An Econometric Model for Short-Term Forecasting in Barbados

(An Interim Report)

by

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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

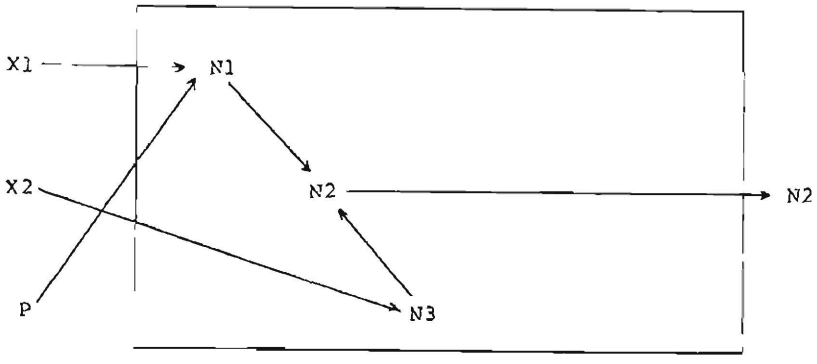
An economic model is a synopsis, in words or numbers, of economic activity, showing how one set of transactions influences another. A macroeconomic model does this for the economy as a whole, lumping many activities into broad categories such as imports, exports, interest rates, wages and credit, each 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 valu of variable number ten because of these (specified) consideration 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 croeconomic 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 Model 1 because it is only the first of what we envisage as a series of continually updated versions of a macro model for Barbados. Model 1 tries to incorporate all the insights we have gained so far in 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 pe 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 posibility we check for a relationship (it should be an inverse one) between the wage rate - 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 (what economists, who are overly fond of such euphemisms, like to call 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 tradable 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 tradables in Model 1) rise more quickly than do the prices of non-tradables. The sixth test in the model is for the relationship between imports, national income and the relative prices of tradables and non-tradables.

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 [1983] 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 first 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 of the 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.

Figure 2

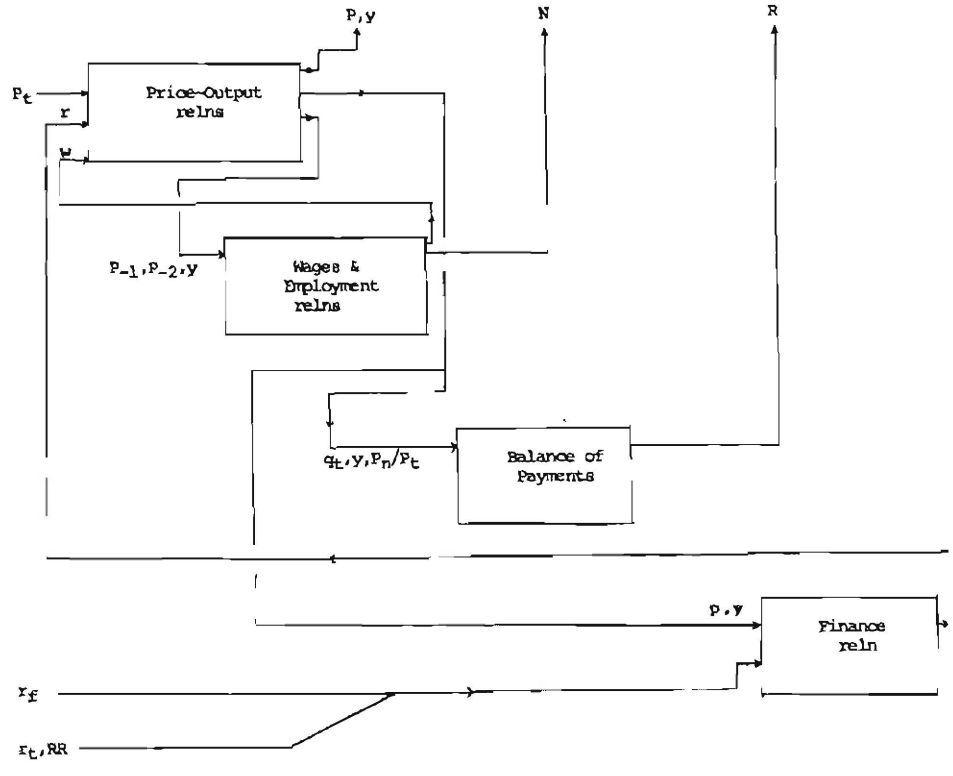


Table 1

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

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

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

Balance of Payments

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

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

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 tradable 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 tradables; 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.

The Significance of the Relationships

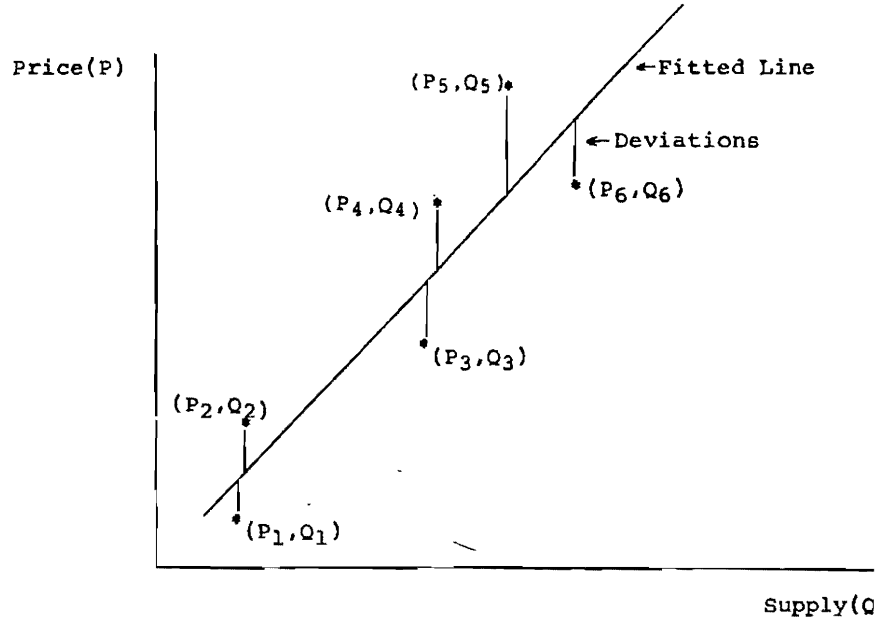
Our next step is to quantify the relationships. By how much does the supply of tradables increase if we raise the price of

tradables by ten percent? What effect will a one percent rise in the loan rate have on the price of non-tradables? To answer questions such as these we collect data on all the variables for the years 1958 to 1982 and test for association among them using the technique known as least squares.

