An Econometric Model for Short-Term Forecasting in Barbados

by

Daniel Boamah

Carlos Holder

Clyde Mascoll &

DeLisle Worrell

CENTRAL BANK OF BARBADOS

RESEARCH DEPARTMENT

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A macroeconomic model is an attempt by its author to describe in broad outline the relationships betwen the many kinds of activity that go to make up 'the economy'. It provides a bird's eye view of what makes the economy go and how one aspect of activity reacts to another.

The choices facing us in building a macro model for Barbados were to assemble the model sector by sector or to develop a global model, where the activities of each sector are condensed into a one or two relationships. Although the second alternative sacrifices much richness in the detailed presentation of the relationships, it allows a good grasp of the links between different parts of the economy. This essential outline of the economy's structure is usually hard to detect in models with sectoral detail, so we have chosen to present a global model, in the first instance.

Much current economic discussion in Barbados is bedevilled by lack of a global perspective. For example, when interest rates rise, firms focus on the effects on their costs and cash flows and individuals worry about their ability to service mortgages; but it is often not clear what the overall economic implications will be. The global model is intended to deal with issues such as this; it will be supplemented, in due course, by more explicit sectoral models.

This essay begins with a brief discussion of econometric models - what they are, what they may be used for and how they vary according to the use for which they are intended. We discuss how we go about building a macro model for the Barbados economy - which sectors were chosen and why, how the sectors affect one another, and what the individual equations mean. We then test the model and discuss the results. Are they an acceptable description of the Barbadian economy, and what do we learn from them? The next step will be to use the model for economic forecasts under carefully specified conditions. Alternative forecasts will be prepared using different economic policies and different states of nature.

Nature and Uses of Economic Models

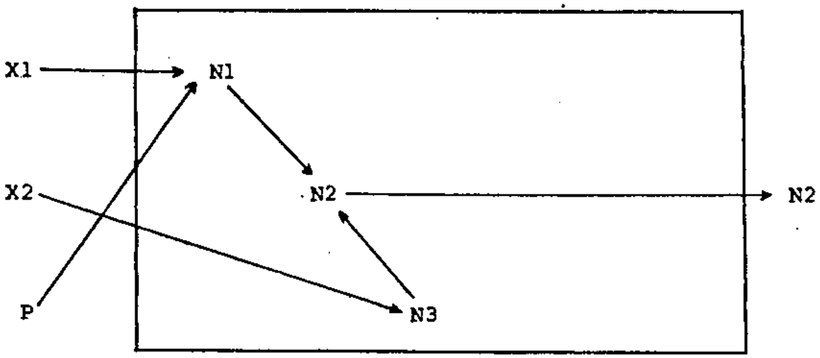
An economic model is a synopsis, in words or numbers, of economic activity, showing how one set of transactions influences another. A macroeconomic model does this for the economy as a whole, lumping many activities into broad categories such as imports, exports, interest rates, wages and credit, each a collection of many somewhat diverse transactions. Conventionally, we divide the items included in the model into factors which are beyond the control of the model user ('exogenous' variables), factors which the user can manipulate ('policy' variables) and factors which change in accordance with the interrelations of exogenous and policy variables as specified by the model ('endogenous' variables). Among the endogenous variables a group which is of special interest to us are the

factors by which we may measure the overall performance of the economy. They include variables such as income and employment and we refer to them as 'outcomes'.

The model may be regarded as a machine which is fed with inputs (exogenous and policy variables) and which produces outputs (endogenous variables), some of which are simply for use by the machine itself - like the electricity generated in a motor car engine - while others (the outcomes) are the justification for building the machine in the first place. Figure 1 shows what a very simple model might look like. The model gives the relationships between three endogenous variables (the Ns) one of which (N2) is the outcome that interests the user. The endogenous variables are acted upon by two exogenous (the Xs) and one policy variable (P). This model might say, for example, that the prices of imports (exogenous variable X2) determine local price levels (N3); income levels (N1) depend on investment (X1) and government expenditure (P). The two endogenous variables thus determined - prices and income - will enable us to derive the demand for imports (N2), let us say. This system would not represent a particularly useful description of the Barbadian economy, but the more elaborate model which we describe later is constructed on the same principles.

An econometric model provides statistical measures of the relationships between variables, based on what has occurred in the recent past. For each relationship we begin with a theory: 'we believe that variables one, two, etc, jointly affect the value of variable number ten because of these (specified) considerations' Theoretical considerations usually also give us a view as

Figure 1



X1, X2	exogenous variables
P	policy varible
N1, N2, N3	endogenous variables
N2	outcome

Arrow indicate lines of causation

to whether variable number one will cause number ten to increase or decrease. We then observe the behaviour of all the variables in this relationship over a period of the recent past which is sufficiently long to allow systematic influences to emerge (at least 15 observations on each variable, more if possible). We then employ statistical methods of deriving estimates of the magnitude of interaction among the variables.

Clearly, a single model will not serve all purposes. A macroeconomic model cannot deal with the details of each sector. Many factors affecting sugar production, for example, will be

left out of the macro model completely - cane fires, factory efficiency, weather, etc. The model must also be tailored for its users. Variables which are policy for some users (government budget, in a model for official use) are exogenous for others (government budget, in a model for use by businessmen). The model will differ according to the length of each period of observation. In a model using quarterly data imports may be related to expenditure one or two quarters later; but annual imports will not bear much resemblance to expenditure patterns two years later.

The Central bank model is only one of several that will have to be constructed for Barbados. We will need sectoral models for the main export activities, for banking, for government and for wages and employment. We will need models for the private sector, where experiments can be made with different official policies. Large firms may wish to have models for their own activities. And we expect to produce a quarterly model to complement the present version, which is based on annual data. It may be possible to combine the sectoral models with the macro model, in course of time.

The Central Bank of Barbados Model 1.

We call the system to be presented in this paper Mode. because it is only the first of what we envisage as a series of continually updated versions of a macro model for Barbados. Mo. 1 tries to incorporate all the insights we have gained so far exploring relationships between broadly defined categories of economic activity. In the process of using this model for forecasts we expect to gain a deeper understanding of many of these processes. Moreover, economic innovations are causing subtle shifts in the nature of economic activity, as time goes by. In due course it will be necessary to replace Model 1 with a new version which corporates these changes.

Model 1 uses annual data and is intended for medium term forecasts, up to five years. It will be used to test for the influence on national output and prices of such policy variables as interest rates and exogenous variables such as the prices of goods which Barbados imports and exports. We expect to use it to make forecasts highlighting the implications of changes in the policy and exogenous variables.

We build up the model by working backwards from the outcomes which are of principal interest to us - prices and output. We divide the entire national output into two categories - tradable goods and non-tradables. Sugar production and the assembly of electronic components are examples of tradable actvities. Firms producing in these sectors in Barbados are faced with pre-determined prices, given to them from foreign markets. They may decide on the volume to be produced, based on the relationship between their costs of production and the pre-determined price their product will fetch. The fixed price facing the producer is the distinguishing characteristic of the tradable goods sector.

