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A Quarterly Econometric Model of Panama*

1. INTRODUCTION

This paper reports on a new econometric model for a Latin American country—Panama. The purposes of this model are fourfold:

1. To provide a framework for the systematic analysis of the available short-run data about the Panamanian economy.
2. To make short-run predictions of developments in the Panamanian economy.
3. To provide a tool for simulating the effects of changes in policies and in other exogenous variables on the Panamanian economy.
4. To serve as a prototype for the development of similar models for other Latin American economies.

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Some previous econometric work on Panamá has been done by Stavrou and Arboleda. One of the features of the present model that distinguishes it from that model and most other econometric models of developing economies is that it is based on quarterly observations. To our knowledge this is the first time that a medium-scale, quarterly econometric model has been estimated for a developing economy. Other distinguishing features include the product and sectoral detail (especially for the critical agricultural sector), the effort to identify separate supply and demand considerations in a number of sectors, and the related distinction among sectors and products for which prices are set by the government, by the international market, or by internal balance between supply and demand.

The paper is organized as follows. Section 2 describes the structure of the model. Section 3 discusses its sample performance. Section 4 reports on some dynamic multiplier runs for changes in various policy instruments.

2. MODEL STRUCTURE

The model contains 97 endogenous and 71 exogenous variables. To determine the endogenous variables there are 55 estimated behavioral or technological relations and 42 identities. The sample period for relations estimated from quarterly data is generally 1965-1973, or 36 observations.[1] For some of the agricultural products the unit of observation is a year, in which case the sample period generally is 1962-1973, or 12 observations.

The estimation technique primarily used for estimated relations is ordinary least squares (although in some cases maximum likelihood procedures are utilized for autocorrelated error structures). The expected returns of adopting more sophisticated methods seemed less than the expected costs of doing so, given the nature of the data, some questions about the robustness of alternative estimators, and the opportunity costs of sophistication in estimation procedure in exploring various model structures. Polynomial distributed lags (including geometric and Almon lags as special cases) are used to represent adjustment processes and the creation of expectations. Dummy variables are included to explore the extent of seasonality due to annual patterns in agricultural production and demand, Christmas demand, and so on. (DM_i, where i indicates the quarter, with the fourth quarter as the reference point). For each estimated relation the coefficient of determination corrected for degrees of freedom ($\bar{R}^2$), the standard error of estimate (SE), the Durbin Watson statistic (D),[2] and the sample period are presented after the estimates. The t-statistics are given in parentheses under the point estimates.

The model is specified basically in real terms (i.e., stock and flow variables generally are deflated). Both demand and supply features enter into the determination of the macroeconomic aggregates of interest, given the history of past values of all variables, current government policies, current international prices and market conditions, and other variables exogenous to the Panamian economy. Capacity adjustments on the supply side tend to occur less rapidly than many adjustments on the demand side, however, so in an immediate sense the model is as much demand as supply determined.

The discussion of the model specification below is organized around seven blocks of variables: government policies, production of value added in real terms, final demand, prices, wages and the labor market, the monetary sector, and identities. With this specification the model can be used to explore the impact of changes in a number of government policies (subsection 2.1) or other exogenous variables on the following major areas of macroeconomic policy concern:

1. Nominal stability (i.e., the rate of change of prices).
2. Real stability (i.e., the rate of utilization of available physical and human resources).
3. Structural change (i.e., relative shifts in sectoral production and in demands).
4. Income distribution (i.e., real wages, employment, sectoral conditions—including particular emphasis on agriculture).
5. International economic position (i.e., level of reserves, balance of trade in goods and services).
6. Growth (i.e., level and composition of physical and human resource investment).

2.1 Government Policies

Within the framework in which the Panamian government has operated some of the major policy tools that most governments use are not available. This is particularly true in the international monetary area, where the Balboa has been maintained completely convertible at parity into the United States dollar, with the latter actually serving as the paper currency in circulation, and where there has been no central bank to engage in the usual type of monetary policy. Nevertheless, the government has a number of policy variables that can be assumed to be exogenous in this model. Of course, for some of these instruments the degree of exogeneity depends on the time period of reference and/or the availability of external resources. Government expenditures and revenues, for example, while somewhat independent in the short run, combine to determine the government deficit (surplus) and are constrained by the availability of means of covering that deficit. The maintenance of complete convertibility also obviously limits the range of many policy options, once other basic decisions have been taken.[3]

2.1.1 Government Expenditures: include current consumption ($\overline{C}_g$), investment ($\overline{I}_g$), and net transfers to families ($\overline{TR}_i$) and to government enterprises ($\overline{TR}_{ge}$). Government investment basically includes the creation of new or replacement capital stock but also some purchases of private plant and equipment (most notably during the sample, the purchase of private utilities).

2.1.2 Government Revenues (including loans): Taxes include those on imports ($\overline{TX}_M$), sales, production and other indirect ($\overline{TX}_{SP}$) and direct income ($\overline{TX}_D$). As is the case for most developing countries, indirect taxes are relatively more important than in the developed countries. Nontax inflows include net income from government enterprises ($\overline{Y}_{ge}$), net income to the government from casinos, hippodromes, and lotteries ($\overline{Y}_{gche}$), and net loans to the government ($\overline{L}_g$).

2.1.3 Canal Zone: The net income from the canal zone ($\overline{Y}_{cz}$) is presumed to be the result of negotiations with the United States Government and of canal usage. Although it is far from completely under the control of the Panamian Government and thus not a direct policy instrument in the sense of some of the other variables considered in this section, it is appropriate to treat it as exogenous to the model.

2.1.4 Free Zone: The net income from the free zone of Colon ($\overline{Y}_{fz}$) depends upon the level of intra- and inter-American trade and the capacity of the zone. In recent years the government has taken steps to expand that capacity, but, unfortunately, within the resource constraints for this study data could not be located that permit the endogenization of this variable. Therefore, net income from the free zone is considered to be an exogenous government policy instrument, even though it is the net result of a whole set of policies and of the level of international trade activity.

2.1.5 Government Set Prices and Minimum Wages: The government sets prices ($\overline{P}_i$) for some major products (e.g., basic agricultural and food staples; see subsection 2.2.2.1 below). It then regulates international trade flows to assure that such price policies are effective. It also sets sectoral minimum wages ($\overline{W}_i$) although adjustments in these minimums during the sample period were very infrequent.

2.1.6 Monetary Variables: As is suggested above, within the framework of complete convertibility maintained through the sample period, the options for monetary policy have been quite limited. Nevertheless an attempt has been made to fix interest rates ($\overline{R}$)[4] and to control sectoral credit allocations ($\overline{CRDT_i/CRDT}$). While there is no direct representation of the factors associated with the substantial expansion of international banking activity in Panama following the 1970 banking law, Johnson (1976) concluded that the benefits to Panama have been limited. Nonetheless, the expansion of this activity certainly has had an impact on the real value added from banks and other financial institutions within the model framework.

2.2 Production of Value Added (V) and Exports (X) in Real Terms

It is convenient to distinguish among three major categories of goods and services: export oriented, other traded and tradable, and nontraded.[5]

2.2.1 Export-Oriented Goods and Services[6]

2.2.1.1 Agricultural and Fishing: Panama's major nonpetroleum goods exports come from this sector. Within the model two major products are emphasized.

The real export value of *bananas* ($\overline{X}_B$) is assumed to be determined by the banana-producing companies, independently of the rest of the model. Attempts to estimate banana export functions on the basis of responses to variables such as deflated prices (both short- and long-run) and weather conditions were not fruitful.

The real export value of shrimps ($\overline{X}_{SH}$) is dominated by a negative shift in the first quarter, when fishing has been limited to maintain the stocks, and a positive response to relative prices with a lag of over a year:

$$SHRIMP = \underset{(-6.64)}{-0.0081} \; DM1 \qquad (2.2.1.1\text{-}1)$$

$$+\underset{(.08)}{0.0002} \; P_{SHR}/P_{WH}$$

-0.0020 (-1.81)	P_{SHR}/P_{WH-1}
-0.0032 (-3.74)	P_{SHR}/P_{WH-2}
-0.0033 (-2.37)	P_{SHR}/P_{WH-3}
-0.0024 (-1.52)	P_{SHR}/P_{WH-4}
-0.0005 (-.35)	P_{SHR}/P_{WH-5}
+0.0025 (2.07)	P_{SHR}/P_{WH-6}
+0.0066 (3.08)	P_{SHR}/P_{WH-7}
+0.0116 (2.88)	P_{SHR}/P_{WH-8}
+0.0179 (2.82)	P_{SHR}/P_{WH-9}

$\bar{R}^2 = 0.733, SE = 0.0024, D = 2.36$, 1968.2 - 1973.4

Second-degree Almon polynomial distributed lag unconstrained,

$$\Sigma \alpha_i = \underset{(1.40)}{0.0095}$$

The initial negative price response is somewhat puzzling, but explorations with alternative specifications have not led to a preferable formulation.

These agriculture and fishing exports enter into the determination of total agricultural and fishing production (Q_A) and total real agricultural and fishing value added (V_A) together with the other primary products that are considered in subsection 2.2.2.1 below.

2.2.1.2 Petroleum Products: Since the establishment of a refinery in Panama, this subsector has been a major subsection of gross output within the industrial production and export subsectors. Because of the need to import petroleum inputs and because the production mix of petroleum products does not coincide exactly with the domestic consumption mix, imports remain important for this subsector. Within the model, production (Q), value added (V), domestic demand (D), imports (M), and exports (X) for this subsector (FL) are determined by the following set of relations:[7]

$$
\begin{aligned}
Q_{FL} = {} & \underset{(0.923)}{10.5145} * P_{FL}/P_{WH_{IND}} + \underset{(3.11)}{0.3730} * V_{IND} \\
& + \underset{(2.30)}{0.4148} * Q_{FL_{-1}} - \underset{(-1.05)}{11.6128}
\end{aligned} \qquad (2.2.1.2\text{-}1)
$$

$\bar{R}^2 = 0.941, SE = 0.8885, D = 1.61,$ 1965.3 - 1972.4

$$
V_{FL} = \underset{(1.45)}{0.1147} * Q_{FL} + \underset{(0.767)}{1.1171} + 0.7764 * u_{-1} \qquad (2.2.1.2\text{-}2)
$$

$\bar{R}^2 = 0.751, SE = 0.5206, D = 1.81,$ 1965.3 - 1972.4

$$
\begin{aligned}
D_{FL} = {} & \underset{(9.35)}{0.1755} * V - \underset{(-2.19)}{9.3326} * P_{FUEL}/P_{WHOLESALE} \\
& + \underset{(2.52)}{2.8671} * DM2 + \underset{(1.26)}{1.2431} * DM3 \\
& - \underset{(-2.66)}{2.66} * DM1 + 0.2658 * u_{-1}
\end{aligned} \qquad (2.2.1.2\text{-}3)
$$

$\bar{R}^2 = 0.854, SE = 2.16, D = 1.98,$ 1965.4 - 1972.4

$$
\begin{aligned}
M_{FL} = {} & \underset{(1.17)}{0.0098} * V + \underset{(4.55)}{0.6828} * M_{FL_{-1}} - \underset{(-6.92)}{3.9775} * DM1 \\
& - \underset{(-0.53)}{0.2928} * DM2 + \underset{(2.17)}{3.7647}
\end{aligned} \qquad (2.2.1.2\text{-}4)
$$

$\bar{R}^2 = 0.68, SE = 1.2384, D = 2.12,$ 1965.3 - 1973.4

$$
X_{FL} = Q_{FL} + M_{FL} - D_{FL} \qquad (2.2.1.2\text{-}5)
$$

Real production responds to the price of petroleum products relative to the industrial wholesale price index (which represents the cost of inputs) and to the current level of domestic industrial real value added. This response occurs with a lag due to adjustment processes but still is fairly quick. The estimated relation is consistent with most of the variance in the dependent variable (and with a higher proportion of the variance than in the other three estimated relations in this set).