For any pair of variables we believe to be associated we may plot all the values we have on a chart. The co-ordinates of each point on the chart are the values for variable number one (the price of tradables, for example) and variable two (the supply). We try to fit a straight line which comes as close as possible to all points plotted. To do this we take the distance between the plot and the corresponding point on a fitted line, square that number, and add up the squares computed at each point. We then chose the line which gives the smallest sum of squares. The technique is illustrated in Figure 3.

We have run two sets of tests, the first with the values of each variable and the second with the logarithms of those values. If we believe that a dollar has the same effect whether it was earned in 1958 or 1982 or that a change of ten points in price index has the same impact at all times we should place greater faith in the first set of results. However, it is more likely that proportionate changes will bear a constant relationship over time. A ten percent increase in income in 1982 may well raise the demand for imports by the same proportion as it did in 1958, although the dollar values in 1982 will far exceed those for 1958. Our observations on the results of the

Figure 3



test will therefore rely mainly on the logarithmic specifications; however, we comment on discrepancies between the results obtained from the two procedures whenever such discrepancies occur.

Our tests were conducted using the 'ordinary' least squares technique. Statistical theory suggests this is not an appropriate method for dealing with equation systems which must be solved simultaneously. In time we expect to move on to an alternative, the 'two stage' least squares technique. We have already carried out tests using the latter method and they indicate that our results will not change in such a way as to invalidate any of the conclusions which follows, although the measures of interaction among variables may be a litle different. However, the two stage technique requires us to select what are known as instrumental variables; the choice will affect our results. We have not yet fixed upon the appropriate choice of instrumental variables, so we base our initial report on the ordinary least squares results.

The results of the first test, for factors influencing the supply of tradable goods, indicate that supply increases with rising prices of tradables. The rate at which volume increases is a little under half the rate of price increase (Results of the tests are summarised in Table 2). Neither increased wages nor rising finance costs have inhibited supply; the values of the coefficients measuring the relationship between these variables and supply are not significantly different from zero. One may not conclude from this that exorbitant wage and interest increases will have no harmful effect, but it seems that, on the

Table 2

Significant Relationships*

Variable to be Explained	Variable Exercising Influence				Measures of the Quality of the Relationship		
	Name of Variable	Coefficient Measuring Influence			$\bar{R}^2$	D-W Statistic	SEE
		Mean Value	Range: Lowest to Highest**				
Output of tradable goods	Price of tradables	0.45	0.15 to 0.74		0.83	1.77	0.10
Output of non-tradables	Income	1.25	1.05 to 1.45		0.99	1.53	0.04
	Relative prices	-0.07	-0.09 to -0.06				
Price of non-tradables	Output of non-tradables	0.72	0.56 to 0.88		0.992	1.53	0.07
	Price of tradables	0.65	0.38 to 0.91				
	Unit labour costs	0.41	0.22 to 0.61				
Wages	Effect of expected inflation	0.19	-0.01 to 0.39		0.987	2.21	0.005
Employment	Income	0.17	-0.11 to 0.36		0.72	2.19	0.05
Imports	Income	1.53	1.49 to 1.57				
Loan Interest rate	Income	0.25	0.09 to 0.41		0.90	2.19	0.06
	Discount rate	0.30	0.19 to 0.41				
	Reserve requirement	-0.31	-0.43 to -0.19				

* Based on logarithmic relationships.

** Equivalent to two standard deviations on either side of the mean value; it is 95% probable that the 'true' value of the coefficient will lie in this range.

Notes: $\bar{R}^2$: the coefficient of determination, adjusted for degrees of freedom (a measure of the strength of the relationship: maximum value is unity)

D-W: the Durbin-Watson statistic, a measure of the quality of the relationship.

SEE: the standard error of the estimate, an alternative measure of the strength of the relationship.

whole, the patterns of change for these variables in the past twenty-three years has not served to depress the output of tradable goods.

The demand for non-tradable goods seems extremely responsive to income, but much less so to changes in their prices relative to those of tradables. Any change in income causes a proportionate change in demand which is 23% larger. Economic contraction will therefore serve to depress the non-tradable sector quite rapidly, while expansion will tend to strain productive capacity. However, the authorities will not make much headway if they try to stabilise the market for non-tradables by means of changes in relative prices; to reduce demand by one percent relative prices must rise by 14%.

The prices at which non-tradable goods are offered on the market respond as expected to increases in demand, increases in the price of tradables and excessive increases in wages (that is, wage increases which exceed productivity gains). They all inflate the price of non-tradables. In the short run of about a year prices will usually harden if demand strengthens. All firms expect they can permit themselves healthier margins without damaging sales (and the better run will use this ease to strengthen reserves or to invest in expansion or market consolidation). Our tests indicate that a ten percent increase in demand provokes a seven percent increase in prices. An increase of the same magnitude in the price of tradables goods has a similiar effect, a reflection of the very high proportion

of imported inputs which are used directly in the production of non-tradables or which, like fuel, are important costs of firms supplying services to other non-tradable producers. If wage increases exceed the growth in output per worker to the extent that unit labour costs rise ten percent, non-tradable prices will go up by four percent. In contrast to their effects on tradables, wages will affect the market for non-tradables in a significant way. The effects of the costs of finance are negligible.[1]

The results for the determination of wages 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 had no measurable effect on wages. Workers have not generally succeeded in keeping up with the rate of inflation as we believe they anticipate it. In general wages seem to have risen by only 20% of what workers would have wished for in order to fully offset the inflation they anticipated.