It may be contrasted with the construction industry, or the provision of electricity. Local firms engaged in these activities may set product prices, taking account of their costs (and subject, in the case of electricity tariffs, to acceptance by the Public Utilities Board). But the price they set, along with consumers' incomes, will determine the amount people can afford to buy and therefore what level of output can be marketed. This interplay of demand and supply in the determination of output is what differentiates the non-tradable from the tradable sector. The firm producing non-tradables does not face a given price at which he can produce as much as he profitably can. He must find a level of profitable output which he can offer at a price the consumer is willing to accept. If he bids too high, he will have excess stocks; if he bids too low he will not be able to keep up with his orders but he may lose money on each one.

In order to reduce to two the number of sectors we have to deal with we group sugar, other agriculture, tourism and manufacturing together as tradable goods and we take their output all together. The remaining categories given in the usual breakdown of the GDP - mining, public utilities, construction, distribution, transport, financial and business services, general services and government - make up the total for non-tradables. We compute price indices for tradables and non-tradables, based on weighted averages of the deflators (an index used to discount increases in the value of output which result entirely from increases in price) for each activity. This gives us four variables with which to summarise the national output and the value of that output - the volume and the price of tradables and the volume and price of non-tradables. Even with this level of compression we shall end up with a fairly complex system. Had we used each category of the usual GDP breakdown we would have defeated our original purpose (for Model 1) by including considerable sectoral detail.

The output of tradable goods will vary with the relationship between the pre-determined price of the product and the cost of production. Production costs include the costs of imported inputs; their prices are assumed to move in the same way as the prices of tradable goods, allowing us to use the price of tradable goods to represent both the product price and the price of inputs. Again this simplifies the model at some expense in terms of specificity. In later versions of the model we hope to determine how realistic this assumption is. Production costs also depend on the wages paid to labour. However, if each worker produces more output from one period to another (or the same amount with fewer hours of work) firms will be able to pay higher wages for given product prices. We therefore modify the wages index by a variable which measures the rate of output per worker (a kind of unit cost of labour measure) and use this to help explain the volume of tradable goods produced. A third factor which enters into the cost of production is the interest paid on borrowings for working capital. The first test in our model measures how these three factors influence the output of tradables. From it we expect to deduce how much the output of

tradables will change when there are changes in the price of tradables, wages (provided they are not offset by changes in output per worker) and interest rates on bank loans.

In the market for non-tradables we must first estimate how much people want to buy. The demand for non-tradables should depend on the level of national income and the price at which non-tradable goods are offered for sale. The demand will also depend on how much tradables cost; if non-tradables become very expensive some buyers will postpone or shelve expenditure on non-tradables and buy cheaper tradables instead. For example, it is quite plausible that, should the price of home-construction increase relative to the price of cars, a homeowner may put off extensions or modernisation of his house and replace his car instead.

Whether the full amount of non-tradables demanded at any price will in fact be forthcoming depends on the accuracy with which firms anticipate that demand and the speed with which they respond. We assume that firms make reasonably accurate forecasts of demand, but that it takes them some time to adjust their levels of production. They have a good notion of the amounts their customers will wish to purchase at each offer price; they compare these prices with their cost of production. They use the same three factors employed by firms in the tradable sector - imported materials, labour and bank finance (We would expect non-tradable firms to use these inputs in different proportions than tradable firms, giving a different relationship between factor prices and the price of the product). Bearing in mind this cost structure, non-tradable firms raise or lower production from the previous year's level to supply an amount that consumers seem willing to buy at a price which is remunerative to them.

The model tests adjustments in the market for non-tradables from the firm's point of view. The second test in the model describes the amount firms decide to produce, an amount which reflects the demand they expect. The demand is influenced by the level of national income and the relative prices of tradables and non-tradables, as described in the penultimate paragraph. The price at which that output will be offered will depend on the set of variables which determine the firm's cost - the price of inputs (by assumption, the same as the price of tradables), wages, output per worker and the cost of bank finance. This relationship provides the model's third test.

Taking these first three relationships together we find that, in order to determine prices and output we need to know values for the price of tradables, the wage rate, employment and bank loan rates. The price of tradables is exogenous, given to the country on world markets. The others will be explained by the rest of the model.

The levels of wages we observe results from bargains struck between employers and workers. We do not know which side has the greater bargaining strength, but we may be able to make

some inference by observing the outcomes of past negotiations. Employers' offers are conditioned by the price at which they can sell their product and the average output per worker. If prices are good and the workforce highly productive they can offer better wages than they otherwise might. Workers' wage demands are based on their current wages and the rate of inflation they expect over the life of their contracts. At the very least, they want to maintain their standard of living. Usually they hope to do rather better than that; whether they succeed depends on their bargaining strength. We assign a weight, a certain percentage of the total bargaining strength, to the factors that determine the employers' offer, with a weight equivalent to the remaining bargaining strength to the factors that guide workers' wage demand. We do not have to specify the values of these weights beforehand; we can infer them from the results of our fourth test, which measures the effects on wages of all the factors mentioned in this paragraph - product prices, expected prices and output per worker.

The level of employment may be regarded as an outcome of the model; it is one of the policy maker's principal interests. In addition, knowing the level of employment associated with a given output gives us a measure of output per worker, which feeds back in to the determination of the levels of output and price. This is a good example of the interdependence of the relationships embedded in the model. In order to obtain a consistent set of results in a model such as this we must determine the values of all its variables simultaneously. For this reason systems such as the one we are building are known as simultaneous equation systems.

Employment depends on the level of output. In general, if output increases we expect additional job creation, although the proportionate increase in jobs may be smaller than the proportionate increase in output, if there is any tendency for productivity to increase systematically over the years. Firms may have some discretion in the number of workers they employ to secure a given output. It may be possible to produce that output with a little less labour (and a more sophisticated piece of machinery) if the cost of labour is relatively high. To account for this possibility we check for a relationship (it should be an inverse one) between the wage rage - relative to the price level - and the level of employment. The fifth test is designed to produce estimates of the effects on employment of changes in output and changes in the wage-price ratio or the real wage.

Another objective of the model is to determine the extent of reserve depletion. Reserves increase when exports, tourist receipts, net capital inflows and miscellaneous foreign exchange receipts exceed imports of goods and services, including debt service payments. Exports and tourist receipts can be deduced from the output of tradeable goods, of which they comprise the overwhelming proportion. Capital inflows depend partly on government and partly on foreign investment in the private sector, including public utilities in a prominent role. These factors do not depend in a systematic way on any other variable appearing in Model 1; capital inflows are therefore regarded as exogeneous in this model. Miscellaneous receipts is a residual, an unpredictable hodge-podge which is not susceptible to any consistent explanation. We are left to provide an explanation for changes in imports. Demand for imports should increase as national income rises; we would expect relatively slower growth of imports if import prices (the same as the prices of other tradeables in Model 1) rise more quickly than do the

prices of non-tradeables. The sixth test in the model is for the relationship between imports, national income and the relative prices of tradeables and non-tradeables.

There remain two variables endogeneous to the system for which we have provided no explanation - loan interest rates and the rate of inflation expected by workers. The loan rate is set by commercial banks, subject, in recent years, to a ceiling imposed by the Central Bank. When the rate banks wish to charge hits that ceiling the loan rate becomes a policy variable. At other times the rate will depend on the flow of deposits to the banks, and the proportion that has to be set aside in reserves, as stipulated by the Central Bank. The supply of deposits in turn depends on the level of national income. (In some countries deposits vary with their interest yield; in Barbados this appears not to be the case. See Worrell and Prescod (1982) and Worrell (1983). If banks are short of liquid funds to lend they may have resort to the Central Bank's discount window or to loans from their overseas offices or correspondents. The costs of these borrowed funds also influence the loan rate. The test for influences on the loan rate includes as explanatory variables national income, the required reserve ratio, an appropriate interest rate chosen from the foreign financial market where banks most frequently borrow, and the Central Bank discount rate.