In the estimated relation between real value added and production the assumption is made that there is no substitution between primary factors and intermediate inputs in the production process. Real value added is estimated to be only 11 percent of real production at the margin with a substantial degree of positive autocorrelation. This low value reflects the great importance of material inputs—especially crude petroleum—in the production process. As a result, value added per unit of petroleum production is relatively limited (with no significant trend).

Real domestic demand is estimated to respond positively to total real value added (representing general economic activity) and negatively to the price of petroleum products deflated by the wholesale index with some positive serial correlation. The estimated marginal propensity to demand petroleum products out of total value added is about 18 percent. There also is evidence of a negative seasonal effect for the first quarter and a positive one for the second and possibly the third.

Imports might be interpreted as an adjustment toward general economic activity as represented by total real value added. The estimated marginal propensity to import petroleum products out of total value added is only about 1 percent—much smaller than that noted above for domestic demand. The levels of significance of the variables, however, suggest that this relation basically reflects an autocorrelated structure. In any case there is evidence of a significantly negative downturn in the first quarter, which is parallel to that observed in the domestic demand relation (although here there is less evidence of significant seasonal effects for the next quarter).

Exports, finally, are that part of supply that is not consumed domestically. This assumes that undesired inventories are not accumulated, but regulated through changing production or foreign trade. This also assumes that petroleum products can be considered to be relatively homogenous.

2.2.1.3 Services: Exports of services are much more important than exports of goods in the Panamanian case. As is indicated in subsections 2.1.3 and 2.1.4 above, two important components of these services are treated as exogenous—net income from the canal and from the free zone. Exports of other services are estimated to depend on the level of tourism[8] and on the degree of overall international trade activity as represented by exports:

$$X_{OS} = \underset{(9.30)}{1.0809} * \overline{\text{TOUR}} + \underset{(5.32)}{0.2972} * X - \underset{(-4.56)}{19.5711} \qquad (2.2.1.3\text{-}1)$$

$\bar{R}^2 = 0.895$, $SE = 3.595$, $D = 1.85$, 1967.1 - 1973.4

Both of these variables probably are serving partially as proxies for nontourism activity in business and finance by foreigners in Panama. Multicolinearity makes it very difficult to identify the relative importance of tourists versus others.

2.2.2 Other Trade and Tradable Goods and Services: This category is subdivided into two groups, depending upon whether or not the government plays a major role in fixing prices.

2.2.2.1 Prices Set by Government with Imports to Fill the Gap: For nonexported, basic agricultural goods and staples the government effectively sets prices and allows imports to cover any shortfalls in production. The prices are set early enough each year so that farmers can know with certainty harvest prices before planting. The hope is that the elimination of price uncertainty induces higher production (see Behrman [1968] for evidence of such an effect in the case of another developing country). However, the prices are set, if anything, below the level required to clear the market using only domestic supplies in hopes of keeping the price of wage goods low for nonagricultural laborers. Of course, although the government may increase domestic supplies through the reduction of uncertainty, it cannot set domestic prices significantly below marginal international prices and still obtain the necessary imports unless it provides subsidies.

For each of the major agricultural products a supply function is included in the model. In cases in which two crops are harvested each year (i.e., corn, rice, and beans) separate functions are estimated for each crop. Whether there are one or two crops per year, the functions are based on annual data. Within the quarterly model these annual outputs are allocated to quarters under the assumption that the harvest occurs uniformly each year over the harvest months reported by the Controloría in the original data source. To obtain total real value added in agriculture and fishing (V_A), a price weighted average of these products plus those in subsection 2.2.1.1 is constructed (Q_A), and the following autocorrelated quarterly relation is used:[9]

$$\underset{}{V_A} = \underset{(6.58)}{7.2811 * DM3} - \underset{(-9.61)}{10.5548 * DM2} - \underset{(-4.32)}{7.0837 * DM1} \qquad (2.2.2.1\text{-}1)$$

$$+ \underset{(8.03)}{0.1822 * Q_A} + \underset{(22.85)}{31.9352} + 0.1604 * u_{-1}$$

$\bar{R}^2 = 0.903$, $SE = 2.2765$, $D = 2.24$, 1965.2 - 1972.4

The coefficient of Q_A includes the effects both of including only the major products in the weighted index and of translating from total value to value added (although the positive autocorrelation and constant terms make interpretation somewhat difficult). The dummy variables are included to explore the possibility that the seasonality of the agricultural and fishing products not included in the Q_A index differs from those included. The point estimates suggest that, indeed, total real agricultural value added is relatively lower in the first half year and higher in the second than the Q_A index implies.

The supply functions for the individual major products underlying the aggregate index are as follows:

$$CORN\ 1 = \underset{(3.56)}{435.6612} * [[P(NEW\ CORN) * 5.0 + P(DRY\ CORN)]/2{*}I.\ DEF.\ AGRO] - \underset{(-3.27)}{21.7018} * R + \underset{(8.80)}{25.8653} * AREA\ 1 - \underset{(-3.35)}{1927.2855} \qquad (2.2.2.1\text{-}2)$$

$$\bar{R}^2 = 0.943,\ SE = 62.93,\ D = 2.21,\ 1962 - 1973$$

$$CORN\ 2 = \underset{(1.27)}{73.4465} * [P(DRY\ CORN)/AGRICULTURAL\ WAGE * 0.0015]_{-1} + \underset{(5.20)}{5.9953} * WEATHER - \underset{(-1.22)}{396.4975} \qquad (2.2.2.1\text{-}3)$$

$$\bar{R}^2 = 0.827,\ SE = 70.94,\ D = 1.57,\ 1966 - 1973$$

$$RICE\ 1 = \underset{(3.71)}{605.5264} * [(PRICE_1 RICE + PRICE_2 RICE)/2.0(I.\ DEFL.\ AGR. * 0.01)] + \underset{(2.13)}{5.2289} * WEATHER - \underset{(-.81)}{1.0063} * AGRIC.\ WAGES/(IMPL.\ DEFL.\ AGR. * 0.01) - \underset{(-1.55)}{1279.5138} * DUMMY65 \qquad (2.2.2.1\text{-}4)$$

$$\bar{R}^2 = 0.407,\ SE = 300.44,\ D = 1.53,\ 1962 - 1973$$

$$RICE\ 2 = \underset{(1.78)}{276.1946} * [PRICE_1 RICE/(IMP.\ DEFL.\ AGR. * 0.01)] \qquad (2.2.2.1\text{-}5)$$

$$+ \underset{(3.32)}{3.8095}\, WEATHER + \underset{(1.93)}{2.2038}\, WEATHER_{-1} - \underset{(-1.74)}{1791.5229}$$

$\bar{R}^2 = 0.716$, $SE = 52.00$, $D = 2.38$, 1963 - 1973

Second-degree Almon, polynomial, distributed lag constrained to be zero at $t - 1$,

$$\Sigma \alpha_i = \underset{(2.94)}{6.01}$$

$$BEAN\ 2 = \underset{(1.65)}{12.3289} * [PRICE_2 BEAN/ (IMPL.\ DEFL.\ AGR. * 0.01)] + \underset{(6.37)}{1.1258} * WEATHER - \underset{(-1.61)}{120.7988} \quad (2.2.2.1\text{-}6)$$

$\bar{R}^2 = 0.810$, $SE = 14.98$, $D = 2.47$, 1961 - 1973

$$(BEAN\ 2 + BEAN\ 1) = \underset{(1.05)}{4.9668} * [PRICE_2 BEAN/ (IMPL.\ DEFL.\ AGR. * 0.01)] + \underset{(9.95)}{1.1222} * WEATHER - \underset{(-.92)}{42.9709} \quad (2.2.2.1\text{-}7)$$

$\bar{R}^2 = 0.917$, $SE = 10.29$, $D = 1.78$, 1961 - 1973

$$BEAN\ 1 \equiv (BEAN\ 2 + BEAN\ 1) - BEAN\ 2 \quad (2.2.2.1\text{-}8)$$

$$TOBACCO = \underset{(3.32)}{0.2737} * [P(TOBACCO)/ (AGRIC.\ WAGE * 0.0015)] + \underset{(3.10)}{7.3248} * AREA + \underset{(1.14)}{3.5294} \quad (2.2.2.1\text{-}9)$$

$\bar{R}^2 = 0.787$, $SE = 1.32$, $D = 1.64$, 1965 - 1973

$$COFFEE = \underset{(1.44)}{1.0993} * [P(COFFEE)/ (IMPL.\ DEFL.\ AGRIC. * 0.01)]_{-1} + \underset{(4.28)}{0.3666} * WEATHER + \underset{(1.45)}{33.8494} \quad (2.2.2.1\text{-}10)$$

$\bar{R}^2 = 0.616$, $SE = 5.32$, $D = 2.51$, 1962 - 1973

$$SUGAR = \underset{(2.33)}{7.2779} * [AGRIC.\ CREDIT/ (IMPL.\ DEFL.\ AGRIC. * 0.01)] \quad (2.2.2.1\text{-}11)$$
$$- \underset{(-2.78)}{187.3050} * DUMMY\,65 + \underset{(1.15)}{0.8600} * WEATHER$$
$$+ \underset{(4.55)}{299.6557} * P(SUGAR)/(IMPL.\ DEFL.\ AGRIC. * 0.01)_{-1}$$
$$- \underset{(-2.93)}{958.6281}$$
$$\bar{R}^2 = 0.943, SE = 63.99, D = 2.10, 1961 - 1973$$

$$CHICKEN = \underset{(2.76)}{18.9480} * LIVESTOCK\ CREDIT/ (IMPL.\ DEFL.\ AGRO.\ /100) \quad (2.2.2.1\text{-}12)$$
$$+ \underset{(3.72)}{15550.3872} * P(CHICKEN)/ (IMPL.\ DEFL.\ AGRO./100)$$
$$- \underset{(-2.10)}{2953.6937}$$
$$\bar{R}^2 = 0.944, SE = 130.86, D = 2.55, 1964 - 1973$$

$$EGG = \underset{(10.29)}{51.3208} * AGRICULTURAL\ CREDIT/ (IMPL.\ DEFL.\ AGRO./100) \quad (2.2.2.1\text{-}13)$$
$$+ \underset{(19.12)}{3767.7559} * P(EGGS)/(IMPL.\ DEFL.\ AGRO.\ /100)$$
$$\bar{R}^2 = 0.930, SE = 165.64, D = 3.17, 1964 - 1973$$

On a general level, these individual supply functions seem to be reasonably satisfactory.[10] All but two of the relations are consistent with over 70 percent of the variance in the dependent variable over the sample period. With the exception of eggs, serial correlation is not an apparent problem. However, the number of observations is quite limited in some of these estimates (e.g., *CORN* 2) because of the lack of critical data for the earlier years.

