A P* Model of Inflation in Puerto Rico

Rodríguez, Carlos A.

University of Puerto Rico, Rio Piedras Campus

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A P* MODEL ANALYSIS OF INFLATION IN PUERTO RICO

Carlos A. Rodríguez[*]
University of Puerto Rico

Abstract
One can analyze and forecast the inflationary potential in the Puerto Rican economy using the "P* model." Given the nature of the monetary sector in Puerto Rico (PR), the model is put into the context of variables from the mainland United States (US). The results indicate a long-run relationship between the money supply (M1) of the US and the price level in PR, between M1 and real production in PR, and between M1 and the prime rate in PR. The implications for forecasting and policy are discussed.

JEL Codes: C32, C52, C53

Key Words: Econometric Modeling, Time Series Analysis, Forecasting Methods, Monetary Economics.

I. Introduction

Inflation is a global problem almost all countries have suffered from one time or another. Due to the recent history of high inflation in Latin America, many governments still hold the management of the price level as a primary objective of policy. In a number of countries in the region, high inflation rates have negatively impacted levels of investment while also distorting the tradeoffs between consumption and saving. Puerto Rico (PR) is unique in that the commonwealth government has not considered inflation in its policy agenda. Nevertheless, inflationary pressures in PR exist and one need only point out that factor price increases in raw materials, salaries, intermediate inputs, etc., have had a direct effect in destabilizing the economy of island over the last thirty years.

The main reason for ignoring inflation in PR owes greatly to the relationship of the island with the mainland US. A majority of imported products, be they final goods or intermediary, hail from the mainland. Likewise, the minimum salary is determined in Washington and the currency is the US dollar. Puerto Rican politicians have made the assumption PR is a price(-level) taker.

Given the adverse effects of inflation on the island, one should question the price(-level) taker assumption and understand the *degree* to which commonwealth public policy may control inflation. One may turn to P* model as an indicator of the evolution of magnitudes of price levels and expected inflation. (see, for example, Hall and Mine, 1994; Hallman and Anderson, 1995; Orphanides and Porter, 1998; Galindo, 1997). The P* model arose out of the necessity to estimate the relationship between monetary aggregates and production levels; indicators are sought for long-run tendencies in the price level. The model has also been used to gauge the feasibility of economic policy in the control of price levels (Allen and Hall, 1991). Its advantage lies in the capacity of the model to forecast prices using simple rules regarding movements in production levels and monetary aggregates. Nevertheless, such forecasts assume the circulation velocity of money is a constant and that one can use the interest rate as a proxy for the opportunity costs of money (Orphanides and Porter, 1998).

The P* model measures inflationary potential by estimating the price level toward which the economy is

adjusting in the long run as a function of the quantity of money in circulation (Galindo, 1997). Equilibrium is assumed in the long run for both the circulation velocity of money as well as the corresponding level of production. Any permanent change in the circulation velocity of money or in the level of potential production would generate a permanent divergence between the real price level and that forecasted by the model. Therefore, the estimated value of the price level in the long-run can serve as a robust indicator of current monetary conditions.

Despite encouraging empirical findings from the P* model, some authors (Orphanides and Porter, 1995; Arnold, 1995) question the causality between price levels and monetary aggregates. Inasmuch as production levels are a function of expectations, the circulation velocity may also be a function of expectations. In the case of Puerto Rico, the money supply is endogenous to the market and not administered by the government or any other autonomous entity in the island.[1] Given such dependence, one quickly deduces that PR has little to no control over the evolution of inflation and cannot target price levels by means of monetary policy. Similarly, given the asymmetrical relationship between the two economic systems, the price-level in PR does not significantly affect the price-level on the mainland. However, this high degree of dependence of the island economy may throw doubt on the assumption of a stable circulation velocity of money. To understand the instability, the P* model will estimate the error correction

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[1] Due to a high level of integration of capital markets with the mainland US, the economy of PR is not affected significantly by international economic instability and external flows of capital.

by considering the prime interest rate as a measure of the opportunity costs of maintaining money balances (Rodríguez y Toledo, 2003). The following application attempts to analyze not only the impact of inflation on the island economy but also the role the P* model may play in the public policy debate.