People base their expectations about inflation on recent experience, giving greatest weight to the price performance of the most recent year. Economists are still experimenting with models to describe the relationship between the expected price and what that price eventually turns out to be. For Model 1 we tried two descriptions, only the second of which is reported in this paper. First we arbitrarily assigned a weight of 2/3 to the most recent year and a weight of 1/3 to the previous year and used the geometric mean of the weighted values of prices in those two years as a measure of the expected price. The second method involved estimating the weights implicitly by substituting the prices of the previous two years for the expected price in the wages test.

A Summary Description ofthe Model

The model comprises a set of price-output relationships, a group of wage and employment relationships, balance of payments relationships and a financial relationship. The full system is represented graphically in Figure 2. It is set out in symbolic notation in Table 1.

Inside the box in the top left hand corner of figure 2 we have the price-output relationships, the first three in our description of the model. If we supply information about the prices of tradeable goods, the loan interest rate and the wage level, we may use this segment of the model to derive output and the price level. We check on world markets for the price of tradeables; loan rates and wages come to us from elsewhere in the model.

The next box contains the fourth and fifth relationship, for employment and wages. We supply the level of output just determined and prices from previous periods, now known from observation. Wages and employment are the outputs of this segment.

Information on output and prices, derived from the first box, becomes the input for the balance of payments segment of the model. These relationships tell us what demand for foreign exchange reserves will result from an anticipated level of income and prices.

Income and prices are also inputs to the finance relationship, along with an exogeneous variable (a foreign interest rate) and two policy variables (the discount rate and the reserve requirement.) From these the finance equation produces an estimate of the loan interest rate.

Figure 2

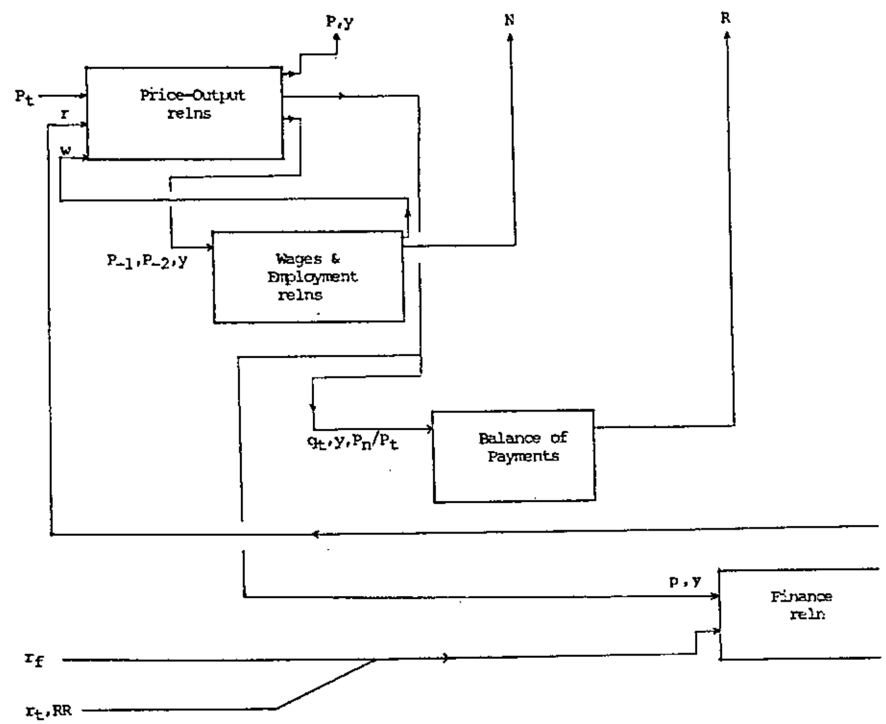


Table 1

The Econometric Model

Prices and Output

$$q_t = q_t, (\overset{+}{P_t},\ \overset{-}{WN/y},\ \overset{-}{r})$$

$$q_n = q_n\ (\overset{+}{y},\ \overset{-}{P_n/P_t},\ \overset{+}{q_n}(-1))$$

$$P_n = P_n(\overset{+}{q_n},\ \overset{+}{P_t},\ \overset{+}{WN}/y,\overset{+}{r})$$

Wages and Employment

$$W = W\ (P^e \overset{+}{\Delta y}/\Delta N,\ W_{-1}(1+P^e))$$

$$N = N\ (\overset{+}{y},\ W/\overset{-}{P},\ \overset{+}{N_{-1}})$$

Balance of Payments

$$m = m\ (\overset{+}{y},\ P_n/\overset{+}{P_t})$$

Finance

$$r = r\ (\overset{+}{Y},\ \overset{+}{r_f},\ \overset{+}{r_b},\ \overset{+}{RR})$$

Price Expectations

$$P^e = P^e\ (\overset{+}{P_{-1}},\ \overset{+}{P_{-2}})$$

Identities

$$P\ = aP_t + (1 - a)\ P_n$$

$$y\ = q_t + q_n$$

$$\Delta R = P_t\ (q_t - m) + K$$

$$Y\ = Py$$

Variable Names

K: net transactions on capital account and balance of payments financing

m: imports in 1980 values

N: employment

P: GDP deflator

P^e: expected value of the deflator

P_n: price index for non-tradables

P_t: price index for tradables

q_n: value of non-tradable output in 1980 values

q_t: tradable output in 1980 values

R: foreign exchange reserves

r: loan interest rate

R_b: Central Bank ordinary discount rate

R_f: interest rate on Eurodollar deposits in London

RR: reserve requirement ratio for commercial banks

W: index of wages

Y: GDP in current values

y GDP in 1980 values

Empirical Estimates

The estimated model, with the ordinary least squares (OLS) technique, is presented as table 1. Statistical theory suggests that the OLS estimator may not be appropriate for dealing with simultaneous equation systems but initial exploratory work with the two stage least squares (2SLS) technique suggests that the results will not change in such a way as to invalidate the main conclusions of the study.

The estimates of the factors influencing traded goods output suggest that the sector's supply increases wth rising prices of tradeables but does not respond to either rising finance costs or increased wage costs (equation 1). The coefficient of the latter two variables are not significantly different from zero. One may not conclude from this that exorbitant wage and interest rate increases will not depress output in the sector, but generally historical evidence over the reference period indicates that increases in these variables have not served to depress the output of tradeable goods.

The demand for non-tradeable goods seems extremely responsive to income but less so to changes in their prices relative to those of tradeables. The elasticity estimates suggest that any change in incomes causes a proportionate change in demand which is about 24% larger. Economic contraction may depress the non-tradeable sector quite rapidly while expansion may tend to strain productive capacity in the sector. However, a stabilization policy geared towards the manipulation of relative prices may entail significant costs. To reduce demand by one percent, relative prices must rise by about five percent.