On a more detailed level, these supply results may be summarized as follows:

1. The price (or weighted averages of prices for various qualities) of the product of concern, relative to the price of alternatives (as

represented by the agricultural deflator) or relative to the agricultural wage has a significantly positive coefficient in each of the estimated relations.[11] As has been found in many other studies of developing agriculture (see Behrman [1968, 1973a] and the references therein), significant price responses are pervasive in Panamanian agriculture. In one particular respect, however, these results differ from previous studies. The response in Panamanian agriculture generally is to the current actual price, not to some representation of expected prices based on past experience. This difference, of course, reflects the government policy of announcing fixed harvest prices before planting so that farmers expectations for the harvest prices are in fact the actual prices.[12]

2. Following the traditional Nerlovian agricultural supply model (e.g., Nerlove [1958] Behrman [1968]) the possibility of adjustment lags was explored in all of the relations. In no case, however, is evidence obtained of an adjustment process longer than a year.[13] The implied rapid adjustment well may reflect the same characteristic as described above. With certainty about product prices, farmers can be less cautious in switching from one product to another.[14]
3. Originally it was hoped that data from the survey of area planted would be available quickly enough so that data from this survey could be used in forecasts for one or two quarters into the future and the specification could distinguish between the allocation of area and the allocation of other inputs to the production process. Currently, however, the survey data are not processed sufficiently quickly to permit the possibility of using planting data from the survey in ex ante forecasts of harvests. For all of the agricultural crops except for the first corn crop and tobacco, moreover, combining the area allocation decision with the rest of the production process results in a formulation at least as consistent with the variation in production as when area is treated separately, and therefore area is not included as a separate variable.
4. The government has attempted to affect agricultural production by channeling credit to it. In each relation, therefore, the effects of the real quantity of credit[15] and the cost of credit were explored. Significantly positive coefficient estimates for the quantity of real credit are presented for sugar, chicken, and egg production. A significantly negative coefficient estimate for the cost of credit is indicated for the first crop of corn. Thus these credit variables do appear to have had some significant impact on the quantities of agricultural production, with the quantity of credit being more important than the cost, as has also been found in other

studies of developing economies. It is not clear from the estimates, of course, whether only these farm products are responsive to such credit variables or only the producers of these products have had access to credit.

5. In the agricultural sector much more than in most other sectors of the economy, the magnitude of output depends on weather conditions. As a partial index of these conditions, crop-specific rainfall indices (in which provincial rainfalls are weighted by the shares of the provinces in total national production of each specific crop) are included. For seven of the nine crops (all but the first corn crop and tobacco), such rainfall indices have significant positive coefficient estimates. Of course, more sophisticated indices (e.g., incorporating humidity, sunlight, the timing of rainfall, the deviations of rainfall from some ideal amount, etc., might lessen substantially more the unexplained residuals).

To this point in this subsection, emphasis has been on agricultural production. The rest of the subsection is devoted to the food-processing industries, which, of course, utilize agricultural production and imports as their major intermediate inputs.

The treatment of the food-processing industries within the model is somewhat similar to the treatment of petroleum products (see subsection 2.2.1.2 above). Production (Q), value added (V), exports (X), domestic demand (D), and imports (M) for this subsector are determined by the following set of relations based on quarterly data:[16]

$$Q_{FD} = \underset{(1.13)}{4.7919} * CRDT_{IND}/P_{FD} + \underset{(21.95)}{0.9523} * Q_{FD_{-1}} + \underset{(1.67)}{1.1667} \qquad (2.2.2.1\text{-}14)$$

$$\bar{R}^2 = 0.983,\ SE = 0.6224,\ D = 2.18,\ 1965.2 - 1972.4$$

$$V_{FD} = \underset{(4.03)}{0.2186} * Q_{FD} + \underset{(2.59)}{3.5761} + 0.7528 * u_{-1} \qquad (2.2.2.1\text{-}15)$$

$$\bar{R}^2 = 0.916,\ SE = 0.3900,\ D = 2.28,\ 1965.2 - 1972.4$$

$$D_{FD+A} = \underset{(1.15)}{0.1476} * C_P - \underset{(-1.32)}{9.3819} * DM2 - \underset{(-2.23)}{15.63} * DM3 + \underset{(7.82)}{50.4920} * DM1 + \underset{(2.06)}{43.1742} + 0.4840 * u_{-1} \qquad (2.2.2.1\text{-}16)$$

$$\bar{R}^2 = 0.769,\ SE = 14.9650,\ D = 1.97,\ 1965.3 - 1972.4$$

$$M_{FD+A} = \underset{(3.4943)}{0.4933} * M_{FD+A_{-1}} + \underset{(1.1945)}{0.0064} * V \qquad (2.2.2.1\text{-}17)$$
$$+ \underset{(3.3820)}{0.0161} * C_P$$
$$- \underset{(-5.3254)}{1.4044} * DM1 - \underset{(-2.1227)}{0.6331} * DM2$$
$$\bar{R}^2 = 0.828, SE = 0.5899, D = 2.0793, 1965.3 - 1973.4$$

$$X_{FD+A} = Q_{FD} + M_{FD+A} - D_{FD+A} \qquad (2.2.2.1\text{-}18)$$

These relations imply that real food processing basically is autocorrelated with a weak response to the availability of real industrial credit. Unfortunately (at least in regard to tying this production into the rest of the model), no statistical support could be found for a response to such variables as relative prices or the availability of domestic and/or imported agricultural inputs.

Real value added is an autocorrelated function of gross production (once again under the assumption of no substitution between intermediate and primary inputs). Note that real value added at the margin is about 22 percent of gross production in the food-processing subsectorial—about twice as high as in petroleum (relation 2.2.1.2-2 above).

Real domestic demand for processed food depends primarily on overall private consumption (C_P) with significant positive autocorrelation and with some upward shifts in the first and third quarters. The marginal propensity to purchase processed food out of private consumption expenditures is about 15 percent. The positive constant implies that this marginal propensity is lower than the average propensity.

Real import demand for processed food basically is a geometric adjustment toward total private consumption with negative seasonal effects for the first half of the year. The different seasonal pattern between this and the domestic demand relation and the slower adjustment in this case may reflect greater supply lags for imported commodities. From the point of view of integrating these relations with the rest of the model, unfortunately there is once again no evidence of significantly nonzero price responses in either the domestic demand or the import estimates. Real exports from this subsector, finally, are residually determined and thus reflect all of the considerations in the other relations.

2.2.2.2 Prices Set by World Markets and Tariff Adjustments: The rest of the industrial sector (i.e., total industry minus food processing and petroleum products) is combined into a set of relations analogous to those for the other two industrial subsectors:

$$Q_{OT} = \underset{(1.03)}{0.1583} * Q_{OT_{-1}} + \underset{(4.60)}{3.4557} * P_{OT}/P_{WH} + \underset{(4.39)}{34.8404} - \underset{(-1.85)}{0.5101} * DM1 - \underset{(-1.15)}{0.2989} * DM2 + 0.9409 * u_{-1} \quad (2.2.2.2\text{-}1)$$

$$\bar{R}^2 = 0.987, SE = 0.8153, D = 2.01, 1965.4 - 1972.4$$

$$V_{OT} = \underset{(8.76)}{0.0057} * Q_{OT} * TIME + \underset{(11.16)}{12.4302} + 0.7704 * u_{-1} \quad (2.2.2.2\text{-}2)$$

$$\bar{R}^2 = 0.981, SE = 0.5400, D = 2.03, 1965.3 - 1972.4$$

$$D_{OT} = \underset{(14.67)}{0.7987} * D_{OT_{-1}} + \underset{(4.85)}{0.1646} * C_P - \underset{(-5.29)}{9.2818} * DM1 - \underset{(-1.23)}{2.4753} * DM3 - \underset{(-1.52)}{6.0372} \quad (2.2.2.2\text{-}3)$$

$$\bar{R}^2 = 0.961, SE = 3.3099, D = 2.59, 1965.4 - 1972.4$$

$$M_{OT} = \underset{(2.7440)}{0.1264} * V + \underset{(2.0806)}{0.4826} * M_{OT_{-1}} - \underset{(-6.9608)}{11.4924} * DM1 - \underset{(-1.3768)}{2.2004} * DM2 - \underset{(-1.9903)}{2.9536} * DM3 \quad (2.2.2.2\text{-}4)$$

$$\bar{R}^2 = 0.8512, SE = 3.1806, D = 2.1664, 1965.3 - 1973.4$$

$$X_{OT} = Q_{OT} + M_{OT} - D_{OT} \quad (2.2.2.2\text{-}5)$$

In comparison to the other industrial subsectors, these relations seem to be relatively successful as evidenced, for example, in the degree of consistency with the variance in the dependent variables. Production in this sector basically adjusts with substantial positive serial correlation to the deflated product price with some possibility of a downward shift during the first half year. Real value added is a secularly increasing proportion of real gross product with substantial positive serial correlation. Real domestic demand slowly adjusts positively to real private consumption expenditures with significant downward shifts in the first and third quarters. The marginal propensity to purchase other industrial products out of real private consumption expenditures is about 19 percent. Real imports adjust toward total economic activity (as represented by total real value added) with significant seasonal shifts downward for the first three quarters (probably reflecting the relative concentration of these imports prior to Christmas sales). Real exports, finally, are determined as a residual.

2.2.3 Noninternationally Traded Products: The rest of the economy (i.e., that not included in subsectors 2.2.1 and 2.2.2) is composed primarily of various service sectors: construction, utilities, commerce, banking, insurance, real estate and other finance, housing, transportation, public administration, and services not otherwise covered. These sectors constitute a substantial proportion of total value added. Unfortunately, however, comparatively little data are available for exploring the determinants of production in these sectors. In the specifications estimated, therefore, recourse had to be made to reduced-form adjustments to overall economic activity (or to some component thereof).[17] Although these formulations probably represent important links among sectors, the implicit lack of substitution that is assumed probably overstates real world rigidities.