II. The history of inflation in Puerto Rico

PR became a Commonwealth of the US in 1952. The negotiation of Commonwealth status culminated in a Puerto Rican constitution that would specify the areas of intervention between the federal government of the US and that of territorial government of PR. Although the constitution of PR did not really change the fundamental relationship between the two governments, the new status was nevertheless beneficial to the dominant political party in PR (Partido Popular Democrático) as well as to Washington, as it seemed to address the United Nations mandate for decolonisation (Villamil, 1975). Coincidentally, the political settlement of commonwealth status accompanied the emergence of the US as the dominant country throughout the world. The island quickly became a logical choice for US hegemony in both political and economic terms in the wake of the Second World War and the onset of the Cold War, with all its concomitant military expenditures.

Given the geopolitics of the day, Washington gave priority to resolving long-standing problems in PR through an economic strategy of development through investment and export. In exchange, the PR government would show flexibility and abandon its previous reform program. For example, in 1947, the First Law of Industry Incentives (Ley de Incentivos Industriales) was approved which gave a tax holiday on profits for foreign companies working on the island. The following year, in a show of liberalization. the government of PR would sell the

factories it had recently sponsored under the program of *Fomento*[2] The objective of both moves was to attract a variety of industries to the island and the model of development became known in English by the metaphor "Operation Bootstrap" or in Spanish "Operación Manos a la Obra" (literal translation: Operation-Hands at Work).

Through the fiscal incentives of Operation Bootstrap, the island began industrializing and fundamental transformations took place in the productive processes of the island economy. During the initial phase (1947-1956), labor-intensive light manufacturing was attracted (Departamento de Comercio, 1979; Dietz, 1989; Villamil, 1975), consisting primarily of textiles which consumed little energy and generated low levels of pollution. However, textiles are a quintessentially competitive industry and generated only low levels of profit. The comparative advantage in textiles shifted quickly in the wake of the Kennedy Round of the GATT negotiation, which lowered tariffs on labor-intensive manufacture from the Far East. In other words, any efficiency advantage of the island in the production of textiles did not compensate for the differential salaries between PR and, say, Hong Kong. This deteriorating comparative advantage was accentuated by implementation of the US federal minimum wage in the island. One can even say that, during this period, inflation was driven by compliance with the mandated US minimum wage floor.

The second stage of industrialization (1956-1973) witnessed construction of refineries and a large-scale petrochemical industry both, driven by a federal quota system that apportioned importations of petroleum to distinct states. The absolute and relative role of labor diminished with respect to capital during this second phase.[3] Inasmuch as both refineries and petrochemicals are highly energy-intensive, both would also be highly polluting. (Commerce Departament, 1979; Dietz, 1989; Villamil, 1975). Therefore, the subsidy was both fiscal and environmental. The hope of the island government was the development of oil-refining capacity would generate supplies of intermediary products for local industry while also reducing the energy dependence of the island. For example, an ample supply of relatively low cost electric power would facilitate energy-intensive industries like aluminum, broadening the raw material base of PR. However, that did not happen. Industry tended to prefer proximity to its markets rather than proximity to its inputs. (Villamil, 1975).

One can argue that Operation Bootstrap made PR little more than a "manufacturing enclave" within the US. The sole advantage for PR seemed to be the employment that would be generated from final assembly; the disadvantages appeared manifold. The latter begin with the fact that most businesses were administered from the US, employing almost no local management; likewise, the lion's share of inputs came from the mainland. Local light industries would now have to compete directly with those from the mainland whose variable costs were far lower. For these industries, factor prices had increased, thereby aggravating already extant structural problems. The tourism sector was also not exempt from these costs increases, which were compounded by high transportation costs to/fro the

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[2] A national and international boycott of the government financed factories (Fomento) also precipitated their closure. Nevertheless, the closure may also be attributed to the difficulties in establishing distribution channels with the larger market (Lewis, 1949).