The price at which non-tradeable goods are offered on the market respond, as expected, to increases in demand, increases in the price of tradeables and increases in wages above productivity gains (equation 2). All the three variables will tend to inflate the price of non-

Table 1 Estimates of the Equations of the Model

Results - Levels of Variables (t-statistics in brackets)

$$Q_t = 116.11 + 1.45P_t - 0.593WN/y - 2.895r \qquad (1)$$
(7.210) (3.332) (-0.278) (-1.043)

$R^2 = 0.826$ D-W = 0.92 SER = 21.95

$\bar{R}^2 = 0.801$ F-statistic = 33.22

$$Q_n = -59.304 + 0.852y - 0.011P_n/P_t + 0.149Q_{n-1} \qquad (2)$$
(-1.083) (8.332) (-2.061) (1.277)

$R^2 = 0.980$ D-W = 1.50 SER = 23.74

$\bar{R}^2 = 0.977$ F-statistics = 320.78

$$P_n = -35.628 + 0.077Q_n + 0.991P_t + 1.358WN/y - 1.59r \qquad (3)$$
(-9.210) (5.313) (7.408) (2.382) (1.712)

$R^2 = 0.975$ D-W = 2.40 SER = 8.14

$\bar{R}^2 = 0.980$ AR(1), rho = 0.08 F-statistics = 176.87

$$N = 36.911 + 0.035y - 21.839W/p + 0.584N_{-1} \qquad (4)$$
(2.687) (2.204) (-1.534) (3.471)

$R^2 = 0.759$ D-W = 2.08 SER = 4.716

$\bar{R}^2 = 0.723$ F-statistics = 21.00

$$M/P = -0.529 + 0.007y + 0.002P_n/P_t + 0.089r \qquad (5)$$
(-1.285) (3.881) (0.176) (1.086)

$R^2 = 0.898$ D-W = 1.69 SER = 0.553

$\bar{R}^2 = 0.884$ AR(1), rho = 0.42

$$r = -2.454 - 0.002Y + 0.122r_f + 0.976RR \qquad (6)$$
(-3.547) (-3.778) (1.466) (8.065)

$R^2 = 0.898$ D-W = 1.71 SER = 0.602

$\bar{R}^2 = 0.883$ F-statistics = 61.52

$$W = 57.73 - 6.944 \times 10^{-4}P^e dy/dn + 0.0039(W_{-1}(1 + P^e)) \qquad (7)$$
(1.975) (-0.193) (6.222)

$R^2 = 0.981$ D-W - 1.72 SER = 9.90

$\bar{R}^2 = 0.978$ AR(1), rho = 0.07 F-statistics = 291.39

$$P^e = -0.094 + 0.629P_{-1} + 0.375P_{-2} \qquad (8)$$
(-1.417) (117.51) (60.31)

$R^2 = 0.998$ D-W = 2.18 SER = 0.152

$\bar{R}^2 = 0.997$ F-statistics = 8.86

$$P = -20.888 + 1.511P_t - 0.036P_n \qquad (9)$$
(-3.032) (6.487) (-0.225)

$R^2 = 0.961$ D-W = 1.66 SER = 11.11

$\bar{R}^2 = 0.952$ AR(2), rho(1) = 0.54, rho(2) = -0.49

F-statistics = 109.7

tradeables. On the other hand, the interest rate variable does not carry the expected positive sign but the coefficient is not significantly different from zero. Our results indicate that a ten percent increase in the demand for the sector's output provokes more than five percent increase in prices. Of particular importance is the effect of changes in traded goods prices on the price of non-tradeables. We infer that a ten percent increase in the latter price evokes about the same increase in the former, a reflection of the very high proportion of imported inputs which are used directly in the production of non-tradeables.

Employment, as expected, rises with the growth of output, and hence of effective demand. The response is, however, very limited. It requires about ten percent increase in real output to evoke a two percent gain in employment. Therefore, relying strictly on gains in output to fight unemployment may not be an effective means to reduce unemployment. We cannot infer much from real wage increases on employment as the coefficient of the variable is not significantly different from zero.

Imports respond vigorously to changes in income, increasing by about 12 percent for a ten percent gain. However, neither relative prices nor interest rates appear to have measurable impact on the demand for imports (equation 5). The loan interest rate largely depends on the level of national income and the reserve requirement ratio. Foreign interest rates do not provide the expected major influence on domestic interest rates, perhaps because banks have been very sparing in their resort to overseas accommodation during periods of tight liquidity.

The results for the determination of wages (equation 7) indicate that concern with expected inflation is the main influence on the pattern of wage formation. Changes in the value of the average worker's output have no discernible impact on wages. Prices of the previous two periods appear to be the main determinants of current and hence the expected prices. Last period's prices provide about two-thirds of the influence compared to one-third by prices lagged

two periods.

According to equation (9), the price of tradeable goods appears to provide the mair influence on domestic prices, with, surprisingly, no measurable impact from the price of non-tradeables. This is not what one should expect in reality and we intend to have another look a1 that equation.

Simulation

Simulation is a technique for evaluating a model by comparing its predictions with wha actually happened. If we supply the model with exogenous and policy variables such as price for tradeable goods and the required reserve ratio the model will produce values for endogenou variables such as output and the overall price level. For the simulation we provide the values o all exogenous variables over the last twenty years and allow the model to generate values fo output, non-tradeables prices, wages, imports, loan interest rates, employment and foreig exchange reserves. We then compare these computed series with te values actually recorde for each variable. Forecasting involves the solution of the model for the endogenous variable beyond the period over which the model was estimated.

The summary statistics for the simulation (P-exogenous) is presented in table 2; tables and 4 report on the ex-ante forecast values for the endogenous variables from 1983-85. Judgin from these statistics, the model does reasonably well at tracking the endogenous variables Figures 1 through 18 provide evidence of the tracking performance of the model for the tw cases when the domestic price (P) is considered first as exogenous and then as endogenou Since in many instances the tracking pattern is simular in both cases, the discussion only deal with the case when P is exogenous.

The model is reasonably good at tracking the output of tradeables (QT) (see figures 1 and 10). Between 1964 and 1982 it maps the average growth rate of Qt quite accurately, although it misses most of the yearly fluctuations. It records the upswing in Qt between 1973 and 1980, too optimistically at first, but underestimates the actual gains in the last few years of that sub-period. The simulation also detects the 1981-83 downswing, though it does not register as severe a contraction as was actually witnessed.

The model accurately records the pattern of growth of non-tradeables (Qn) (figure 6). The simulated series accelerates and slows down in step with the actual, and declines when it declines. Many of the year-to-year fluctuations have been picked up. The growth pattern of the price of non-tradeables (Pn) has been correctly tracked by the model. Both the trends and yearly variations of the simulated pattern bear accurate resemblance to actual observations. There was litle inflation up to 1971, followed by strong inflationary pressures between 1972 and 1980, with a subsequent decline after 1981.

The broad pattern of the behavior of actual wages (figure 3) are correctly perceived but the model overestimates wages between 1964 and 1974 and underestimates them from 1974 onwards. Similarly the trends in the employment variable are generally perceived but the model consistently underestimates employment in the years before 1974 and also misses the period-to-period fluctuations after that year (see figure 4).

The interest rate simulation is also reasonably good, although the loan rate is underestimated between 1964 and 1969 and slightly overestimated between 1969 and 1975. The model appears to pick up the periodic changes of the variable after 1974 quite well (figure 9). Despite the import equation attracting the highest RMSQ error in the simulation, the predicted pattern duplicates the actual movement quite reasonably up to 1980. Thereafter the simulated values underestimate the recorded values.