The estimated relations follow (in the same order as indicated above):

$$V_{CNT} = \underset{(2.79)}{0.1372} * (I_{PL} + I_H) + \underset{(2.52)}{1.8825} * DM1 + \underset{(6.17)}{0.6742} * V_{CNT_{-1}} \qquad (2.2.3\text{-}1)$$

$$\bar{R}^2 = 0.742, SE = 1.77, D = 1.94, 1966.3 - 1973.4$$

$$V_{UTL} = \underset{(23.98)}{0.9789} * V_{UTL_{-1}} - \underset{(-2.74)}{0.6152} * DM3 + \underset{(1.67)}{0.0028} * Y - 0.3071 * u_{-1} \qquad (2.2.3\text{-}2)$$

$$\bar{R}^2 = 0.942, SE = 0.5476, D = 1.92, 1966.2 - 1974.4$$

$$V_{CMM} = \underset{(10.06)}{0.0695} * Y - \underset{(-2.87)}{0.4310} * DM2 + \underset{(5.00)}{6.3565} + 0.6479 * u_{-1} \qquad (2.2.3\text{-}3)$$

$$\bar{R}^2 = 0.949, SE = 0.4008, D = 2.37, 1966.3 - 1973.4$$

$$V_{BNK} = \underset{(12.69)}{0.9583} * V_{BNK_{-1}} + \underset{(1.08)}{0.0648} * (DD^T + CRDT^T)/P_{WH} + \underset{(.860)}{0.2266} \qquad (2.2.3\text{-}4)$$

$\bar{R}^2 = 0.989$, $SE = 0.3209$, $D = 2.21$, 1965.3 - 1973.4

$$V_H = \underset{(4.87)}{0.5933} * V_{H_{-1}} + \underset{(3.65)}{0.0109} * K_H - \underset{(-2.95)}{0.3277} \qquad (2.2.3\text{-}5)$$

$\bar{R}^2 = 0.998$, $SE = 0.1086$, $D = 1.60$, 1965.3 - 1973.4

$$V_{TRN} = \underset{(1.83)}{4.1809} * (P_{WH}/W_{TRN}) + \underset{(1.31)}{0.0427} * V + \underset{(1.72)}{0.1711} * X - \underset{(-7.16)}{5.5711} * DM3 - \underset{(-3.79)}{9.0422} \qquad (2.2.3\text{-}6)$$

$\bar{R}^2 = 0.826$, $SE = 1.97$, $D = 2.33$, 1965.1 - 1973.4

$$V_{PA} = \underset{(9.38)}{0.1910} * \bar{C}_G + \underset{(1.78)}{0.9101} \qquad (2.2.3\text{-}7)$$

$\bar{R}^2 = 0.7190$, $SE = 0.681$, $D = 2.02$, 1965.2 - 1973.4

$$V_{SRV} = \underset{(57.22)}{0.1656} * Y - \underset{(-2.56)}{0.4424} * DM1 - \underset{(-1.79)}{0.2996} * DM3 + 0.8024 * u_{-1} \qquad (2.2.3\text{-}8)$$

$\bar{R}^2 = 0.981$, $SE = 0.6375$, $D = 1.96$, 1966.2 - 1974.4

With the exception of construction and possibly transportation, these relations are quite consistent with the variations in the dependent variables. Not too much should be made of this fact, however, given the preponderance of autocorrelated structures and that the data for most of these sectors are constructed from assuming rigid relations with similar activity variables.

Taken at face value, the relations suggest that the following activity indices are highly related with value added in each of the sectors: real investment in plant and housing for construction, real national income for utilities, commerce and other services, real demand deposits and credit for banks and other financial institutions, total real value added, and exports for transportation and real government consumption for public administration. Real value added in housing services is more of a production relation with output dependent on the stock of houses. Only for transportation is there any evidence of substitution possibilities in a response to relative prices. Seasonal dummies suggest a relative upward shift in the first quarter for construction (during which time rain is relatively limited) and downward shifts in the first quarter for other services, in the second quarter for commerce, and in the third quarter for utilities and transportation. Adjustments are estimated to be slowest (in order) for utilities, banks and other financial institutions, and construction and housing, which does not seem to be an obviously unreasonable ordering (although the autocorrelated terms for utilities, commerce, and other services make such a ranking tentative).

2.3 Final Demand:

In most macroeconometric models aggregate product is determined primarily or exclusively by aggregate demand. Such a feature is a common criticism of many of the models for developing economies since the critical bottlenecks are often thought to be on the supply side.

Within the present study demand continues to have an important role because for quarterly time units there may be more possibility for flexibility in demand than in supply (although such a statement really holds much more for supply capacity than for capacity utilization). However, an attempt is made to incorporate supply features and their interaction with demand factors (see subsection 2.2). For the three industrial subsectors (i.e., petroleum products, food processing, and other industry) the data permit a fairly satisfactory approximation to the representation of a supply and demand framework.[18] For the other sectors, subsectors, and products considered in section 2.2, the available data do not permit satisfactory representation of individual demand relations. Therefore, relations are included for the traditional major components of aggregate demand so that the model can be closed on an aggregate level.

2.3.1 Private Consumption (C_P):[19] A number of different hypotheses about private consumption behavior were considered—permanent and life cycle income, wealth and liquidity effects (as represented by the real value of capital stock and of demand deposits), the impact of sectoral and factoral distribution, and the role of the credit market (both in terms of cost and credit availability). The most satisfactory function is the following:

$$C_P = -0.8865 * RR + 0.9446 * YD - 1.8497 * DM1 \quad (2.3.1\text{-}1)$$
$$(-1.21) \qquad (58.59) \qquad (-2.39)$$
$$- 1.3446 * DM3 + 9.8786 + 0.8268 * u_{-1}$$
$$(-1.58) \qquad (1.35)$$
$$\bar{R}^2 = 0.994, SE = 2.559, D = 2.77, 1965.2 - 1973.4$$

This relatively simple function states that real private consumption is a positively autocorrelated function of disposable income (YD) with negative seasonal shifts in the first and third quarters and possibly a negative response to real interest rates (RR). The fast adjustment and the relatively high marginal propensity to consume of 0.94 imply a relatively large multiplier, *ceteris paribus.* However, because of supply constraints and monetary behavior, many of the traditional total multipliers are relatively small within this model. (See section 4 below.) The possible inverse response to real interest rates is explicable in light of the way in which the consumption series is calculated as well as any intertemporal substitution effect. Basically, consumption is a residual, given the assumption that inventory changes are proportional to output changes. The negative response to real interest rates thus may reflect the response to the cost of holding inventories on that part of inventories that is not proportional to output.

2.3.2 Investment (I): Investment is a much smaller component of total final demand than is consumption but generally is thought to be quite important because of its relatively great volatility. Careful empirical investment studies for developing countries are few in number. Conventional wisdom about investment functions for the developing economies emphasizes the importance of quantitative variables such as the availability of credit and foreign exchange instead of neoclassical considerations although Behrman (1972b, 1976b) presents some evidence of behavior consistent with the neoclassical model for a relatively high per capita income Latin American economy.

For the quarterly Panamanian model a number of alternatives have been explored. Within the model real investment is determined by an adding up identity and a set of five estimated relations, one each for investment in plant and other nonhousing construction (I_{PL}), private housing investment (I_{H_P}), investment in machinery and equipment (I_M), change in inventories ($D[INV]$), and depreciation(DEP):

$$I_{PL} = 0.0505 * (CRDT/P_{PL}) + 0.0339 * (CRDT/P_{PL})_{-3} \quad (2.3.2\text{-}1)$$
$$(4.05) \qquad (2.11)$$

$$+ \underset{(1.22)}{0.0414} * VP_{-4} - \underset{(-.23)}{1.1443}$$

$\bar{R}^2 = 0.784$, $SE = 3.341$, $D = 1.80$, 1966.1 - 1973.4

$$I_{H_P} = \underset{(-2.62)}{-9.7786} * (P_H/P_C) + \underset{(10.2)}{0.0582} * K_H \qquad (2.3.2\text{-}2)$$

$$+ \underset{(1.77)}{1.4856} * DM1 + \underset{(2.06)}{1.7189} * DM2 - \underset{(-2.86)}{8.7722}$$

$\bar{R}^2 = 0.837$, $SE = 1.922$, $D = 1.43$, 1965.4 - 1973.4

$$I_M = \underset{(1.12)}{2.1949} * DM3 + \underset{(1.66)}{0.3648}\ CRDT_{IND}/P_M \qquad (2.3.2\text{-}3)$$

$$+ \underset{(2.98)}{0.4086} * I_{M_{-1}} + \underset{(1.39)}{0.5615} * \%UT + \underset{(2.32)}{0.8801} * \%UT_{-1}$$

$$+ \underset{(2.83)}{0.9380} * \%UT_{-2} + \underset{(1.80)}{0.6674} * \%UT_{-3} - \underset{(-2.99)}{285.1436}$$

$\bar{R}^2 = 0.660$, $SE = 4.721$, $D = 2.10$, 1966.2 - 1973.4

Almon polynomial distributed lag; third-degree constrained zero at $t - 4$,

$$\sum_{i}^{3} a_i = \underset{(3.04)}{3.0470}$$

$$D(INV) = \underset{(1.23)}{3.7326}\ DM1 + \underset{(16.89)}{1.7406}\ D(V) - \underset{(-.97)}{1.4326} \qquad (2.3.2\text{-}4)$$

$\bar{R}^2 = 0.899$, $SE = 7.420$, $D = 2.67$, 1965.3 - 1973.4

$$DEP = \underset{(10.22)}{0.0111} * K - \underset{(-1.55)}{3.5784} + 0.3155 * u_{-1} \qquad (2.3.2\text{-}5)$$

$\bar{R}^2 = 0.870$, $SE = 1.436$, $D = 1.39$, 1965.3 - 1973.4

These estimates suggest that real investment in plant and other nonhousing construction responds primarily to the real value of credit (with some lag in the complete response) and perhaps somewhat to replacement needs as represented by the lagged value of potential output (i.e., the secular trend through the peak of real value added). Real private investment in housing apparently is partially for replacement needs (and therefore, related to the stock of housing, K_H) with an upward seasonal shift for the first half year, but also there is some evidence of a price response on the demand side to the tradeoff between housing and other consumer items (P_H/P_C). Real investment in machinery and equipment is a distributed lag adjustment to the degree of capacity utilization ($\%UT$) and the availability of real industrial credit ($CRDT_{IND}/P_M$) with an upward shift in the third quarter. Inventory change depends on the change in real value added, possibly with an upward shift in the first quarter (but the part of inventories not proportional to real value added are included with private consumption, see subsection 2.3.1 above). Real depreciation depends on the stock of real physical capital with some positive autocorrelation.