[3] As seen in Box 3 of the Appendix (Statistical Series), the mean of gross internal investment in fixed capital went from a minimum value of 73.9 million dollars in 1947 to a maximum value of 973.5 in 1972.

island. To make matters worse, the government did not undertake an adequate promotional campaign to promote the island on the mainland. Generalized factor price increases were exaggerated in food markets due to quasi-monopolistic conditions and, in 1974, the Planning Board of PR formally called for expansion of the antitrust section of the Justice Department and for a clear policy that would deploy the Import and Distribution Corporation to encourage competition. The fact that nothing happened is evidence of the political strength underpinning the structural problems on the island. For the most vulnerable segments of the population, faced with high price levels and low levels of employment, migration to the mainland became the relief valve (Perloff, 1952). Nevertheless, migration and the subsequent remittances did not resolve the economic instability generated by inflation and unemployment.

By the mid-sixties, measures were being proposed to address the structural problems of integration with the federal system. Among the proposals were certain job classifications being exempt from the US minimum wage, the reduction of legal holidays, and a moratorium on new fringe benefits. Restrictions on foreign investment was also discussed in the context of the possibility that the majority of Puerto Rican government bonds might end up in the hands of foreign investors aggravating the political dependency of the economy and leading to the real possibility of capital flight, with all the attendant negative impacts for public finance. Such arguments were generally ignored.

The year 1976 may be considered a watershed in the economic development of PR. For the previous thirty years, the strategy of economic development had been based on attracting foreign capital via tax holidays, *de jure* and *de facto* subsidies (infrastructure and the environment) and relatively low salary scales (Quiñones,

1994). Section 936 of the Federal Tax Code[4] of 1976 took effect and granted a credit for income generated from assets and liabilities originating in PR as well as for taxes paid on foreign income. A deduction would also apply to dividends remitted to the parent company (Junta de Planificación, 1994; Ruiz y Zalacaín, 1996). Most of the multinational companies who responded to these fiscal incentives hailed from the US.

Section 936 was created to attract foreign investment in PR and offset some of the negative impacts of compliance with other federal laws, viz., the minimum wage and the Jones Act[5]. There is little doubt the incentive package enabled the development of a high technology sector on the island which would become one of the most dynamic sectors (Quiñones, 1994)[6].

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[4]   The antecedents to Section 936 originate in 1921 with Section 262. Section 262 of the Federal Income Tax Code was designed for US companies established in the Philippine Islands, then a possession of the US. The requirements to qualify for exemption under the Section were: at least 80 percent of the income would originate from commercial activities in the possession and 50 percent or more from incomes that originated in company operations in the possession (the condition 80-50). In 1955, this law was incorporated into the Federal Income Tax Code as Section 931, which continued offering a full exemption to incomes generated from US corporations in Puerto Rico, American Samoa, Guam and the Panama Canal.

[5]   The Act requires island-mainland ship transportation fly under the American flag (one of the most expensive in the world), imposes US citizenship on Puerto Ricans, and reserves to the US all powers correspondent to customs, immigration, mail services, maritime law, defense, commerce and all matters relating to sovereignty.

[6]   More than 60 percent of the 936 firms are in clothing, pharmaceuticals, machinery, and scientific and professional instrumentation (Catalá, 1993)

Businesses operating under Section 936 generated, both directly and indirectly, a large number of jobs and investment. The new activity also contributed to the tax coffers of the island through taxes on the repatriation of profits, income, and patents. Nevertheless, President Clinton overturned Section 936 on August 20, 1996 and a transition period was established for the phasing out of the incentives. During this period, the government is to seek new stimuli for industrial development. However, the flaw in such reasoning is the assumption that PR enjoys instrumental complementarity; indeed, the only significant attraction of capital to the island seems to have been the tax incentives (Catalá, 1993).

To this day, the nature of the problem of economic development in PR is not really distinct from what it was thirty years ago. None of the measures inspired by the various development models has fundamentally resolved structural problems of development. One sees persistent economic instability as well as a recent decline in the real Gross Domestic Product, a high level of unemployment and a downward cycle of fixed capital investment accompanied by inflation rates higher than those on the mainland. Nevertheless, the standard of living of Puerto Ricans does not seem to have borne the full brunt of this instability, cushioned by federal transfers and pubic and private debt that, in turn, translate into inflationary pressures from the demand side.