From the forecast values (table 4) we infer that if prices of tradeable goods grow by about five percent per year, then the average growth rate (1982-88) of tradeable and non-tradeable goods are expected to be about six percent and two percent respectively, in real terms. That, in turn implies an annual average growth rate of real output of about three percent. Similarly prices of non-tradeables are expected to grow by 11%, nominal imports by 10% and nominal wages also by 10%. The above growth rates, especially those for tradeable goods, wages and imports appear too high, and so the assumed values for the exogenous variables may have to be altered.

Summary and Conclusions

In this paper an attempt has been made to explain the workings of the Barbados economy with a simple econometric model. The model relies on the product market instead of production function to explain real output determination. The economy has been divided into tradeable and non-tradeable goods sectors.

Real output in the tradeable sector is largely influenced by prices in the sector, while relative prices and real output are the main determinants in the non-traded sector. Real output also exerts the main influence in the determination of employment, real imports and domestic interest rates. The model has been estimated with annual data and the endogenous variables simulated through the historical period of the data. Also, forecast values for these endogenous variables over the period 1983-88 have been estimated.

Standard tools of statistical inference suggest that the independent variables generally give a good explanation of the dependent variables, and as such of the workings of the economy. However, it should be stressed that the work is basically exploratory and that some refinements in the data, estimating and forecasting techniques may be necessary in order to improve upon the model's tracking and forecasting performance.

Table 2.

Appendix

Ex-Post Simulation Statistics

(P - Exogenous)

	Av. Err.	Av. Abs. Err.	M. Sq. Err.	Rmsq.	Theil-u	Std. Err.
P^e	-.029	.079	.010	.099	.001	.095
r_d	.026	.544	.410	.641	.050	.640
Q_t	5.120	17.258	468.231	21.639	.520	21.024
W	4.431	24.649	805.214	28.376	.128	28.028
N	3.293	8.717	112.981	10.629	.058	10.106
P_n	-.970	7.379	172.522	13.135	.067	13.099
M	-13.620	46.485	4327.105	65.781	.053	64.355
Q_n	2.963	22.615	820.683	28.648	.028	28.494

Table 3.

Forecasting Results (1983-88)

P - Exogenous

Year	P^e	r_d	Q_t	W	N	P_n	M	Q_n
1982	177.026	8.750	222.640	243.200	96.900	120.300	1107.500	607.760
1983	200.084	6.506	273.182	246.590	98.253	174.877	1364.970	596.035
1984	215.507	6.282	282.730	263.769	99.162	184.889	1454.458	610.259
1985	225.567	5.859	293.256	288.364	99.404	195.950	1555.098	629.160
1986	236.409	6.291	301.850	321.946	98.655	206.293	1681.928	650.197
1987	248.228	6.063	312.743	367.427	96.581	218.102	1803.322	671.294
1988	260.649	6.502	322.396	428.813	92.793	229.525	1949.682	693.688

Table 4

Forecasting Results (1983-88)

P - Endogenous

Year	r_d	Q_t	P_n	P	Q_n	M	P^e	W	N
1982	7.577	262.551	163.407	165.794	604.275	1049.597	173.903	146.316	118.144
1983	6.506	273.182	174.839	175.057	595.545	1092.569	167.856	153.143	116.183
1984	6.282	282.730	184.883	184.822	610.190	1176.437	172.130	160.010	115.939
1985	5.859	293.256	195.949	195.004	629.150	1264.072	181.743	170.527	116.358
1986	6.291	301.850	206.293	205.817	650.195	1374.254	191.806	184.566	116.888
1987	6.063	312.743	218.102	217.031	671.295	1479.684	202.422	202.58[illegible]	117.185
1988	6.502	322.396	229.526	229.014	693.687	1607.866	213.526	225.410	117.057

Table 5

Forecasting - Expected Values of Exogenous Variables (1983-88)

Year	(a) Y \$m	(b) r_f (%)	(c) y (\$m)	(d) $\Delta y/\Delta w$ (\$000)	(e) s= WN/y	(f) P_t 1975=100)	(g) r_R (%)	(h) P (1975=100)
1982*	1804.2	13.11	830.5	13.225	28.379	127.4	11.75	208.3
1983	1816.1	12.50	830.5	0.048	31.368	133.8	10.75	218.7
1984	1894.7	11.75	850.4	9.950	32.787	140.5	10.75	228.5
1985	2091.2	11.00	871.7	10.143	34.263	147.5	10.75	239.9
1986	2250.7	10.75	893.5	10.381	35.800	154.9	11.50	251.9
1987	2422.3	11.25	915.8	10.136	37.420	162.6	11.50	264.5
1988	2606.8	11.00	938.7	10.409	39.100	170.8	12.25	277.7

Notes: *Actual values used for 1982.

a: Based on the definition Y = Py.

b: Random.

c: Assumes average 2.5% annual growth after 1983.

d: Calculated from definition, assuming approximately 2% annual growth rate for N.

e: Calculated from definition, where W is assumed to grow at 5% per year.

f: Assumes 5% average annual growth rate.

g: Random.

h: Assumes 5% average annual growth rate.