2.3.3 Net **Foreign Demand**: The conventional wisdom is that fluctuations in net foreign demand are a major source of instability in developing economies.[20] For the Panamanian model total exports equal the sum of those from agriculture and fishing (subsection 2.2.1.1), petroleum (subsection 2.2.1.2), services (subsection 2.2.1.3), processed food and agricultural (subsection 2.2.2.1), and other industrial products (subsection 2.2.2.2). Total imports equal the sum of petroleum products (subsection 2.2.1.2), processed food and agriculture (subsection 2.2.2.1), other industrial products (subsection 2.2.2.2), imported machinery and equipment (subsection 2.3.2), and services. Therefore, the following function for the real imports of services is the last that is required to determine net foreign demand. However, see subsection 2.7 below for a further discussion of import response to exogenous changes within the complete model.

$$M_S = \underset{(2.79)}{0.0221} * YD + \underset{(15.20)}{0.3490} * (X + M) - \underset{(-7.09)}{31.5263} \qquad (2.3.3\text{-}1)$$

$$+ 0.8599 * u_{-1}$$

$$\bar{R}^2 = 0.9709, SE = 1.6279, D = 1.1033, 1965.3 - 1973.4$$

This function states that the real import of services depends on the level of international trade activity ($X + M$) and the level of real disposable income (YD) with a high degree of positive serial correlation.

2.4 Prices (P):

For price determination, goods and services are divided into three basic groups: (1) items for which the government sets prices, (2) internationally tradable items for which the international market (with some adjustment for tariffs and other trade barriers) determines prices, and (3) nontradable items for which domestic market pressures determine prices.

For the first of these groups the only estimated relation necessary is one to translate the weighted average price of specific agricultural products included in the model (see subsection 2.2.2.1) into an overall deflator for agriculture:

$$P_A = \underset{(4.49)}{10.9430} * \Sigma Q_i/P_i/\Sigma Q_i + \underset{(30.29)}{111.9623} \qquad (2.4\text{-}1)$$

$\bar{R}^2 = 0.732$, $SE = 3.4167$, $D = 1.50$, 1965 - 1973

In the second of these groups two price indices are included, one for petroleum products and the other for other manufacturing:

$$P_{FL} = \underset{(1.83)}{1.8321} * DM2 + \underset{(10.83)}{0.7347} * P_{FL_{-1}} + \underset{(8.34)}{0.1430} * P_{VPETRO} + \underset{(2.09)}{11.3827} \qquad (2.4\text{-}2)$$

$\bar{R}^2 = 0.962$, $SE = 2.4642$, $D = 2.40$, 1965.3 - 1973.4

$$P_{OT} = \underset{(2.03)}{0.9880} * P_{USXFMN} + \underset{(2.13)}{20.0116} * DM1 + \underset{(8.03)}{0.8083} * P_{OT_{-1}} - \underset{(-1.93)}{102.9787} \qquad (2.4\text{-}3)$$

$\bar{R}^2 = 0.889$, $SE = 23.12$, $D = 2.14$, 1965.3 - 1973.4

Both of these prices are distributed lag adjustments to international prices—the Venezuelan petroleum price (P_{VPETRO}) for petroleum products and the U.S. price for finished manufactured goods (P_{USXFMN}) for other industrial goods. In both cases there is evidence of upward seasonal shifts—in the second quarter for petroleum products and in the first quarter for processed food. In both cases the simple formulation is consistent with a high proportion of the variance in the domestic price under examination.

For the third group, the estimation of price-determination relations is much more difficult because of the shortage of data. The general assumption maintained below is that substantial pressures carry over from the internationally traded commodities to these nontradables. For housing, in addition to this general influence as represented by the wholesale price level (P_{WH}), some evidence is found for markup behavior on construction wages (W_{CNS}) within an autocorrelated structure:

$$P_H = \underset{(2.77)}{0.0112} * P_{WH} + \underset{(1.56)}{0.0017} * W_{CNS} \quad (2.4\text{-}4)$$
$$\underset{(-2.27)}{-\ 0.5392} + 0.3704 * u_{-1}$$
$$\bar{R}^2 = 0.840, SE = 0.1006, D = 1.46, 1966.1 - 1973.4$$

In addition to these three groups of product prices, the model contains relations to determine the wholesale (P_{WH}) and consumer price indices (P_C):

$$P_{WH} = \underset{(1.85)}{6.02} * P_Q * (1 + TXR_{PS}) \quad (2.4\text{-}5)$$
$$+ \underset{(20.62)}{0.89} * P_M * (1 + TXR_M) + \underset{(2.01)}{39.14} * P_{FD}/P_{FL}$$
$$+ \underset{(2.10)}{74.69} * P_{FL}/P_{OT} - \underset{(-2.02)}{56.9146} * P_{FD}/POT - \underset{(-2.18)}{60.5515}$$
$$\bar{R}^2 = 0.987, SE = 1.4785, D = 1.32, 1965.3 - 1974.3$$

$$P_C = \underset{(2.40)}{1.8120} * P_{FL}/P_{OT} + \underset{(6.57)}{0.2176} * P_{WH} * (1 + TXR_{PS}) \quad (2.4\text{-}6)$$
$$+ \underset{(19.16)}{0.7638} * P_{C_{-1}}$$
$$\bar{R}^2 = 0.994, SE = 0.6366, D = 2.21, 1965.3 - 1973.4$$

Both of these relations are consistent with most of the variance in the dependent variables. The wholesale price index depends on the weighted average of the prices for the first two groups discussed above with an adjustment for the production and sales tax rate (P_Q * [1 + TXR_{PS}]) and on the price of imports with an adjustment for the import tax rate (P_M * [1 + TXR_M]). In addition, three ratios of the components of P_Q are included to reflect the fact that the weights in creating PQ differ significantly from those used in the wholesale price index. The consumer price index is a lagged adjustment to the wholesale price index with a correction for the sales and production tax and with one additional included price ratio to reflect the compositional differences between the two indices.

2.5 Wages (W) and Labor (N) Market:

Eight wage rates are determined within the model. The following sectors or subsectors are included: agriculture (A), food processing (FD), other industry (OT), construction (CNT), utilities (UTL), transportation (TRN), commerce (CMM), and services (SRV). No evidence could be found for a significant impact of plausible variables on the wage of the petroleum-processing subsector so this wage is exogenous. The lack of association with the domestic labor market probably reflects the fact that this industry has a small, highly specialized, and relatively internationally mobile labor force.

The estimated wages relations are:

$$W_A = \underset{(2.86)}{0.4614}\, W_{A_{-1}} + \underset{(3.22)}{2.1749}\, P_C + \underset{(1.88)}{55331.3496}\, V_A/N_A \quad (2.5\text{-}1)$$

$$- \underset{(-1.78)}{17.1230}\, DM1 + \underset{(2.83)}{43.1449}\, DM2 - \underset{(-2.66)}{213.1050}$$

$\bar{R}^2 = 0.690$, $SE = 20.74$, $D = 2.12$, 1966.2 - 1973.4

$$W_{FD} = \underset{(4.19)}{6.9257}\, P_C + \underset{(1.59)}{50598.4709}\, Q_{FD}/N_{FD} \quad (2.5\text{-}2)$$

$$- \underset{(-3.59)}{59.2853}\, DM1 - \underset{(-3.58)}{491.5117}$$

$\bar{R}^2 = 0.678$, $SE = 38.30$, $D = 2.94$, 1965.2 - 1972.4

$$W_{OT} = \underset{(1.62)}{78732.7534} * (Q_{OT}/N_{OT}) + \underset{(8.76)}{7.9330} * P_C \quad (2.5\text{-}3)$$

$$- \underset{(-4.49)}{70.0145} * DM1 - \underset{(-5.05)}{544.1401} - 0.5741 * u_{-1}$$

$\bar{R}^2 = 0.763$, $SE = 35.13$, $D = 2.21$, 1965.4 - 1972.4

$$W_{CNT} = \underset{(1.85)}{23.8715}\, W_{MIN_{CNT}} - \underset{(-1.54)}{9.0375}\, DM1 \quad (2.5\text{-}4)$$

$$+ \underset{(2.23)}{1.0673}\, P_C + \underset{(1.15)}{0.1910}\, W_{CNT_{-1}} + \underset{(1.06)}{0.1483}\, W_{CNT_{-2}}$$

$$+ \underset{(1.17)}{0.1455}\, W_{CNT_{-3}} + \underset{(1.11)}{0.1853}\, W_{CNT_{-4}}$$

$\bar{R}^2 = 0.934$, $SE = 11.77$, $D = 1.92$, 1966.3 - 1973.4

Almon polynomial distributed lag: fourth-degree constrained zero at $t - 4$,

$$\sum_i a_i = \underset{(4.06)}{0.6701}$$

$$W_{UTL} = \underset{(22.72)}{1.3888} * W_{IND} - \underset{(-6.84)}{259.6693} + 0.7337 * u_{-1} \qquad (2.5\text{-}5)$$

$$\bar{R}^2 = 0.958, SE = 24.67, D = 1.78, 1966.2 - 1974.4$$

$$W_{TRN} = \underset{(-1.61)}{-129.4224}\, U_{TRN} + \underset{(3.64)}{58.1994}\, DM1 + \underset{(14.46)}{210.3900} \qquad (2.5\text{-}6)$$

$$\bar{R}^2 = 0.313, SE = 37.24, D = 2.10, 1966.2 - 1973.4$$

$$W_{CMM} = \underset{(0.84)}{14.3458} * W_{MIN_{CMM}} + \underset{(0.85)}{0.2945} * P_C \qquad (2.5\text{-}7)$$

$$+ \underset{(6.52)}{0.7982} * W_{CMM_{-1}} - \underset{(-1.08)}{4.5012} * DM2 + \underset{(1.30)}{36.6111}$$

$$\bar{R}^2 = 0.830, SE = 9.51, D = 2.09, 1966.3 - 1973.4$$

$$W_{SRV} = \underset{(-8.25)}{-841.2583} * U - \underset{(-6.63)}{56.7755} * DM1 \qquad (2.5\text{-}8)$$

$$+ \underset{(5.81)}{52.1794} * DM2$$

$$+ \underset{(8.84)}{1.3078} * P_C + \underset{(8.84)}{1.7437} * P_{C_{-1}} + \underset{(8.84)}{1.3078} * P_{C_{-2}}$$

$$- \underset{(-1.29)}{129.9296} - 0.3549 * u_{-1}$$

$$\bar{R}^2 = 0.940, SE = 19.52, D = 1.99, 1966.2 - 1974.4$$

Polynomial Almon distributed lag: third-degree constrained at $t - 3$,

$$\sum_i^3 \alpha_i = \underset{(8.84)}{4.3592}$$

The underlying model of wage determination in each case basically assumes that the level of sectoral wages adjusts in a manner described by a polynomial to (some of) a set of six variables:

1. The unemployment rate (U) has significantly negative coefficients in only two sectors—transportation and services. Although these sectors employ a fairly considerable number of workers, it is hard

to argue that there is evidence of widespread Phillips curvelike phenomena.[21]

2. Minimum wages have been in effect for most of the sample period. However, there has been relatively little variance in the legal minimums. Only for construction and commerce is there evidence of any significant effect of the legal minimums on actual levels. Perhaps this pattern reflects the fact that in most other sectors average wages have been significantly above the minimum levels.
3. In discussions of sectoral wage determination one frequently encounters suggestions that particular sectors act as pacemakers for other sectors. Some evidence supporting such a phenomenon is present in estimated dependence of wages in utilities on the industrial wage (which is defined as the weighted average of the wages of the three industrial subsectors).
4. Expectations concerning the level of prices are widely thought to be an important determinant of wage levels. In a sectoral quarterly study of Chilean wage determination Behrman and Garcia (1973) report that such expectations are the most important single determinant of wages (although that study is for a country with a much more inflationary history). In the present study current and lagged values of the consumer price index are used to represent such expectations. Its impact is fairly pervasive in that it enters directly with a significantly positive coefficient at the 5 percent level in five cases and indirectly through the industrial wage in a sixth (utilities). The only exceptions are commerce (where it is significantly nonzero only at the 30 percent level) and transportation.
5. Neoclassical theory predicts that at the margin wages depend on productivity. The data do not really permit consideration of marginal changes in this study. However, for the three goods-producing sectors (i.e., agriculture, food processing, and other industry) positive coefficients are obtained for average productivity (Q/N or V/N), thus lending some support to the hypothesis that labor productivity influences wages.
6. Dummy variables are included to represent seasonal shifts. The dominant such shift is a negative one for the first quarter, which occurs in five cases: agriculture, food processing, other industry, construction, and services. A negative shift also occurs in commerce in the second quarter. Positive shifts are indicated for transportation in the first quarter and for agriculture and services in the second quarter.

In addition to sectoral wages, the number of workers (N) demanded by each sector is determined within the model. Because of data inadequacies, no attempt is made to explore elaborate hypotheses about the determination of these variables. Instead a fixed coefficient relation between laborers per unit of output (N/Q for the goods-producing sector, N/V for the rest) is posited at any point of time, but the possibility is explored of secular trends or seasonal effects.

In the same order as the above sectoral wage equations (but with the addition of petroleum products) the estimated relationships so obtained are:

$$N_A/Q_A = \underset{(7.13)}{390.8770 * DM3} - \underset{(-6.56)}{373.8969 * DM1} - \underset{(-0.99)}{2.0573 * TIME} + \underset{(9.08)}{783.9133} - 0.0487 * u_{-1} \quad (2.5\text{-}9)$$

$$\bar{R}^2 = 0.811, SE = 129.7989, D = 1.96, 1965.2 - 1973.4$$

$$N_{FL}/Q_{FL} = \underset{(-1.92)}{-0.6932 * TIME} + \underset{(5.36)}{78.1941} + 0.7182 * u_{-1} \quad (2.5\text{-}10)$$

$$\bar{R}^2 = 0.682, SE = 5.15, D = 1.91, 1965.2 - 1972.4$$

$$N_{FD}/Q_{FD} = \underset{(-2.61)}{-1.0684 * TIME} + \underset{(16.48)}{268.9546} + 0.6483 * u_{-1} \quad (2.5\text{-}11)$$

$$\bar{R}^2 = 0.815, SE = 7.17, D = 2.19, 1965.2 - 1972.4$$

$$N_{OT}/Q_{OT} = \underset{(-2.29)}{-1.1640 * TIME} + \underset{(23.47)}{462.7063} + 0.4350 * u_{-1} \quad (2.5\text{-}12)$$

$$\bar{R}^2 = 0.486, SE = 14.29, D = 1.98, 1965.2 - 1972.4$$

$$N_{CNT}/V_{CNT} = \underset{(1.18)}{5.6457 * TIME} + \underset{(5.40)}{1055.9553} + 0.3643 * u_{-1} \quad (2.5\text{-}13)$$

$$\bar{R}^2 = 0.160, SE = 181.7, D = 1.45, 1965.2 - 1973.4$$

$$N_{UTL}/V_{UTL} = \underset{(-1.88)}{-10.5935 * TIME} + \underset{(4.64)}{1120.2303} + 0.7285 * u_{-1} \quad (2.5\text{-}14)$$

$$\bar{R}^2 = 0.706, SE = 91.39, D = 1.16, 1965.2 - 1973.4$$

$$N_{TRN}/V_{TRN} = \underset{(-3.12)}{-12.0572} * TIME + \underset{(7.68)}{1188.8130} \qquad (2.5\text{-}15)$$

$$\bar{R}^2 = 0.200, SE = 301.6, D = 2.92, 1965.2 - 1973.4$$

$$N_{CMM}/V_{CMM} = \underset{(7.00)}{24.8742} * TIME + \underset{(5.63)}{815.7081} + 0.3448 * u_{-1} \qquad (2.5\text{-}16)$$

$$\bar{R}^2 = 0.771, SE = 139.1, D = 1.41, 1965.2 - 1973.4$$

$$N_{SRV}/V_{SRV} = \underset{(1.90)}{4.9557} * TIME + \underset{(25.34)}{2668.9864} \qquad (2.5\text{-}17)$$

$$\bar{R}^2 = 0.071, SE = 156.2, D = 1.91, 1965.2 - 1973.4$$

The dominant pattern in these relations is a negative secular time trend in labor demanded per unit output, quite possibly with positive serial correlation. In seven of the nine cases the estimated coefficients of time are significantly nonzero at the 5 percent level. Five of these seven are negative, indicating secular increases in average labor productivity. Two of these seven are positive, indicating declines in average labor productivity in commerce and services (perhaps due to overcrowding because of the absorption of underemployed labor?). For agriculture and construction, the coefficients (negative and positive, respectively) are significantly nonzero only at the 25 percent level. For agriculture alone, there is evidence of seasonal patterns with a downward shift in the first quarter and an upward shift of approximately the same magnitude in the third quarter (during which many of the major crops are harvested).

The last relations in the labor market part of the model allow measurement of sectoral unemployment, defined as the difference between the exogenous secular trends through the peaks of sectoral labor usage and the sectoral demands for labor as estimated from the last set of relations. Total unemployment is obtained by summing these residuals across sectors. The unemployment rate (U) is defined by dividing unemployment by the secular trend. Notice this measure need not coincide with the usual sample survey measurement of unemployment, nor is it likely that full employment, so defined, is a desirable target.

2.6 Monetary Sector:

As noted in the discussion of government policy variables in subsection 2.1, the complete convertibility of the Balboa and the U.S.

dollar substantially limits the effectiveness of monetary policy. The use of the U.S. dollar for paper currency, in fact, makes it impossible even to measure accurately the complete Panamanian money supply. Panamanian prices reflect these institutional arrangements by being relatively dependent on international prices as compared to domestic monetary policy even in the short run (see subsection 2.4 above).[22]

Within the model, as also noted above, credit (both total and sectoral allocations) is exogenous. The only monetary variables that are endogenous in the model are domestic demand deposits in real terms (DD/P_C) and (sometimes) the interest rate (R):

$$\begin{aligned} DD/P_C = & -6.6000 * R(P_C) + 0.9455 * [DD/P_C]_{-1} \\ & \quad (-1.84) \qquad\qquad\quad (16.11) \\ & - 0.0333 * R_{US} + 0.0014 * Y + 0.0024 * Y_{-1} \\ & \quad (-1.64) \qquad\qquad (0.83) \qquad\quad (1.86) \\ & + 0.0027 * Y_{-2} + 0.0020 * Y_{-2} - 0.8232 \\ & \quad (1.80) \qquad\qquad (1.05) \qquad\quad (-1.92) \end{aligned} \qquad (2.6\text{-}1)$$

$\bar{R}^2 = 0.994$, $SE = 0.130$, $D = 2.40$, 1966.2 - 1973.4

Almon polynomial distributed lag: third-degree constrained zero at $t - 4$,

$$\sum_i^3 \alpha_i = \underset{(2.25)}{0.0085}$$

$$\begin{aligned} R = & \ 1.7901 * (CRDT^T/DD^T) + 0.4636 * R_{-1} \\ & \quad (4.92) \qquad\qquad\qquad\qquad (3.97) \\ & + 0.0924 * R_{-2} - 0.0711 * R_{-3} - 0.0267 * R_{-4} \\ & \quad (1.39) \qquad\quad (-0.79) \qquad\quad (-0.43) \\ & + 0.2254 * R_{-5} + 1.5112 \\ & \quad (1.47) \qquad\quad (1.62) \end{aligned} \qquad (2.6\text{-}2)$$

$\bar{R}^2 = 0.949$, $SE = 0.4291$, $D = 2.06$, 1966.2 - 1974.4

Almon polynomial distributed lag: second-degree unconstrained,

$$\sum_i \alpha_i = \underset{(4.82)}{0.7295}$$

Both of these relations are consistent with considerable portions of the dependent variables.

The holding of real demand deposits depends on a fairly slow lagged adjustment to factors that determine desired real demand deposits. The first of these is permanent income as represented by a distributed lag over four periods. The other two factors are related to opportunity costs. The rate of inflation ($R(P_C)$) represents the opportunity cost in terms of holding real goods. The U.S. interest rate (R_{US}) represents the opportunity cost in terms of holding foreign debt instruments. No evidence was found of a response to domestic interest rates.

The interest rate depends on a polynomial adjustment to demand versus supply pressures as represented by total credit relative to total demand deposits. No evidence was found of a direct tie to international interest rates (an indirect tie exists through demand deposits) despite the increasing integration of Panama into international markets in the 1970s. Possibly this reflects the dominance in the sample of the period before the structural shift caused by the banking law of 1970. In that earlier period local interest rates seem to have been relatively independent of international money markets.

2.7 Identities:

A number of identities are included in the model. For the most part, these merely define various aggregates as the sum of their components (i.e., total value added equals the sum of individual sectoral values added, total exports equal the sum of the individual exports, total imports equal the sum of the individual imports, total aggregate demand equals the sum of the components of final demand, etc.). There are also identities that define such residuals as the balance of trade (equal to exports minus imports) and the government deficit (equal to expenditures minus inflows).