In summary, one can say that the inflation in Puerto Rico over the last generation originates more in the supply side than in the demand. The evidence suggests that inflation in factor prices has led only partially to heightened consumer demand. For example, the very high population density of the island and its legal status within the US, translated into steady and significant increases in the real price of land. To the extent that locally owned assets (e.g., land) were being liquidated for consumption, the causation of inflationary pressure

runs from the supply to the demand side. Unraveling the inflationary behavior of the Puerto Rican economy can help policy-makers perceive what measures are indeed available to them and thereby challenge the facile assumption that the island is merely a price(-level) taker.

III. Putting the model in the context of Puerto Rico

With the widespread assumption that inflation is lockstep with the US economy, there has been an absence of analysis of the evolution of inflation in PR. No consensus exists among economists in PR regarding the variables that determine inflation on the island nor any consideration of the possible role of public policy. To fill this lacuna, the following P* model is proposed as an indicator for expected inflation. The advantages of the model can be itemized:

1. One can include internal variables, like production level in PR, as well as the usual variables of the US economy that directly affect the magnitude of inflation.

2. One can forecast prices based on patterns in the behaviour of production levels and monetary aggregates, assuming the circulation velocity of money is constant as determined by the opportunity costs of money (Orphanides and Porter, 1998);

3. One can identify inflationary potential by estimating the price level to which the inflation will tend to adjust in the long run, as these are a function of the quantity of money in circulation (Galindo, 1997). Such estimation is grounded in the assumption that the circulation velocity of money and the potential production will seek equilibrium levels in the long run.

4. By comparing the real level of prices to that forecasted, one can also identify permanent changes in the national economy with respect to the circulation velocity of money or in the potential production level

A word of caution: because the island does not have *absolute* control over inflation, traditional monetary policy is not possible nor could the island ever impact the US variables in the model. Despite this, the P* model can be used as a general identity to analyze the behavior of the inflation rate in PR and the inertial effect based on the estimation of an error correction model.

One begins by considering the peculiar relationship of the economy of PR to that of the US. In a number of works, inflation in Puerto Rico has been found to be a monetary phenomenon. Toledo (2000) finds it so in both the short run and long run and claims a relationship of co-integration exists between inflation in Puerto Rico and the monetary supply in the United States. This result was also supported in a simplified IS-LM model of the Puerto Rican economy. (Rodríguez 2002)

The scenario described above has been greatly complicated by unanticipated interventions in US monetary policy, whose reverberations pass through the interest rates on federal funds. Such events impact unemployment and inflation in PR for a prolonged transitional period as the island economy is not resilient to immediate shocks. Toledo y Rodríguez (2003) have found both inflation and unemployment rates respond to the reduction in the interest rate on federal funds. The temporary effect of an increase in the federal fund rate to the inflation rate is negative but the permanent effect is positive. As expected, the unemployment rate tends to decline as a result of falling interest rates.

One can conceptualise the interest rate as a mechanism of transmission for the monetary policy of the US on PR. This means that the economic agents in PR should take into account fluctuations in the magnitude of US monetary policy instruments, which will subsequently generate macroeconomic shocks in PR that reverberate over time.

IV. Theoretical Framework

The P* model is based on the feasibility of using a monetary aggregate with unitary elasticity with respect to prices as an indicator of their the long-run relationship. It is an expression of the quantitative equation of money (Galindo, 1997; Orphanides and Porter, 1998) using the Unites States money supply: [7]

$$M_t V_t = P_t Y_t \tag{1}$$

where:

M_t = money supply of the United States;
V_t = money circulation velocity in Puerto Rico;
P_t = level of prices of Puerto Rico;
Y_t = national production of Puerto Rico.

The equilibrium level of prices (P*) can be obtained from (1):

$$P*_t = \frac{M_t V_t}{Y_t} \tag{2}$$

Applying natural logarithms, the estimation of (2) is represented by:

$$p_t = \beta_1 m_t + \beta_2 y_t + \beta_3 v_t + \varepsilon_t \tag{3}$$

where the lowercase letters denote natural logs. In this equation $\beta_1 = 1$, $\beta_2 = -1$ and $\beta_3 = 1$. The equation also

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[7] Although the variable M1 is a saving and transactions instrument, it shows a great structural stability with the variables of study.