Employment rises with the growth of output, but very slowly. A ten percent rise in output secures only a two percent gain in employment. This suggests that unemployment will prove stubborn, resistant to quite handsome growth rates. Wage increases do not appear to cause any significant worker retrenchment, even if they exceed the rate of price increase. The coefficient of the wage-price ratio is not significantly different from zero. This evidence indicates that firms will not employ more workers, for a given level of output, if wages fall

relative to prices, nor will they lay off workers under the same circumstances if wages rise relative to prices. Wage increases may have an effect on unemployment, but only via the demand for the firm's product. If increased wages cause price increases which reduce the demand for local production then firms may retrench, cutting labour and output together.

Imports respond vigorously to changes in income, increasing by 15% for a 10% income gain. If a reasonable growth rate is to be sustained the tradable sector must make a major contribution, since it is the sector which produces a surplus of foreign exchange that can be used to finance the imports required to support income growth. Capital inflows, exogenous to this model, provide the other major source of finance for imports. A rise in the price of tradables relative to that of non-tradables has no measurable impact on import demand.

The cost of bank finance tends to rise with increases in income, suggesting that the demand for credit may grow more swiftly than the supply of deposits to the banks, in response to expansion of output. The Central Bank discount rate has also provoked changes in the banks' lending rate. The foreign interest rate has no significant effect, perhaps because banks have been very sparing in their resort to overseas accommodation during periods of tight liquidity. The Central Bank's reserve requirement remains something of an enigma. Our test indicates that loan rates tend to vary inversely with the level of required reserves.

What the Results Tell Us About Economic Adjustment

The results confirm Barbados' vulnerability to forces deriving from the performance of foreign economies, particularly those of our North American neighbours. The price of tradable goods is the highly influential channel through which such external forces reach the Barbadian economy. Increases in that price generate expansion in tradable output and, in the first instance, inflation in the price of non-tradables. Opposing forces act on the demand for non-tradables; the expansion of tradables creates income which tends to increase the demand, while rising prices depress it. The income effects are much the stronger, however, and output of non-tradables should expand. This process will create a little additional employment at the cost of some inflation. The balance of payments outcome remains ambiguous; the expansion of tradables should increase net foreign exchange earnings, but higher income levels will require more imports. The price of non-tradables may rise almost as quickly as does the price of tradables; tradable prices push up non-tradable prices directly by 65% of their own increase, and growing demand for tradables exerts additional inflationary force. The relative prices of tradables do not rise very much, therefore, and there will be little inducement for consumers to switch to non-tradables.

Foreign interest rates do not seem to matter; they have no effect on the domestic loan rate. In any case, neither production nor expenditure is at all sensitive to changes in the cost of bank finance. Interest rate policies, of whatever kind,

play little role in the adjustment of the economy; they have no detectable impact either on costs of production or on the demand for non-tradable goods.

The impotence of the cost of funds variable renders all monetary policies ineffective. The policies which appear explicitly in the model - the discount rate, the reserve requirement - do affect the loan rate, but its movement creates no further disturbance. Credit restrictions, which do not appear explicitly, will not influence overall performance either, again because of the loan rate's insignificance. Suppose that an increase in income creates new demand for credit but the Central Bank limits the total amount of credit available. Assume that this limit can be effectively applied and that firms and individuals will not sidestep the banking system in their attempts to secure the needed funds. The costs of the credit available should rise because of the excess demand. However, variations in the cost of borrowing never cause any alteration in production and spending decisions.[2]

Although we do not separate the government budget (in order to keep Model 1 as simple as possible) we may infer the effects of fiscal policy via the output of non-tradables, the cost of finance and the index of wages. Government accounts for about one-third of the output of tradables. Therefore, fiscal expansion which is associated with increased provision of government services - not all fiscal expansion is - raises the ouput of non-tradables. That will deflate the average prices of

non-tradables somewhat (it may be represented as a leftward shift in the schedule representing the supply price of non-tradables, the third relationship in the model), and may induce a further small increase in demand for non-tradables. However, the principal effects will be a deterioration in the balance of payments because of the newly created incomes.

If fiscal expansion creates no additional output we are likely to have only a transfer of income from one group of citizens to another. If the expansion is financed entirely out of new tax revenues it has no effect on prices or the balance of payments because our model assigns to all groups the same propensity to spend. The spending power gained by the transfer recipients will be equivalent to the spending power lost by taxpayers. If the government obtains additional financing from the local banking system loan rates will tend to rise. As we have seen, this has no effect on prices or output. If, as is probable, the Central Bank must increase its advances to government, the balance of payments will deteriorate because of the injection of new spending power, not matched by any increase in output or by any reduction in the ability to spend of other groups of citizens (This may be presented as a rightward shift in the demand for tradable goods - our second relationship - and in the demand for imports - relationship number six). We may expect inflation in tradable prices and a deterioration in the balance of payments.

An increase in wage rates in the civil service pushes up general wage levels in this model by about 25% of the percentage rise, because government accounts for about one-quarter of the employed. This will inflate the prices of non-tradables and cut back demand for them a little. The net result may be a small decline in output and an even smaller loss of jobs. There is no apparent reaction in the supply of tradables to changes in wages, as we have noticed previously.