P EXOGENOUS
(EX - POST) SIMULATION

Figure 7

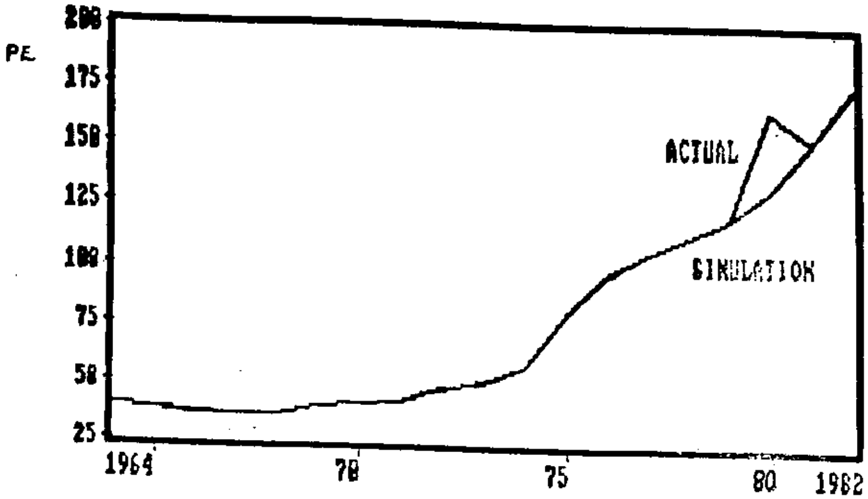


Figure 8

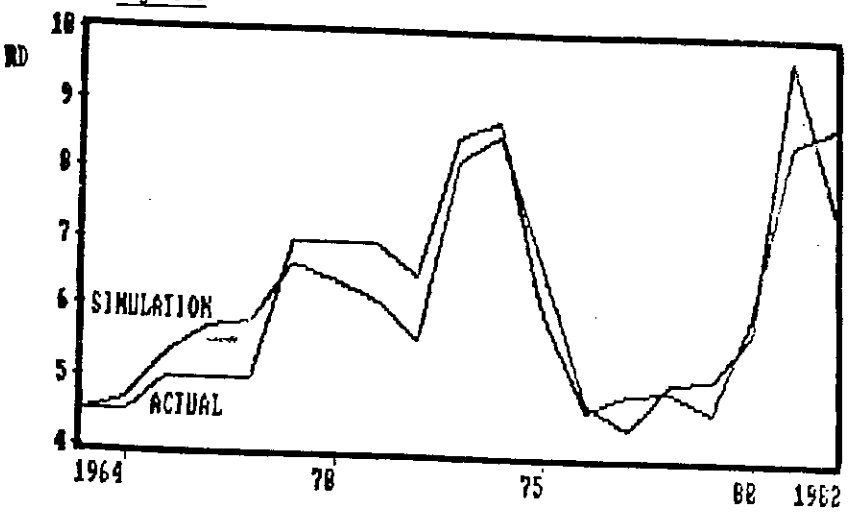


Figure 1

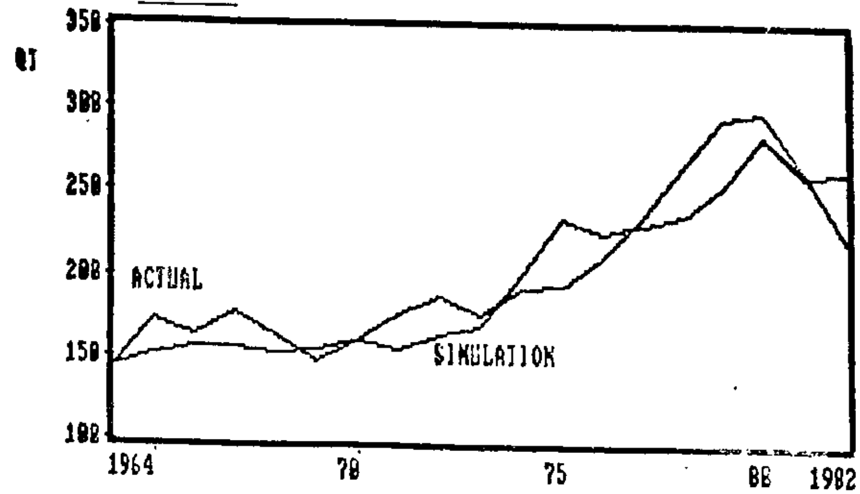


Figure 2

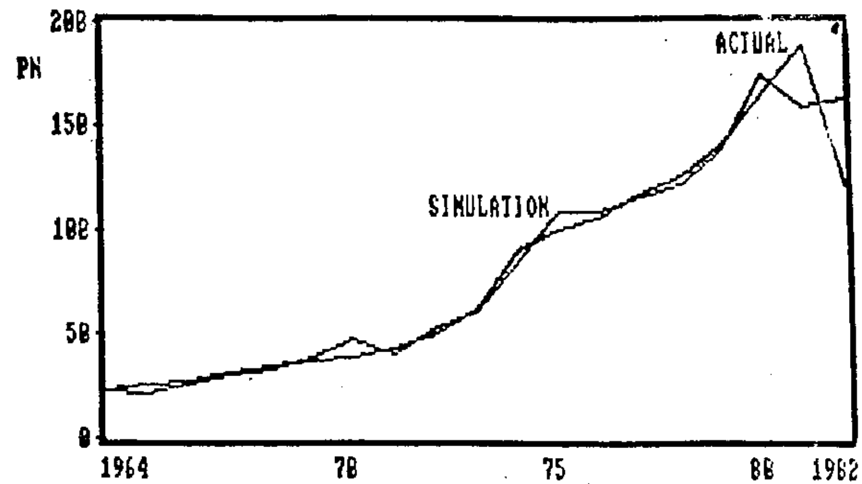
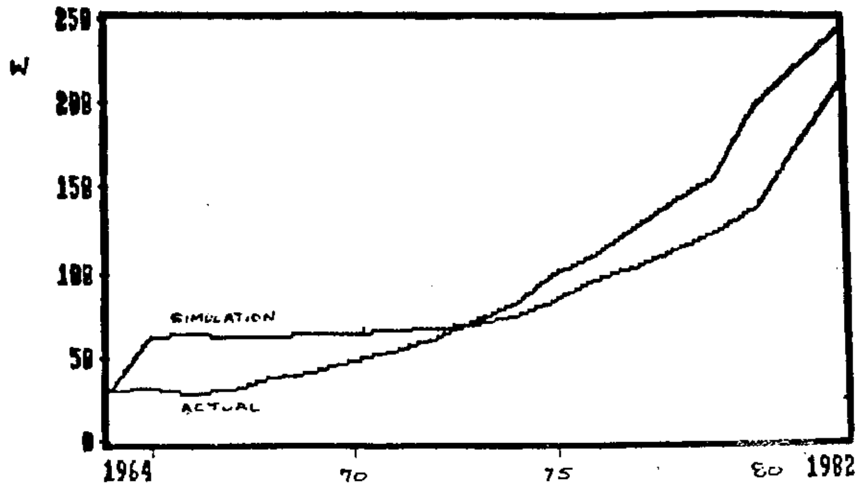


Figure 3



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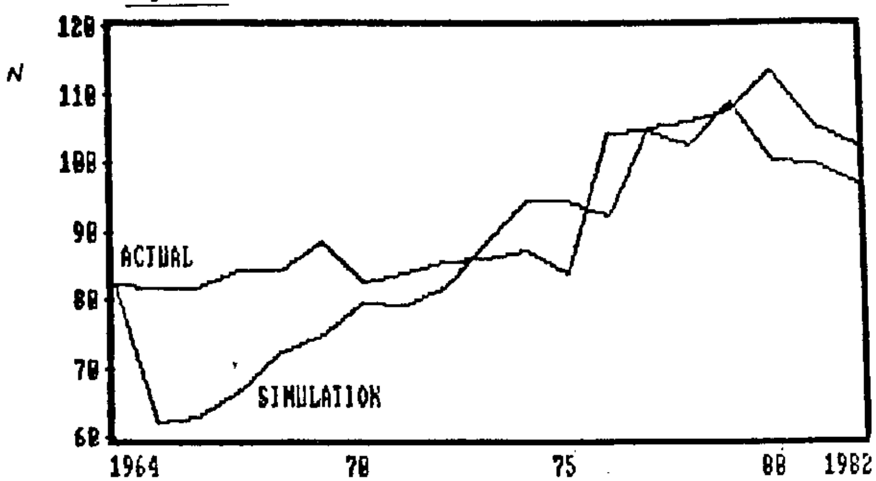

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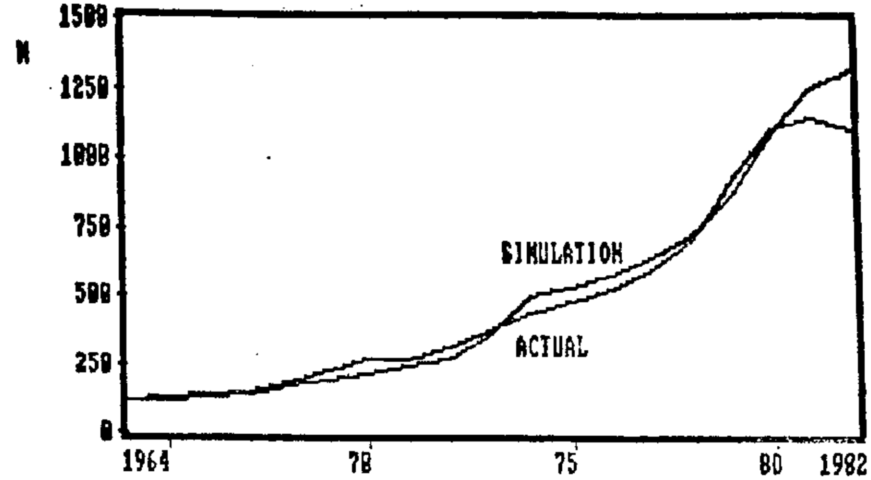