presents a simple rule to forecast behavior of prices, assuming that the velocity of money is constant. A way to improve the predictive capacity of the model, without unduly complicating it, is to estimate separately the circulation velocity of (3) and then substitute that value for the vector z_t. Such a procedure allows a better simulation of the circulation velocity of money in PR and facilitates the search for a less restrictive form that incorporates the distinct dynamic responses of changes in the money supply and the level of economic activity.

$$p *_t = \beta_1 m_t + \beta_2 y_t + \beta_3 z_t + \varepsilon_t \qquad (4)$$
$$\varepsilon_t \sim N(0,\sigma^2)$$

A typical short-cut is to substitute the interest rate for the velocity of money. The use of the interest rate can be defended given the dependence of the island economy on that of the mainland and the correspondence between circulation velocity of money in PR and the prime interest rate in the US. The long-run relationship between the money supply and the prime rate of the US and real production and the level of prices in PR This is also corroborated with empirical evidence (Rodríguez, 2002; Toledo, 2000). So, the prime rate is presented as an approximation of the circulation velocity of money and equation (3) can be rewritten as

$$p_t = \beta_1 m_t + \beta_2 y_t + \beta_3 r_t + \varepsilon_t \qquad (5)$$
$$\varepsilon_t \sim N(0,\sigma^2)$$

where $\beta_1 = 1$ and $\beta_2 = -1$ and $\beta_3 = 1$ (Hall and Mine, 1994; Bordes, Girardin and. Marimoutou , 1993).

Equation (5) is then estimated using the Johansen procedure (1988) to determine the presence of co-integration. Such determination is necessary when a combination of variables exist that share similarity in the order of integration, suggesting the necessity of using series that co-integrate to obtain unbiased and consistent estimates and, thereby, avoid the problem of spurious correlation (Rodríguez, 2001). When a relationship of co-integration is present in the series, the residual variance is minimized in the parametric space and the resulting estimates are highly consistent and will converge on their true value. (Rodríguez, 2001; Novales, 1997; Maddala, 1996; Johnston y DiNardio, 1997)

If the specification of the existence of this phenomenon is in error, one will accept as valid those relationships that are merely spurious in the process of drawing inference (Bhargava, 1986; Maddala, 1996; Maddala and Kim, 1998; Enders, 1995). In terms of political economy, this means that an incorrect execution of the analysis, will lead to erroneous conclusions in policy making (Rodríguez, 2001). Such caution is warranted for any econometric model that uses time series.

If there is a co-integration relation among the variables in the model, the short-run dynamics of this relationship can be represented in an error correction model:[8]

$$\Delta p_t = \alpha_{11}(p - p^*)_{t-1} + \alpha_{12}\Delta p_{t-1} + \alpha_{13}\Delta m_{t-1}$$
$$+ \alpha_{14}\Delta y_{t-1} + \alpha_{15}\Delta r_{t-1} + \xi_{1t} \qquad (6)$$
$$\xi_{1t} \sim N(0,\sigma^2)$$

The lagged difference terms capture the effects of the series, like for example, transportation costs, short-term changes in production and the financial sector, and other peculiarities of the economy of the island which affect

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[8] As only annual production data exists, an annual periodicity is used. If prices need to be forecasted monthly or quarterly, the utilized variable (parameter) can be replaced by any measure that is a good indicator of short-run economic activity.

prices in the short run. The model can also include the effects between the gap of real production and the potential production, which can be associated to a change in prices as a direct result of pressures over the installed capacity or to the differential between the level of unemployment and potential production (Kuttner, 1989; Galindo, 1997). That is to say, changes in the level of prices will have real effects, which can be transmitted through out several periods. In this case, consider the following model:

$$
\Delta p_t = \alpha_{11}(p - p^*)_{t-1} + \alpha_{12}(y - y^*)_{t-1} + \alpha_{13}p_{t-1} \\
+ \alpha_{14}\Delta m_{t-1} + \alpha_{15}\Delta y_{t-1} + \alpha_{16}\Delta r_{t-1} + \mu_{1t}
$$
(7)

The dynamics of inflation is modeled assuming that any increments in the monetary supply generate increments in the price level. Nevertheless, the presence of idle capacity leaves:

$$
(p - p^*)_t = (v - v^*)_t + (y - y^*)_t
$$
(8)