Among the factors internal to the economy but not subject to official control which may affect overall performance are increases in the supply of tradables or non-tradables and large shifts in the wage structure. Substantial gains or losses in output which may come about through the introduction of new products (such as electronics assembly) or windfalls (as in sugar) raise income and cause disturbances to the balance of payments and the domestic price level. If an output gain occurs in the tradable sector the balance of payments should improve, depending on the net foreign exchange contribution of the expanding sector. Conversely, contraction in this sector is painful because of the associated foreign exchange shortage. Output gains in the non-tradable sector worsen the balance of payments - as in the case of fiscal expansion discussed above - and contraction in that sector serves to improve external payments. The inflationary impact is the same for gains of equivalent magnitude in the two sectors.

A wage increase drives up the supply price of non-tradable goods. That dampens the demand, and the system should settle where prices are somewhat higher and output somewhat lower in the non-tradable sector. There is no effect on the output of tradables. Although excessive wage increases may cause some contraction and loss of jobs, therefore, the effect will not be large for modest wage rises. A ten percent general wage increase in 1982, assuming there had been no gain in output per worker would have stimulated a four percent rise in the price of non-tradables and a similar increase in relative prices if tradable prices had remained unchanged. Demand for non-tradables would have declined 0.28% in response, implying a 0.2% fall in national income and resulting in a 0.04% fall in employment.

Simulation

Simulation is a technique for evaluating the model by compromising its predictions with what actually happened. If we supply the model with exogenous and policy variables such as prices for tradable goods and the required reserve ratio the model will produce values for endogenous variables such as output and the overall price level. For the simulation we provide the values of all exogenous variables over the last twenty years and allow the model to generate values for output, non-tradables prices, wages, imports, loan interest rates, employment and foreign exchange reserves. We then compare these computed series with the values actually recorded for each variable. The initial results have been quite disappointing, suggesting that we may

need to re-examine some of our ideas about how the economy works, unless we discover errors in the simulation itself.

The model is reasonably good at tracking the output of tradables - Q_t (see figure 4; the hats in this and subsequent charts denote values simulated by the model). Between 1964 and 1972 it maps the average growth rate of Q_t quite accurately, although it misses the year-to-year fluctuations. It records the upswing in Q_t between 1973 and 1980, too optimistically at first, but understating the actual gains in the last few years of that sub-period. The simulation also detects the 1981-83 downswing, though it didn't register as severe a contraction as we actually witnessed.

The model faithfully records the pattern of growth of non-tradables (Q_n) (see figure 5). The simulated series accelerates and slows down in step with the actual, and declines when it declines. However, the model grossly exaggerates the actual changes and overstates the overall level of Q_n.

The model appears to compensate by grossly understating the movements of the price of non-tradables (P_n). Trends seem t be correctly perceived - little inflation up to 1971, strong inflationary pressure between 1972 and 1981, abating after the latter year. But the magnitude of the variation recorded by the model bears no resemblance to our actual observations. As a result of the poor performace of P_n, the overall price index (P) turns out badly; it is simply a weighted average of P_n and P_t, which is exogenous.

The interest rate simulation is not much good up to 1973, but from 1974 onwards it comes reasonably close to the recorded series. In these years the model produces values for the loan rate (r) which are less than one point away from the actual, in most cases (Figure 9).

The model is not able to capture the movements in any of the remaining variables - imports, wages, employment and foreign exchange reserves. In the first three cases it expects very little change in contrast to what was actually obtained. On the other hand, the model predicts changes in foreign exchange reserves which are far greater than anything the economy produced. The simulation in these areas is being checked; if it holds up we will have to return to the drawing board with this segment of the model.

Tentative Implications for Growth and Stabilisation Policies

Tentatively unemployment appears to be an intractable problem. Even quite respectable rates of growth produce only modest labour absorption. We should not expect any dramatic shifts in the direction of greater labour input per unit of additional output. The country has moved beyond the stage of low-skilled labour intensive production technologies. The 'reservation' wage - the lowest wage a worker considers reasonable for a day of unskilled labour - is now at a level where firms employing large numbers of unskilled workers using simple tools can no longer sell at competitive prices. If anything, the rate of labour absorption may tend to fall as

firms' technology becomes more productive, allowing one man to produce greater output with the assistance of more versatile and more powerful tools. Part of the growth of the labour force may be absorbed into own-account activity - one-person vending stations, transportation services owned and operated by one person, specialists such as craftsmen, divers and artists. However, it seems inevitable that emigration will play an important role in the country's future development. Since the avenues for unskilled migrants have dwindled to almost nothing, Barbados must produce an increasing number of graduates of all levels of schooling who boast skills that are in demand at home and abroad.

The purposes for which government spends seems to be more important than the way in which the fiscal deficit is financed. The effects of fiscal policy depend critically on whether new government spending is used to provide additional public services, to fund transfers of income or to increase wages of civil servants. The public sector borrowing requirement will have serious implications for the balance of payments only if it exceeds the credit available from the banking system and if it finances expenditure on wages and transfers.

Monetary policy does not have much of a role to play, because interest rates do not cause any noticeable changes in what firms decide to produce or in what individuals wish to buy. The monetary authorities may be tempted to control credit directly. The model is not designed to tell us anything about

selective credit controls, of the kind employed by the Central Bank of Barbados. However, we may expect that global credit controls will create incentives to circumvent the banking system, because they limit banks' ability to supply credit without reducing the demand for credit by firms and individuals.

Footnotes

1. This conclusion holds if we assume that equi-proportionate changes have consistent effects (ie. we use the logarithmic results). However, if we use levels instead of logs, interest rate increases do appear to drive up the prices of non-tradables. We suspect this may have been the case in earlier years (which have a disproportionately large influence on these results) but because it did not persist throughout the period of analysis the effect did not show up in the logarithmic results. For measuring influences which have persisted to the present the logarithmic results are to be preferred.

2. This indicates that the system has some other means of adjusting to a shortage of finance - possibly a combination of economies in the use of the available credit and additional use of non-bank financial intermediaries. If the credit restrictions do not bite too deeply, borrowers may get by with lower levels of liquidity - smaller deposit balances and lower average overdrafts. If the restrictions become more burdensome we may expect heavier resort to direct financing (deposits with firms, partnerships and equity-type arrangements) and non-bank financing (credit unions, insurance companies, informal co-operative arrangements and personal money lenders).