The most important question related to the identities is how to close the model given that both aggregate demand and supply are independently estimated. Total product or income can be defined as the sum of sectoral value added[23] (with, perhaps, the change in inventories defined as a residual between total supply and the other estimated components of demand instead of using the estimated relation for the change in real inventories in subsection 2.3 above) or, as is more commonly done, the sum of the components of final demand[24] (with, perhaps, value added in services defined as a residual between total demand and the other components of supply). The function of the model clearly differs under these two assumptions. Because of the hypothesized importance of supply variables in developing economies, the Panamanian model was closed by the former alternative.

However, there are obviously physical and economic limits to which inventories may be drawn down when increased nominal expenditures encounter a given production level. At some point there will be an additional reaction; either prices or the deficit on the current account must increase. Given the size and openness of the Panamanian economy, it seems appropriate to assume that, after some initial reduction of inventories, the basic response to an increase in nominal expenditures that is not accompanied by an increase in production takes the form of higher net imports financed by capital inflows. Since international reserves do not really exist in the Panamanian case, in such a situation, therefore, there may be additional imports beyond those indicated in the above estimated relations. Allowing for such a variation in imports would lead basically to the same general results as are obtained from the monetary model of balance of payments.[25] It is important to keep this additional reaction in mind when predicting the effects of specified policy disturbances. It is interesting to note that some of the results of the model as it is in fact closed, such as small multipliers for government expenditures (see section 4), do suggest reactions of this type.

3. WITHIN SAMPLE SIMULATIONS

This section presents the results of within sample complete model simulations in order to give some idea of the degree of success of the model in tracking the quarterly behavior of major economic variables in the Panamanian economy. These simulations are of two types: single period and dynamic. Before presenting these simulations, four important characteristics of the simulation procedure are mentioned.

1. The structure of the model outlined in the previous section is assumed to be the true structure of the Panamanian economy in the period of interest for these simulations. If biases exist in the estimated coefficients, such biases have an impact on the simulation results. Sensitivity analysis, of course, can be used to explore the effect of any such biases in specific parameter values or in particular relations in the model. Nevertheless, some possibly very important phenomena—such as changes in psychological and political attitudes—are not well incorporated into the model.[26]
2. The simulations presented in this study are all nonstochastic.

3. Except for the set of within sample period single-period simulations presented below, all of the simulations used in this work are dynamic in that in the *n*th simulation period, simulated lagged endogenous values from the first $n - 1$ simulation periods are used instead of actual lagged endogenous values. This procedure permits the tracing out of the time paths of the responses to a given change.
4. Because the model is nonlinear, it cannot be solved by simple matrix inversion. Instead, a Gauss-Seidel iterative procedure is utilized.

Table 2-1 presents summary statistics for the mean of fourteen different single-period simulations and one fourteen-quarter (or three and a half years) dynamic simulation, which is a fairly long period for testing this model. Although the particular results depend on the particular starting points used, they are suggestive of the short-run and medium-run success of the model in tracing out the sample. Both cases include the mean predicted value as a percentage of the actual, the root mean squared percentage error, and the mean absolute percentage error for ten major endogenous variables: total real value added, the major components of real final demand (private consumption, private investment, exports, and imports), the unemployment rate, two representative wage rates (agriculture and other industry[27]), and demand deposits.

Examination of these statistics and graphs of the dynamic simulation (available on request) leads to the conclusion that, for the most part, the model seems to track aggregate behavior fairly well. The mean absolute percentage errors (for the average of the single-period simulations and for the dynamic simulation, respectively) are 1.2 and 1.6 percent for total real value added, 0.4 and 1.0 percent for the consumer price index, and 1.8 and 6.6 percent for demand deposits. For some of the more disaggregated variables (especially private investment, the consumer price index, and demand deposits) and for variables defined as a residual (e.g., the unemployment rate[28]), there appears to be some serial correlation in the errors. As would be expected, generally (but not exclusively, see the agricultural wage) the errors are smaller for the single-period simulation than for the dynamic simulation. All in all, however, the model appears to trace the sample period relatively well in regard to the size of percentage errors and the identification of turning points. This performance leads to some confidence in using the model as a tool to examine the short- and medium-run operations of the Panamanian economy.

Table 2-1. Summary Statistics for Single Period and Dynamic Simulations for Ten Major Variables Behrman Vargas Panama Model

	14 Single-Period Simulations			One 14-Period Dynamic Simulation		
Variables	*Mean Predicted as Percentage of Actual*	*Root Mean Squared Percentage Error*	*Mean Absolute Percentage Error*	*Mean Predicted as Percentage of Actual*	*Root Mean Squared Percentage Error*	*Mean Absolute Percentage Error*
Total real value added (V)	100.2	1.8	1.2	100.9	2.2	1.6
Real private consumption (C_p)	100.4	2.7	1.9	100.6	3.1	2.3
Real private investment (I_p)	104.7	17.4	10.9	122.3	33.1	25.6
Total real exports (X)	100.7	9.9	6.4	101.9	11.8	8.8
Total real imports (M)	100.0	9.3	5.2	101.0	11.5	8.1
Unemployment rate (U)	104.1	20.7	13.9	102.4	21.6	15.2
Consumer price index (P_c)	99.9	0.5	0.4	100.0	1.2	1.0
Agricultural wages (W_A)	100.3	8.7	6.2	100.6	8.5	5.6
Other industrial wages (W_{OT})	100.0	5.4	3.1	99.7	6.7	4.8
Demand deposits (DD)	100.6	2.7	1.8	103.7	9.1	6.6

4. MULTIPLIER RUNS FOR POLICY-RELATED VARIABLES

This section presents the results of multiplier runs for changes in four exogenous policy-related variables: government consumption, sales and production taxes, nonagricultural credit, and net income from the canal. Changes in these particular variables are examined to illustrate the workings of the model. Many other multiplier runs, of course, are possible (e.g., see the list of exogenous policy instruments in subsection 2.1 above).

For each of these four exogenous variables two simulations are presented. In the first, the variable of interest is changed by one unit (i.e., 10^6 Balboas) for one period and then it returns to its previous level. In the second, the change of one unit is sustained for all subsequent quarters. For each simulation only the explicitly indicated alteration in the exogenous variable of interest is made. All other exogenous variables and parameters are fixed at their base simulation values in order not to confuse the impact of the change under examination with other changes.[29]

The base simulation used as a point of reference is the dynamic simulation of the previous section. Table 2-2 presents the multiplier results for each of the simulations described above for the same ten major variables considered in section 3. For total value added, private consumption, private investment, exports and imports, the entries in this table are the changes from the base simulation included in the respective variables as measured in millions of real Balboas. For the unemployment rate, the entries are the changes in terms of a unitless ratio (i.e., percentages divided by 100). For the consumer price index, the entries are changes with reference to a base of 100. For other industrial and agricultural wages the entries are changes in Balboas per quarter. For demand deposits the entries are changes as measured in millions of current Balboas. For each variable in each simulation these changes from the base simulation values are given in Table 2-2 for the first three quarters and the eighth quarter after the initial exogenous change. This allows a reasonably concise presentation of the immediate and medium-term response paths. For the variables measured in millions of Balboas the time paths of the induced changes are really time paths of dynamic multipliers since the exogenous changes are all unit changes.

An examination of Table 2-2 and the data underlying it suggest eight major characteristics that merit emphasis.

1. Because of the simultaneous nature of the system, variables

Table 2-2. Multipliers for Major Economic Variables due to Exogenous Policy-Related Changes[a] Behrman Vargas Panama Model

	Current Government Expenditure								Sales and Production Taxes							
	One-Period Shock				Sustained Shock				One-Period Shock				Sustained Shock			
Variables	*1*	*2*	*3*	*8*	*1*	*2*	*3*	*8*	*1*	*2*	*3*	*8*	*1*	*2*	*3*	*8*
Total value added (V)	0.23	-0.01	-0.01	-0.00	0.23	0.22	0.21	0.18	-0.11	-0.03	-0.01	0.03	-0.11	-0.10	-0.12	-0.27
Private consumption (C_P)	0.22	-0.01	-0.01	-0.01	0.22	0.20	0.19	0.14	-0.13	-0.02	-0.02	-0.02	-0.13	-0.10	-0.11	-0.24
Private investment (I_P)	0.08	0.16	0.19	-0.01	0.08	0.33	0.31	0.54	-0.04	-0.26	-0.11	0.08	-0.04	-0.29	-0.30	-0.46
Total Exports (X)	-0.16	-0.14	-0.04	0.01	-0.16	-0.20	-0.23	-0.35	-0.65	0.02	0.04	-0.06	-0.65	-0.42	-0.36	-0.74
Total imports (M)[b]	-0.03	-0.00	-0.01	-0.00	-0.03	-0.03	-0.03	-0.07	-0.38	-0.01	0.01	-0.01	-0.38	-0.26	-0.23	-0.46
Unemployment rate (U)	-0.01	0.00	0.00	0.00	-0.01	-0.00	-0.00	-0.00	-0.02	-0.02	-0.02	-0.01	-0.02	-0.03	-0.02	-0.00
Consumer price index (P_C)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.33	0.25	0.06	0.44	0.64	0.80	1.36
Other industrial wages (W_{OT})	0.00	0.00	-0.00	-0.01	0.00	-0.00	0.00	0.03	3.46	2.64	2.01	0.47	3.46	5.08	6.31	10.82
Wages in agriculture (W_A)	0.00	0.00	-0.00	*	0.00	0.00	0.00	*	0.95	1.16	1.08	*	0.95	1.83	2.57	*
Demand deposits (DD)	0.03	0.09	0.14	0.07	0.03	0.22	0.27	0.96	-2.03	-1.33	-0.92	0.46	-2.03	-2.80	-3.26	-3.31

Table 2-2. continued

	Nonagricultural Credit								Net Income from Canal Zone							
	One-Period Shock				Sustained Shock				One-Period Shock				Sustained Shock			
Variables	*1*	2	3	8	*1*	2	3	8	*1*	2	3	8	*1*	2	3	8
Total value added	0.03	0.02	0.02	-0.01	0.03	0.05	0.07	0.10	1.88	-0.05	-0.06	-0.04	1.87	1.80	1.75	1.54
Private consumption (C_P)	0.01	0.02	0.02	-0.01	0.01	0.02	0.04	0.03	1.77	-0.06	-0.08	-0.07	1.77	1.68	1.60	1.17
Private investment (I_P)	0.41	0.17	0.11	0.15	0.41	0.56	0.66	0.98	0.67	1.34	1.61	0.04	0.67	1.93	3.35	4.57
Total exports (X)	0.01	0.01	0.02	-0.08	0.01	0.03	0.03	-0.02	2.38	-0.28	-0.30	-0.13	0.67	1.90	3.34	4.55
Total imports (M)[b]	0.01	0.02	0.02	-0.01	0.01	0.03	0.04	0.06	1.79	0.06	-0.05	-0.05	1.79	1.81	1.70	1.22
Unemployment rate (U)	-0.02	-0.03	-0.02	-0.01	-0.02	-0.03	-0.03	-0.00	-0.03	-0.03	-0.02	-0.01	-0.03	-0.03	-0.03	-0.01
Consumer price index (P_C)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.08	-0.06	-0.05	-0.01	-0.08	-0.11	-0.13	-0.17
Other industrial wages (W_{OT})	-0.00	-0.00	-0.01	-0.05	-0.00	-0.00	-0.01	-0.07	-0.62	-0.50	-0.38	-0.10	-0.63	-0.85	-1.03	-1.32
Wages in agriculture (W_A)	-0.00	-0.00	-0.00	*	-0.00	-0.00	-0.00	*	-0.17	-0.22	-0.20	*	-0.17	-0.31	-0.43	*
Demand deposits (DD)	0.01	0.02	0.03	0.40	0.01	0.02	0.04	0.59	0.64	0.99	1.37	1.12	0.64	1.47	2.71	8.40