This equation indicates the deviations in the observed price level and that forecasted should be compensated with fluctuations in the velocity of money and the total production (Galindo, 1997). Inflation (gp_t) can be modeled under the assumption that it tends toward its equilibrium value and the growth rate of inflation (ggp_t) can be estimated in its simpler form (Galindo, 1997):

$$
ggp_t = \phi_{ij}(p - p^*)_{t-1}
$$
(9)

Equation (9) tells us that the rate of growth of inflation accelerates when p*>p and vice versa. In this case, the general form of the model of price gap can be solved:

$$
ggp_t = \delta_{11}(p - p^*)_{t-1} + \sum_{i=1} \delta_{12}(i)\Delta ggp_{t-i-1} + \varphi_{1t}
$$
(10)

This model can also be expressed in the equivalent form for inflation (Hallman, Porter and Small, 1991; Orphanides and Porter, 1998):

$$
gp_t = \gamma_{11}(p - p^*)_{t-1} + \sum_{1=1} \gamma_{12}(i)\Delta gp_{t-i-1} \\
+ \sum_{i=1} \gamma_{13}(i)\Delta z_{t-i-1} + \zeta_{1t}
$$
(11)

V. Empirical Evidence

The series are of annual frequency for the period 1964 to 1997. The variables used in the P* model are the consumer price index (li), the real production level (ly), the prime rate (lr) and the money supply (M1) of the US (lm). All variables are expressed as natural logs.

The tests of unitary roots in Table 1 indicate all variables show the same order of integration. The existence of similarity in the order of integration in the series demonstrates a stable relationship over time, which suggests stability is achieved in the long run (Novales, 1997; Bhargava, 1996).[9] This result is important as it suggests the relevance of the price equation in the long-run (Rodríguez, 2002). So, the necessity arises of using series that co-integrate in order to obtain unbiased and consistent estimates that do not suffer from the problem of spurious correlation. As long

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[9] The determination of the order of integrabilitiy of a series is fundamental and not doing it correctly, in terms of political economy, can lead to erroneous conclusions in decision-making.

as co-integration exists among the variables, the relationship will not hold due to theoretical reasons rather than due to the magnitude of the variables.

In order to determine the existence of the long-run relationship among the variables, a model of autoregressive, unconstrained, lagged vectors is estimated. According to Table 2, the results indicate the presence of at least two vectors of co-integration. The existence of more than one vector of co-integration leads to the rejection of the test of weak exogeneity, as shown in Table 3. This suggests it is not possible to make valid statistical inferences using only one equation. This leads one to conclude there is a strong feedback between the level of economic activity and the price level.

One should note well the alpha values are close to zero which means that, in spite of weak exogeneity, the variables considered contain relevant information to explain the behavior of the system. By being so low, any exclusion of some of the variable would invalidate statistical inference and lose relevant information in subsequent estimations of the information generating process (Ericsson and Irons, 1994; Rodríguez, 2002). So, in rejecting the weak exogeneity hypothesis, one should include more than one co-integration vector for each equation in the error correction form (Ericsson and Irons, 1994; Rodríguez, 2002).

Table I
Order of integration of the series by means of the Dickey-Fuller (ADF)a and Phillips-Perron (PP) tests

Variable	ADF	PP
p_t	-1.754	-1.055
Dp_t	-2.862*	-2.300*
m_t	-1.136	-0.878
Dm_t	-3.235*	-2.818*
y_t	-0.971	-1.475
Dy_t	-5.369*	-5.105*
R_t	-3.055	-2.088
DR_t	-5.553*	-3.928*

*Indicates 95 percent of significance

Table II
Cointegration tests for lp_t, ly_t, lm_t, lr_t

Eigenvalue	H_o:rank = p	$-T \ln(1-\lambda_{p+1})^a$	95%
0.959	p = = 0	105.87	15.00
0.707	p < = 1	40.47	11.23
0.164	p < = 2	5.91	7.37
0.018	p < = 3	0.6	2.98

Eigenvalue	H_o:rank = p	$-T \Sigma\ln(1-\lambda_{p+1})^b$	95%
0.959	p = = 0	152.85**	36.58
0.707	p < = 1	46.98*	21.58
0.164	p < = 2	6.51	10.35
0.018	p < = 3	0.6	2.98

a/ $-T \ln(1 - \lambda_{p+1})$ = maximum characteristic root test;
b/ $-T \Sigma \ln(1 - \lambda_{p+1})$ = trace test;
It doesn't include intercept neither tendency.