Appendix A - Estimating the Model

The results based on the logarithmic specifications, give acceptable explanations of the workings of the Barbados economy; only one equation (representing the labour market) failed to explain more than 80% of the variance of the dependent variable, and its coefficient of determination was an acceptable 0.72%. Two of the seven equations have Durbin-Watson statistics that are in the ambiguous area; the remainder show no evidence of serial correlation by this test.

The output of tradable goods (equation 1) is significantly determined by the price of tradable goods. A ten percent increase in the price of tradable goods causes output to expand by 4.5%. Although the other explanatory variables (wages and interest rates) carry the correct sign, they are both insignificant. This would imply that the cost factors (labour and finance) have little, if any influence, on the production of tradable goods. Any effects may become apparent in the long run.

The demand for non-tradable goods (equation 2) is highly sensitive to the level of income and relative prices but is unresponsive to the cost of finance. The elasticity is just over unity; a ten percent increase in real income results in a 12.5% increase in the demand for non-tradable goods. However, a similar increase in the relative prices causes a one percent decline in demand. The sensitivity to relative prices, although

rather small provides scope for expenditure switching policies. Monetary policy may be impotent since interest rates do not significantly affect the demand for non-tradables.

The price of non-tradables is significantly determined by the output of non-tradables, the price of imported inputs and the level of wages corrected for output per man. Interest rates have no measurable influence. The results of equation 3 suggests that a ten percent increase in non-tradable output, tradable prices and wages lead respectively to increases of 7.2%, 6.5% and 4.1% in the level of non-tradable prices. Wages are determined by last period's wages corrected for price expectations while the demand for labour depends on the level of real income and employment the period before.

Income growth is accompanied by an increase demand for imports (equation 6) and therefore leads to increased pressure on the level of foreign exchange.

The loan interest rate (equation 7) largely depends on the level of national income, the Central Bank discount rate and the reserve requirements. Foreign interest rates are not influential. This phenomenon may be due to the impact that this rate has on the discount rate, ie. its effect may be captured in the discount rate. The results indicate that ten percent increases in income and the discount rate raise the loan interest rate by 2.5% and 3%, respectively. A similar increase in the reserve requirement ratio reduces the loan interest rate by three percent.

Conclusion

Using the conventional descriptive statistics (R^2, Durbin-Watson test, standard error of regression), we accept that the independent variables give a good explanation of the dependent variables and as such of the workings of the economy. However, we must emphasise that this is the initial work and some refinement may be necessary, especially in the labour and wages section. We will also need to address our thought to some 'perverse' results, e.g. the effect of the reserve ratio on the loan interest rates.

Appendix A - Table 1

Estimates of the Equations of the Model

Results Using Levels of Variables

(1) $Q_t = 119.998 + 1.511P_t - 0.7217WN/y - 2.6206r$

(5.45) (3.33) (-0.33) (-0.82)

$R^2 = 0.82$ D-W = 0.98 SER = 22.48

$\bar{R}^2 = 0.79$ LOL = -111.11

(2) $Q_n = -128.536 + 0.7214y - 0.0032P_n/P_t + 0.1441Q_{n-1}$

(-4.25) (8.64) (-3.97) (1.35)

$R^2 = 0.99$ D-W = 1.61 SER = 17.17

$\bar{R}^2 = 0.99$ LOL = -99.48

(3) $P_n = -58.924 + 0.048Q_n + 0.455P_t + 4.7WN/y + 3.314r$

(-11.48) (3.87 (4.64) (10.94) (4.17)

$R^2 = 0.996$ D-W = 1.53 SER = 4.19

$\bar{R}^2 = 0.995$ LOL = 57.01

(4) $N = 34.72 + 0.033y - 21.408W/p + 0.617N_{-1}$

(1.56) (1.73) (-1.30) (2.22)

$R^2 = 0.76$ D-W = 1.99 SER = 5.11

$\bar{R}^2 = 0.68$ LOL = -66.70

(5) $M/P_t = -1.991 + 0.009y + 0.003P_n/P_t + 0.138r$

(-1.66) (5.65) (0.69) (1.18)

$R^2 = 0.95$ D-W = 1.6 SER = 0.57

$\bar{R}^2 = 0.95$ P = 0.41 LOL = -17.92

(6) $r = 5.501 - 0.002Y + 0.436\ r_f + 0.224\ r_b - 0.0008\ RR$

(10.94) (-1.12) (3.65) (3.30) (0.01)

$R^2 = 0.82$ D-W = 1.05 SER = 0.89

$\bar{R}^2 = 0.78$ LOL = -29.84

Results Using Logs of Variables

(1) $LQ_t = 3.848 + 0.4509\ LP_t - 0.0114LWN/y - 0.2018Lr$

(6.61) (2.96) (-0.09) (-0.94)

$R^2 = 0.86$ D-W = 1.8 SER = 0.89

$R^2 = 0.83$ RHO = 0.45 LOL = 24.65

(2) $LQ_n = -2.25 + 1.23Ly - 0.05L(P_n/P_t) + 0.145LQ_{n-1}$

(-6.05) (12.14) (-2.36) (1.77)

$R^2 = 0.99$ D-W = 1.73 SER = 0.04

$R^2 = 0.99$ RHO = 0.40 LOL = 45.22

(3) $LP_n = -4.31 + 0.722LQ_{ny} + 0.65LP_t + 0.411LWN/y + 0.182Lr$

(-13.27) (9.07) (4.89) (4.23) (1.48)

$R^2 = 0.99$ D-W = 1.50 SER = 0.07

$R^2 = 0.99$ LOL = 28.62

(4) $LW = 2.184 - 0.0019LP^e dy/dn + 0.1913L(W_{-1}(1 + P^e))$

(0.61) (-1.07) (1.91)