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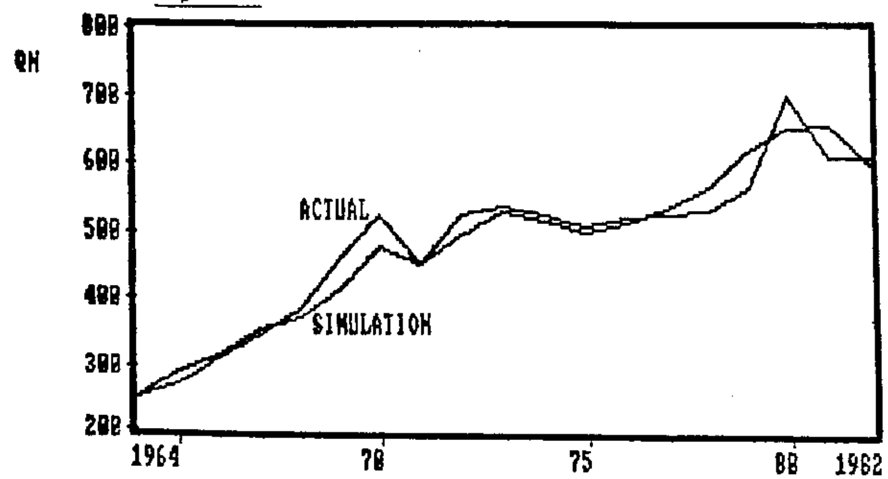


P ENDOGENOUS

(EX - POST SIMULATION)