[a]The top column headings give the exogenous policy-related variables that are changed for each respective simulation. The next column heading distinguishes between a one-period shock and a sustained shock. The next column heading refers to the quarter, starting with the one in which the exogenous change is first experienced. The individual entries give the deviations from the base run in that quarter for that variable due to the exogenous change indicated in the column heading. The mean values of the endogenous variables (with the units in parentheses if they are not 10^6 real Balhoas) are: V (176.9), C_p (137.1), I_p (31.2), X (72.4), M (80.9), U (0.15, unitless), P_C (106.2, unitless), W_{OT} (472.3 Balboas per quarter), W_A (169.9 Balboas per quarter), and DD (241.3 10^6 Balboas).

[b]For these simulations it is assumed that inventories are sufficiently large so that they can absorb the residual shock of increased expenditures that are unaccompanied by equal incrementation in production. If this is not the case, then in such a situation imports will rise more than is indicated here, thereby increasing the deficit on the current account, but without any immediate feedback on the rest of the model. See subsection 2.7.

*Not calculated.

throughout the economy are affected by exogenous changes—the direct impact of which may be limited to a narrow part of the economy. This simultaneity is one factor that makes it difficult to analyze the impact of macroeconomic policy changes without an explicit model with empirically based parameters.

2. Although the more detailed results are not presented here, on a more disaggregated level some of the induced changes are greater than for these aggregates. Such compositional changes may imply results different from those predicted by traditional textbook models (see point 4).
3. The induced changes generally are in the direction that the textbook macroeconomic models suggest. For example, reduced sales and production taxes and increased government expenditures as well as nonagricultural credit or net income from the canal zone all result in immediate increased total value added, private consumption, private investment, and demand deposits.
4. However, there are exceptions. For example, imports decline due to compositional changes when government consumption increases.[30] Also prices (and therefore, wages) increase when sales and production taxes increase because the cost-push aspect of increased taxes outweighs the reduced demand. Furthermore, the compositional changes and increased supplies cause prices (and therefore, wages) to decline when nonagricultural credit or net income from the canal rises—even though the unemployment rate also declines. Finally, increased sales and production taxes cause compositional changes that reduce unemployment even though total production declines.
5. The effects of many of the policy-related variables are immediate. However, some of the major variables (e.g., private investment in the first and third one-period shock simulation or demand deposits in all but the second one-period shock simulation) have their maximum impact only after a lag of several quarters. In other cases there is a sign reversal after an immediate impact in the direction suggested by textbook models (e.g., total value added and private consumption in the first and fourth one-period stock simulations). Such lag patterns complicate the analysis substantially, and therefore, point again to the need for an explicit empirically based model for the analysis of macroeconomic policy changes and contribute to outcomes different (transitorily, at least) from those predicted by traditional textbook models.
6. The sustained shocks generally result in sustained and sometimes somewhat larger changes in the same direction as the initial effects of the one-period shocks. Because of the nonlinearities and overall

constraints of the system, however, once again an explicit model is needed to analyze changes. The impact of a sustained change often cannot be deduced merely by adding up the effects of a number of one-period shocks.

7. Some of the multipliers are of considerable size (e.g., the value-added multiplier of changes in net income from the canal). However, in many cases the multipliers are much smaller than suggested by traditional textbook models (e.g., in response to changes in government expenditures or sales and production taxes) because of the importance of supply constraints. Thus government policy must be selected on the basis of the potential effects (given policy goals) within the Panamanian economy, not on the basis of what is thought to be effective elsewhere and is uncritically transferred to this economy.
8. Although some government policies have substantial effects, that others do not implies that the government has a difficult time trying to attain macroeconomic goals simultaneously. Thus, as economists with as differing points of view as Friedman (1974) and Taylor (1974) recently have emphasized, the lot of a policy-maker in an economy such as Panama is indeed difficult.

NOTES

1. The sample period is constrained by the availability of data. For some relations it is shorter or longer. The basic data were constructed from a large number of quarterly series and the parallel annual series. The quarterly national accounts so constructed are consistent with the annual national accounts. For details of the data construction see Vargas (1976).

2. As is well known, in cases in which lagged values of the dependent variables are included on the right-hand side, the Durbin-Watson statistic is biased toward two.

3. If this model were to be developed further, some of the government variables now considered exogenous could be endogenized by imposing government budgetary constraints and by adding behavioral functions (e.g., tax collections as functions of the tax base, tax rates, and expectational variables). For an example of another Latin American situation in which such endogeneity is very important, see Behrman (1976a, 1976b).

4. Before 1968 this effort reportedly was successful.

5. Of course, it is difficult to be precise about the division among such categories since relative prices in principle could change so as to move a particular good or service into any of these categories. When one examines the details of actual transactions, moreover, the distinctions become quite fuzzy in a number of cases. On a broad level for plausible relative prices, however, the distinctions have some empirical content and usefully characterize the general picture.

6. Included in this subsection are the export-oriented products, not all exports. Some minor exports are discussed below in regard to relations 2.2.2.1 to 18 and 2.2.2.2 to 5.

7. The production and value-added data for petroleum are not "clean" in that they are not separated from "other miscellaneous industries." However, it is clear that the refineries dominate this category.

8. In a subsequent stage tourism could be linked to activities in other countries.

9. Actually V_A also includes some mineral products, but during the sample they were a very small percentage of the total.

10. For the first bean crop (*BEAN* 1), however, it was not possible to find a relation that is reasonably consistent with a priori expectations and with variations in production. Therefore, *BEAN* 1 is calculated by subtracting from total bean production, the estimate of *BEAN* 2 (see relations 2.2.2.1-6 through 8).

11. For the second crops of the three major staples (i.e., corn, rice, and beans) and for coffee the levels at which the price coefficients are significantly nonzero are somewhat less satisfactory (i.e., 10 to 20 percent) than in the other cases. For *RICE* 1 the coefficient of the second price term (actually defined as the inverse of the ratio of the two terms mentioned in the text) is significantly nonzero only at the 25 percent level. In this same relation incidentally, a dummy variable is included for 1965 and the earlier years (*DUMMY* 65) to represent the mean effect of the second price for these years for which wage data are not available.

12. In three of the eleven cases, a one-year lag in the price ratio is more consistent with variations in the dependent variable than is the current price ratio. For two of these three exceptions, however, the gestation period is sufficiently long that annual government announcements do not preclude the need for forming expectations on some other basis.

13. The gestation period of several years for coffee, of course, precludes such rapid complete long-run adjustment. For this tree crop, however, we have not been able to find evidence of a significant long-run price response—perhaps because of the shortness of our sample.

14. That there is no evidence of an adjustment process when there is no reason to have expected prices depend on the past price history brings to mind that in the original Nerlovian formulation, it was not possible to distinguish, that is, identify statistically, the price expectations coefficient from the adjustment coefficient. By including additional variables related to expected yields on farm demand and uncertainty in the desired production relation, however, Behrman (1968) was able to identify the expectations and adjustment parameters.

15. Because of problems of data consistency over the whole sample period, when credit was included in a relation the possibility of a significant coefficient for a dummy variable for 1965 and before (*DUMMY* 65) was investigated (e.g., *SUGAR*).

16. It should be noted that the international trade data and the subsectoral production data are not defined for exactly the same aggregates so the distinction between processed food and agricultural goods is not as clear as would be desired. Therefore, the imports and domestic demand relations include some

important agricultural commodities in addition to processed food. The major agricultural exports, however, are separated out as is indicated in subsection 2.2.1.1 above.

17. Such treatment for these sectors is common in macroeconometric models. For an example in which more extended treatment is undertaken, see Behrman (1972a, 1972b, 1972c, 1973b, 1973c, and 1976b).

18. For petroleum products "supply" is a misnomer given the market structure. Perhaps a "production reaction function" would be better terminology in this case.

19. Government consumption is an exogenous policy variable (subsection 2.1.1).

20. Recent studies have raised questions about the validity of this hypothesis (e.g., MacBean [1966], Mathieson and McKinnon [1974], and the references therein).

21. These estimates are not Phillips curves in the normal sense because the dependent variable is not in rate of change form. Attempts to specify the relations in such a form were not successful. For more successful efforts see Behrman (1971a, 1976b) and Behrman and Garcia (1973) for a discussion of the Chilean case.

22. For a slightly different view, see Borts and Hanson (Chapter 9, this volume).

23. The Chilean model in Behrman (1976b), for example, generally is closed in this way.

24. See Beltrán del Rio (1974) for a summary of Latin American models.

25. See Borts and Hanson (Chapter 9, this volume) for a simplified application to Panama.

26. For example, the psychological and political impact of the advent of the Torrijos government in 1968 or of the discussions regarding the future of the canal are very difficult to incorporate. However, the model can be used to give some insight about such effects. If such a change results in different priorities among macroeconomic goals, then the model can be used to explore the tradeoffs among these objectives. If such a change has an impact on particular parameters (e.g., the productivity of labor, the marginal propensity to consume or export), sensitivity analysis can be used to explore the results.

27. Agriculture is included because of interest in the rural sector. Other industry is included as a representative of a relatively modern sector. (Total industry is not used because the wage in petroleum products is exogenous.)

28. It should be emphasized that the summary statistics in Table 2-1 refer to the error in predicting the unemployment rate in percentage terms for that rate. That is, the unemployment rate averaged about 13 percent over the period examined. A mean absolute percentage error of 15.2 in the dynamic simulation implies an average absolute error in the unemployment rate of less than 2 percentage points (i.e., 15.2 percent times 13 percentage points).

29. Of course, it also may be desirable to explore what happens when a whole package of policy changes are adopted by changing several different policy instruments at the same time.

30. This statement presumes that inventories are sufficiently large to absorb

the increased government expenditures. If inventories are not large enough, imports increase in response to the increased expenditures unaccompanied by equal increments in production. See subsection 2.7 above.

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