$R^2 = 0.99$ D-W = 2.2 SER = 0.09

$R^2 = 0.99$ RHO = 0.95 LOL = 24.12

(5) $LN = 0.411 + 0.1729Ly - 0.1753L(W/p) + 0.6618LN_{-1}$

(0.55) (1.88) (-1.22) (4.29)

$R^2 = 0.75$ D-W = 2.19 SER = 0.05

$R^2 = 0.72$ LOL = 39.46

(6) $LM/P_t = -8.022 + 1.528Ly - 0.024LP_n/P_t$

$(-9.27) \quad (8.02) \quad (-0.47)$

$R^2 = 0.93$ D-W = 1.63 SER = 0.14

$\bar{R}^2 = 0.93$ LOL = 14.64

(7) $Lr = 0.662 + 0.247LY + 0.051Lr_f + 0.303Lr_b - 0.311LRR$

$(2.13) \quad (3.22) \quad (0.62) \quad (5.47) \quad (-5.20)$

$R^2 = 0.92$ D-W = 2.19 SER = 0.06

$\bar{R}^2 = 0.90$ RHO = 0.3 LOL = 36.24

Appendix A

Data Used in the Tests

Year	Y ($m)	r_f (%)	r_b (%)	p^e	ΔR ($m)	ΔK ($m)	r_d (%)	y ($m)	P^e	Δy/ΔN ($000)	WN/y
1958	98.4	2.64					2.0	332.2		n.a.	5.285
1959	104.1	3.87					3.0	408.1		69.000	4.462
1960	119.8	4.18					5.0	332.0		761.011	6.605
1961	128.7	3.58		0.082			5.0	325.0	35.795	2.800	6.650
1962	134.2	3.77		0.087			4.5	325.4	38.925	-0.999	7.493
1963	152.9	3.95		0.039			4.0	381.3	40.928	-139.749	6.599
1964	150.0	4.32		-0.001	7.0	9.1	4.5	389.6	40.365	27.666	6.419
1965	158.2	4.81		-0.033	5.1	10.6	4.5	441.9	39.026	-130.875	6.019
1966	169.6	6.12		-0.060	-2.1	18.5	5.0	475.8	36.678	-338.505	4.710
1967	189.2	5.46		-0.020	10.5	16.5	5.0	520.2	35.933	17.077	4.818
1968	216.7	6.36		0.022	48.2	18.5	5.0	547.6	36.729	11.417	5.987
1969	235.3	9.76		0.079	-42.9	24.4	7.0	606.6	39.656	26.819	5.922
1970	273.5	8.52		0.029	-24.9	26.5	7.0	683.7	40.799	-12.239	5.784
1971	298.4	6.58		0.025	13.7	36.3	7.0	629.2	41.826	-36.333	7.040
1972	257.0	5.46		0.148	-1.0	34.2	6.5	710.4	48.017	47.764	7.229
1973	452.1	9.24		0.049	-25.6	43.0	8.5	731.6	50.364	42.399	8.273
1974	640.4	11.01	10.5	0.143	7.9	28.0	8.75	715.5	57.586	-16.099	9.884

Data Used in the Tests

Year	Y ($m)	r_f (%)	r_b (%)	p^e	ΔR ($m)	K ($m)	r_d (%)	y ($m)	p^e	ΔY/ΔN ($000)	WN/y
1975	700.6	6.99	7.5	0.373	34.9	56.7	6.0	700.6	79.106	4.656	11.975
1976	768.0	5.58	6.0	0.218	-36.0	50.0	4.63	730.3	96.369	1.470	15.679
1977	874.6	6.00	6.0	0.916	29.2	59.9	4.83	757.3	105.199	54.000	17.307
1978	980.3	8.73	6.0	0.073	58.3	84.0	4.88	793.1	112.909	-17.899	18.382
1979	1,189.7	11.96	6.0	0.070	18.1	17.0	4.63	856.4	120.839	9.890	19.753
1980	1,530.1	14.36	7.0	0.106	25.1	100.2	6.0	897.5	133.657	-4.724	22.139
1981	17.7.2	16.51	22.0	0.156	-48.9	242.6	8.5	871.4	154.441	86.999	25.488
1982	1,804.2	13.11	20.0	0.146	65.9	95.6	8.75	830.4	177.026	13.225	28.379
1983						131.6					

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Data Used in the Tests

Year	qt (1975 prices)	P_t (1975=100)	W 1975=100)	N (000)	r (%)	q_n (1975 prices)	P_n (1975=100)	P (1975=100)	M ($m)
1958	134.358	40.0	20.9	84.0	4.5	197.841	15.5	35.1	72.8
1959	158.752	40.0	21.4	85.1	5.5	249.348	18.1	32.1	73.6
1960	137.649	38.2	25.8	85.0	7.0	194.350	19.0	37.8	83.2
1961	142.683	34.6	26.2	82.5	7.5	182.317	19.0	39.5	80.6
1962	134.746	36.4	29.7	82.1	7.0	190.654	19.8	40.9	81.9
1963	157.009	43.6	30.8	81.7	6.5	224.290	21.5	40.1	89.6
1964	143.845	40.0	30.5	82.0	7.0	245.756	22.4	38.5	114.6
1965	172.304	36.4	32.6	81.6	7.0	269.646	25.8	35.8	123.4
1966	163.398	40.0	27.5	81.5	7.5	312.401	26.7	36.0	133.9
1967	177.144	41.8	29.8	84.1	8.0	343.056	31.9	37.1	144.6
1968	163.398	40.0	37.9	86.5	8.0	384.201	34.5	41.0	180.1
1969	147.716	41.8	40.5	88.7	8.5	458.883	37.0	40.7	218.6
1970	161.075	45.4	48.0	82.4	8.5	522.624	38.8	42.4	265.5
1971	176.950	41.8	52.8	83.9	8.5	452.249	42.2	51.1	266.5
1972	186.049	47.3	60.0	85.6	8.0	524.350	50.0	50.0	306.0
1973	175.729	56.4	70.3	86.1	10.5	535.870	61.3	61.8	376.7
1974	192.826	80.0	81.2	87.1	11.0	522.674	89.7	89.5	434.9
1975	193.600	100.0	100.0	83.9	9.75	507.000	100.0	100.0	480.6