Figure 9

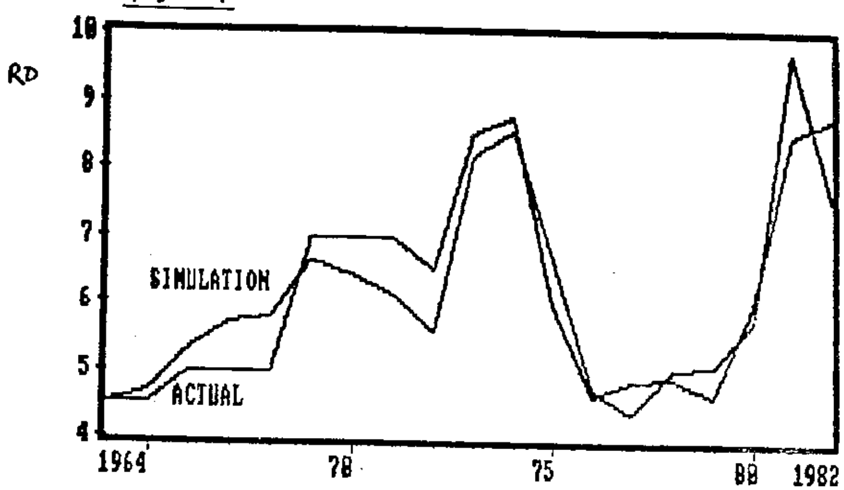


Figure 10

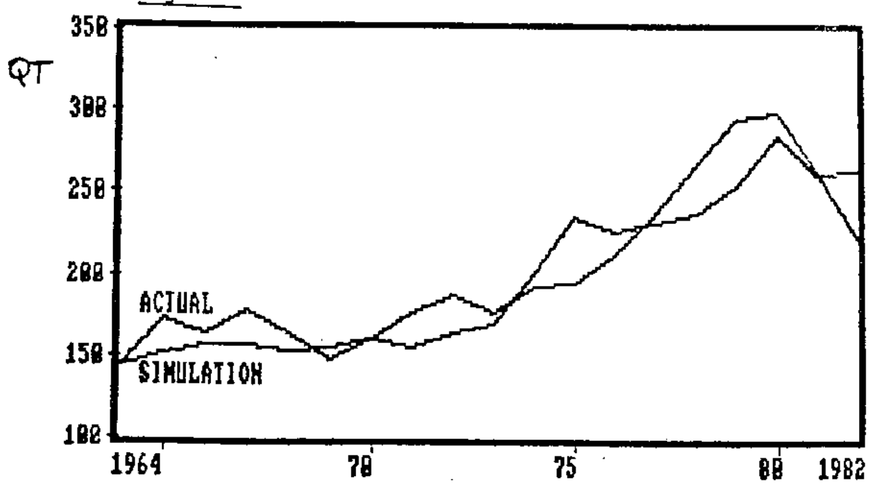


Figure 11

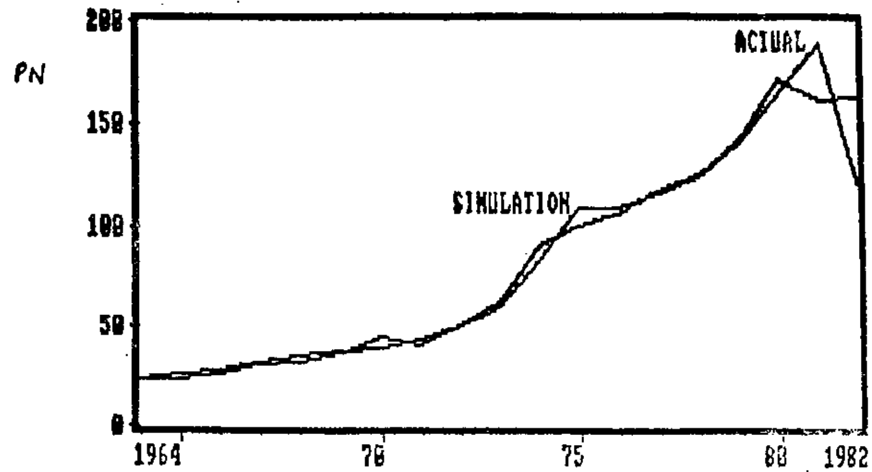


Figure 12

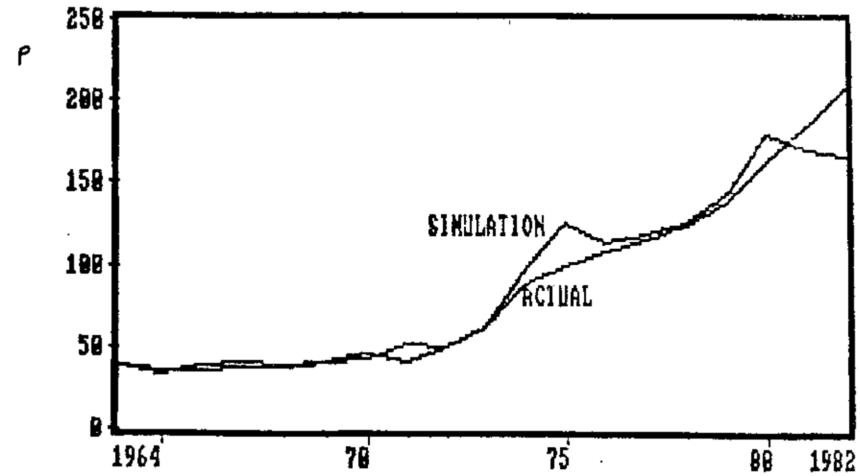


Figure 13

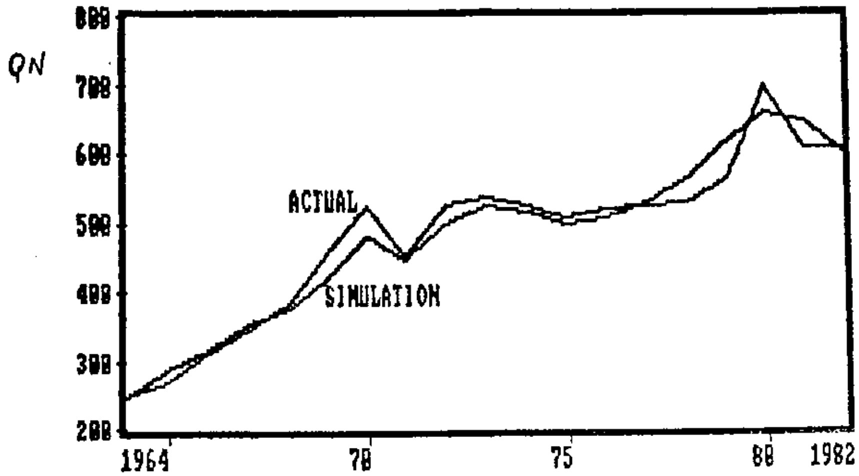


Figure 14

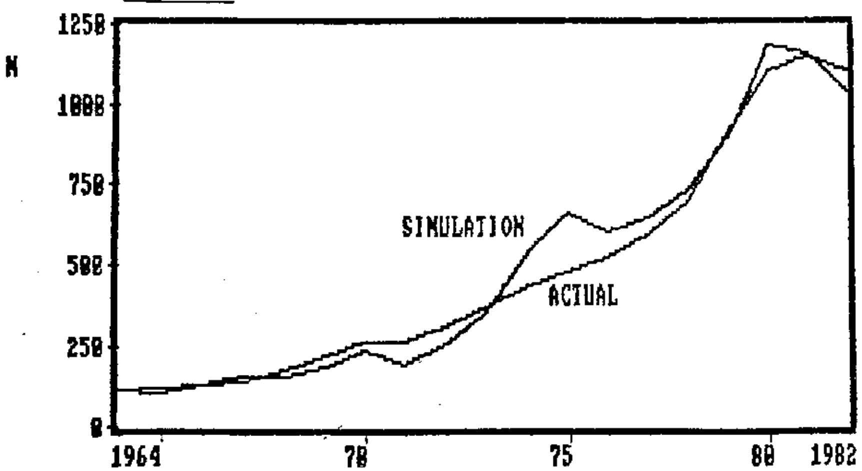


Figure 16

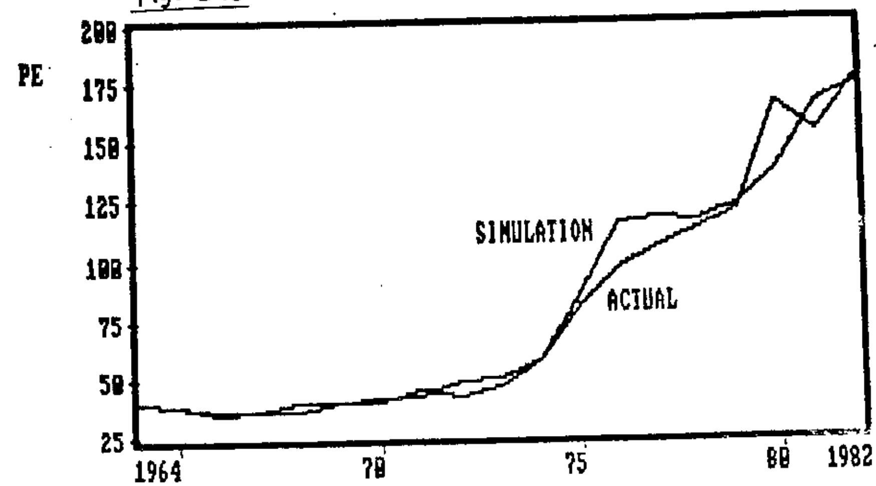


Figure 17

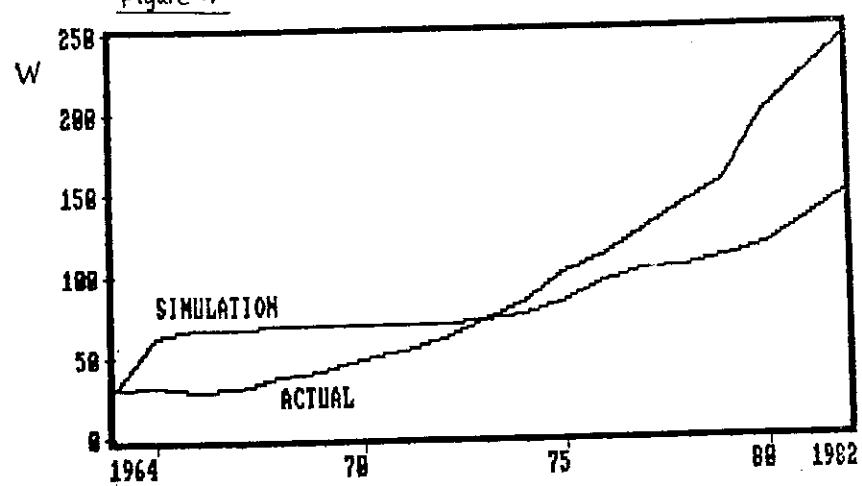
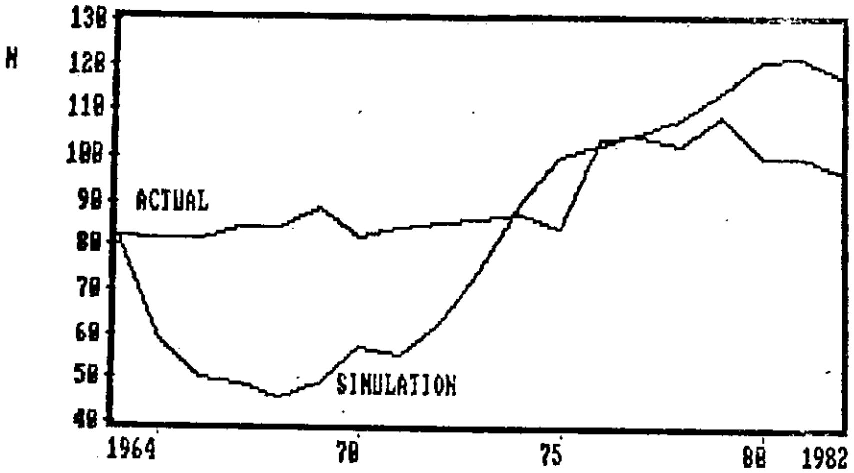


Figure 18



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