By normalizing the first cointegration vector of the model, the restated equation is:

$$li = -0.310 * ly + 1.037 * lm + 0.106 * lr \qquad (12)$$

Maximum Likelihood Test: $\chi^2(2)$ = 11.98

The signs are as expected in standard economic theory. The parameters indicate the relationships economic agents use to maintain the prices in the path toward equilibrium mean short-run price level dynamics can be interpreted in an error correction model.

Table III
Weak exogeneity tests for the price equation

r	DGF	$\chi^2(r)$	LP	LY	LM	LR
1	1	3.84	45.67	27.61	43.80	0.17
2	2	5.99	60.58	47.96	44.69	2.66
3	3	7.81	62.84	49.86	48.95	5.46

Table IV
Alpha Parameters for the price equation

	dlp_t	dlm_t	dly_t	dlr_t
dlp_t	0.125	0.410	0.062	0.000
dly_t	0.073	0.048	0.040	0.000
dlm_t	0.150	0.012	–0.167	-0.000
dlr_t	0.034	0.161	0.800	-0.001

The tests of strong exogeneity, summarized in Table V, indicate the presence of a feedback effect between the level of prices and economic activity. In other words, unexpected changes in the level of the economic activity are being directly transferred to the price level. The surprise effect in prices will affect the expectations of economic agents and, therefore, real production (Hoover, 1981).

Table V
Granger Causality Tests

Lag	$lp_t \rightarrow ly_t$
1	2.822*
Lag	$ly_t \rightarrow lp_t$
1	4.116*
Lag	$lp_t \rightarrow lr_t$
1	0.003
Lag	$lr_t \rightarrow lp_t$
1	13.569*

The results obtained mean that the generating process of information is an approximation to forecast inflation stemming from P*. The final model, presented in Table VI, does not have autocorrelation problems [LM $\chi^2(4)$: 9.880], heteroskedasticity [ARCH $\chi^2(2)$:2.507] and the errors are normally distributed [JB$\chi^2(2)$:0.341].

Table VI
Inflation Model

Dependent Variable: LI
Method: Seemingly Unrelated equations
Date: 04/09/02   Time: 08:47
Sample(adjusted): 1966 1997
Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.535658	0.311386	1.720240	0.0973
ECO(-1)	-3.541897	0.905738	3.910509	0.0006
DI	0.286898	0.267726	1.071612	0.2937
DY	-11.04772	2.881736	-3.833704	0.0007
DM	-1.603489	2.045034	-0.784089	0.4401
DR	0.795845	0.462270	1.721604	0.0970

R-squared	0.583206	Mean dependent var	1.531061
Adj R-squared	0.503053	S.D. dependent var	0.501789
S.E. regression	0.353733	Akaike info criterion	0.926814
SSR	3.253309	Schwarz criterion	1.201639
Log likelihood	-8.829023	F-statistic	7.276183
Prob(F-stat)	0.000223		

VI. Conclusión

Analysis of the present and future evolution of prices in PR is essential for sound public policy. However, few studies have analyzed the evolution of the prices in PR in either the short or long run; the P* model offers a feasible framework to meet this need. According to the results obtained of the application, one may say that the price level in Puerto Rico is a monetary variable that is influenced by both the monetary policy of the United States and the economic activity of the island.

The VAR model captures the empirical regularities in the evolution of prices. Through the Johansen procedure, two co-integration vectors have been established and an estimate then made for the long-run equation of prices. The signs conform to that expected in standard economic theory and the statistical tests yielded satisfactory results. One concludes that the long-run evolution of the price level can be obtained by calculating the co-integration error of the MCE of the price level, which can then be used to estimate the future inflation of PR for local policy purposes.

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Carlos A. Rodríguez is Professor of Economics at the University of Puerto Rico.

Carlos A. Rodríguez, Ph.D.
Department of Economics
University of Puerto Rico
Rio Piedras, PR 00901-3346
Email:carora410@yahoo.com.mx