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Data Used in the Tests Cont'd

Year	$q_t = q$ (1975 prices)	P_t (1975=100)	W (1975=100)	N (000)	r (%)	q_n (1975 prices)	P_n (1975=100)	P (1975=100)	M ($m)
1976	212.572	90.9	110.0	104.1	8.0	517.727	105.2	107.9	524.8
1977	235.998	94.6	125.3	104.6	7.75	521.301	116.4	115.5	596.4
1978	267.168	100.0	142.1	102.6	8.25	525.932	125.0	123.6	699.8
1979	294.853	112.7	155.2	109.0	8.25	561.547	140.5	138.9	925.5
1980	299.112	136.4	198.1	100.3	9.25	598.388	164.8	162.8	1,111.5
1981	263.489	130.1	222.1	100.0	13.50	607.910	188.9	184.6	1,148.1
1982	222.640	127.4	243.2	96.9	11.75	607.760	120.3	208.3	1,107.5
1983		133.8			10.75				

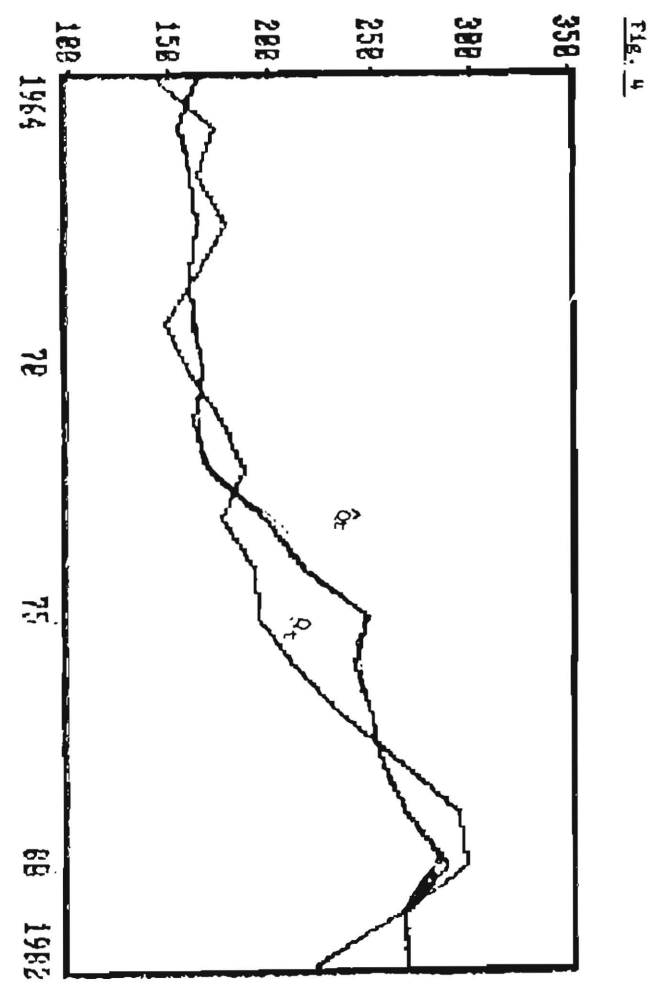

Fig. 4

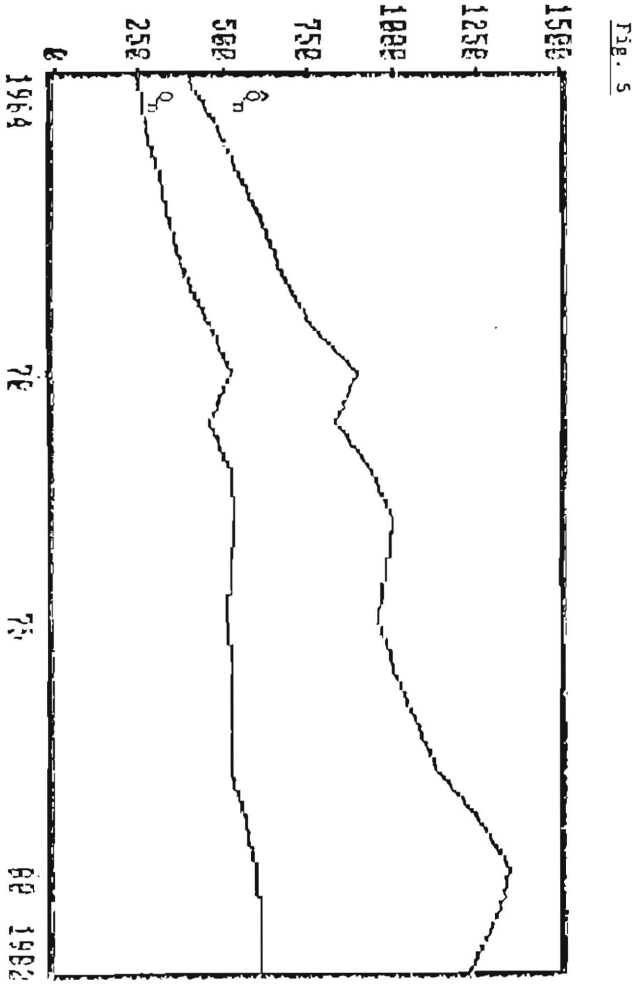

Fig. 5

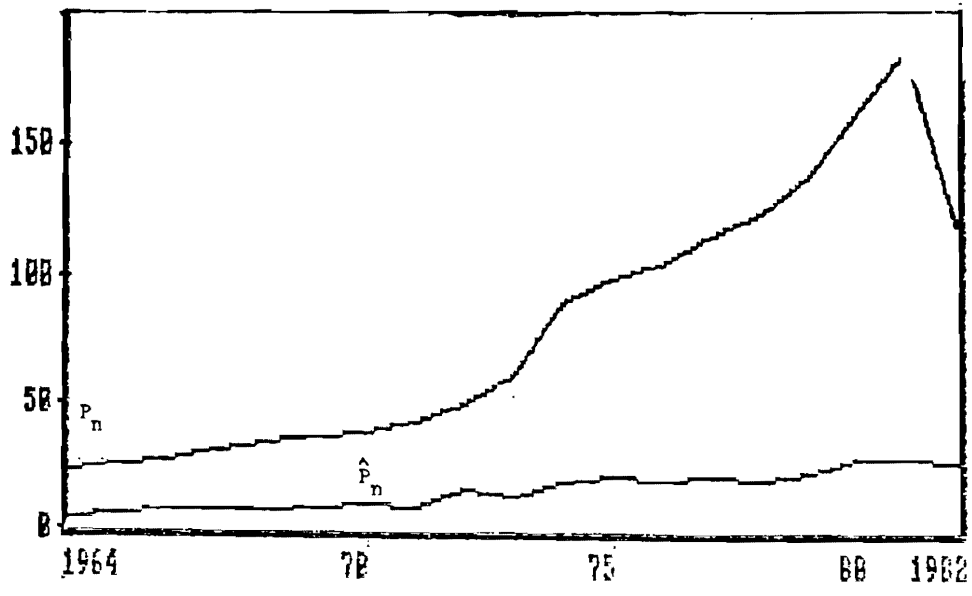

Fig. 8

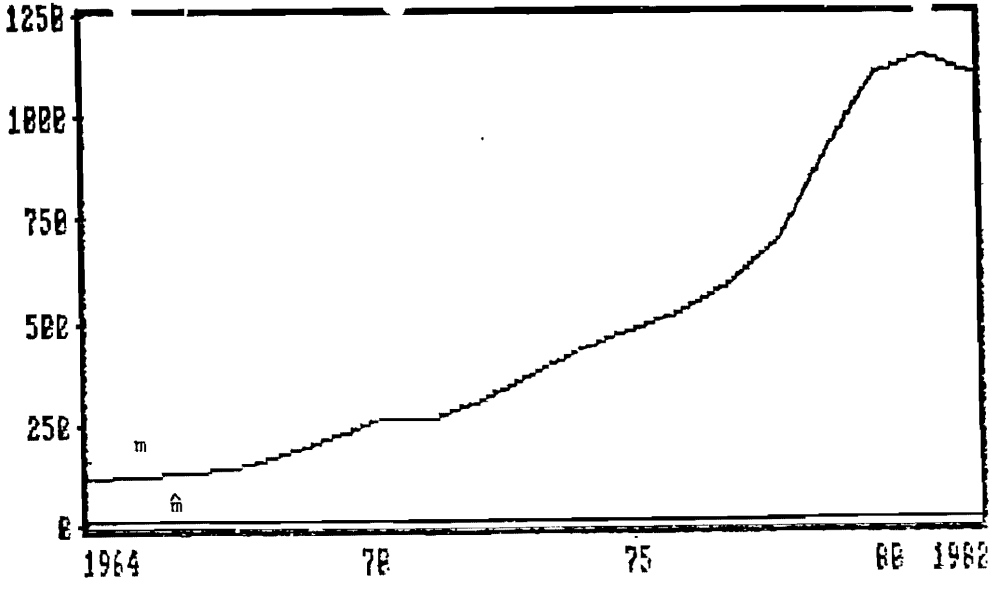

Fig. 7

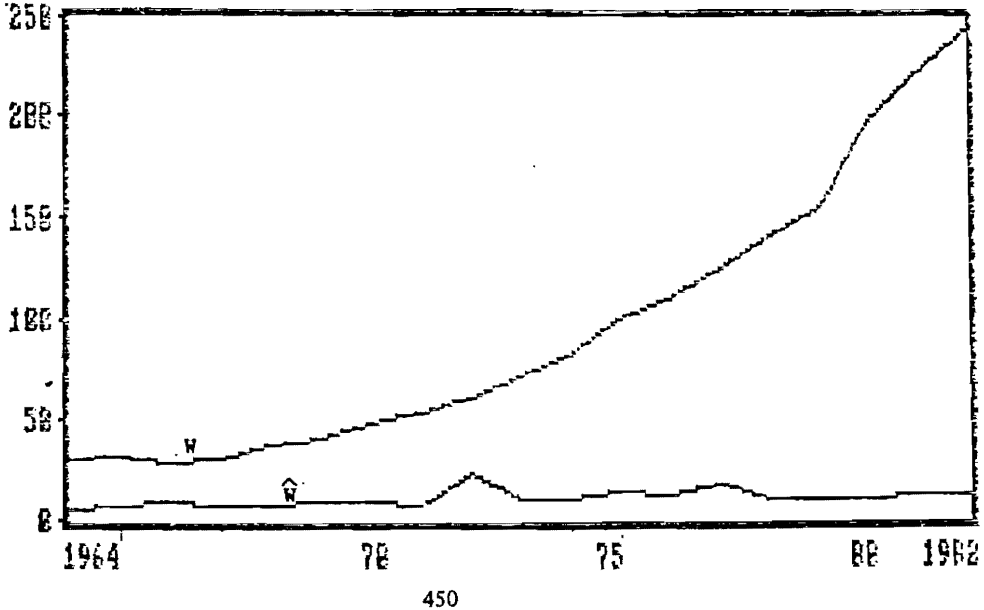

Fig. 9