for refinement to the basic model outlined above. They are not likely to result in wholesale alterations to the general framework. Similarly, it is not anticipated that the policy simulation impacts and conclusions will change markedly due to expanding the scope of the empirical techniques presented above. But given the breadth of economic conditions prevailing across Latin America, steps in these directions may prove helpful in future econometric research of this nature. The spread of inflation targeting will also require the development of tools such as those discussed herein in order to gauge the intensity with which anti-inflationary measures must be imposed. Finally, the adoption of formal inflation targets will logically raise questions about the implied costs in terms of foregone output and employment. The latter suggests a valuable new track for policy research and analysis in developing economies worldwide.

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